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The future of sustainable agriculture: Integrating plant biology, microbiomes and emerging technologies

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Keynote abstract

Agriculture stands at a critical crossroads. The world must produce more food, feed and fiber for a growing population while simultaneously addressing climate change, soil degradation, declining biodiversity, water scarcity, resource limitations, emerging pests and diseases, and increasing environmental concerns associated with intensive agricultural production. Conventional approaches that rely heavily on external inputs have contributed substantially to global food production, but their long-term sustainability is increasingly challenged by diminishing resource-use efficiency, soil and environmental degradation, and climate-related uncertainties. The future of agriculture therefore requires a transition towards production systems that are biologically informed, resource-efficient, climate-resilient, economically viable and environmentally sustainable. At the centre of this transformation lies plant science, increasingly integrated with microbiome research, soil biology, biotechnology and rapidly advancing digital technologies. Plants do not function as isolated organisms; rather, they exist as complex biological systems in continuous interaction with microorganisms and their surrounding environment. The plant-associated microbiome, including microorganisms inhabiting the rhizosphere, rhizoplane, endosphere and phyllosphere, plays fundamental roles in plant nutrition, growth, development, stress adaptation and disease resistance. Beneficial microorganisms can improve nutrient acquisition, stimulate plant growth, enhance root development, regulate plant hormonal pathways, improve tolerance to drought, salinity and temperature stress, suppress plant pathogens and contribute to the maintenance of soil health. Understanding these complex plant-microbe interactions is therefore essential for developing the next generation of sustainable agricultural technologies. The scientific understanding of plant-associated microorganisms has progressed considerably from the use of individual microbial strains towards more complex and functionally diverse microbial communities. Plant growth-promoting bacteria, beneficial fungi, rhizobacteria, endophytes and microbial biofertilizers have demonstrated considerable potential for improving crop productivity and reducing dependence on synthetic fertilizers and pesticides. However, inconsistent performance under field conditions remains one of the major barriers to their widespread adoption. Differences in soil properties, climate, crop genotype, indigenous microbial communities and agricultural management can strongly influence the effectiveness of introduced microorganisms. Future research must therefore move beyond the simple identification of individual beneficial microbes towards a systems-level understanding of microbial communities and their interactions with plants, soils and environmental conditions.

An important emerging direction is the development of microbial consortia and rationally designed synthetic microbial communities (SynComs). Rather than depending on a single microorganism, carefully selected combinations of microorganisms may provide complementary functions related to nutrient mobilization, biological nitrogen fixation, phytohormone production, pathogen suppression and stress tolerance. Advances in microbial ecology, genomics and systems biology are creating new opportunities to identify functional microbial communities and understand the mechanisms underlying their interactions. Nevertheless, successful development of microbial products requires attention to formulation, compatibility, stability, biosafety, quality control, shelf life, field establishment and scalability. Bridging the gap between laboratory discoveries and reliable field performance will remain a major research and technological challenge. At the same time, rapid developments in genomics, transcriptomics, metabolomics, microbiome profiling and bioinformatics are transforming our ability to investigate plant and microbial systems. High-throughput sequencing and molecular approaches can reveal the composition and functional potential of plant-associated microbial communities, while advanced analytical tools can help identify relationships among plant genotypes, microorganisms, soil properties and environmental stresses. These technologies provide an opportunity to move from descriptive studies towards predictive understanding of plant-microbiome interactions. Such knowledge can ultimately support the development of crop-specific and environment-specific biological solutions for sustainable agriculture.

The integration of biological knowledge with spectroscopy, remote sensing, advanced sensors, imaging technologies, artificial intelligence (AI) and machine learning (ML) represents another major frontier. Modern sensing technologies can generate large amounts of information about plant physiological status, nutrient deficiencies, water stress, disease development and environmental conditions without extensive destructive sampling. Spectroscopic techniques, for example, offer opportunities for rapid and non-destructive assessment of plant and soil properties. When combined with machine learning and other data-driven approaches, these technologies can facilitate early detection of stress, prediction of crop responses and development of precision management strategies. The integration

of biological measurements with digital information can therefore contribute to more efficient use of water, fertilizers, pesticides, energy and other agricultural resources. The future of sustainable agriculture will consequently depend not on a single technology or discipline, but on the integration of multiple levels of biological and technological knowledge. Plant genotypes, plant physiology, microbiome composition, soil characteristics, environmental conditions and management practices must increasingly be considered as interconnected components of an agricultural system. This system's approach can help explain why a biological technology that performs well under controlled laboratory conditions may show variable results in farmers' fields. It can also provide a foundation for developing location-specific and crop-specific interventions that are better adapted to real agricultural environments. The next stage will require stronger collaboration among plant scientists, microbiologists, soil scientists, geneticists, biotechnologists, agronomists, data scientists, engineers and agricultural practitioners.

Climate change further reinforces the need for this integrated approach. Rising temperatures, irregular rainfall, drought, salinity, flooding and the changing distribution of pests and diseases are already affecting agricultural productivity in many regions. Developing climate-resilient crops and resilient plant-microbiome systems will therefore become increasingly important. Beneficial microorganisms may contribute to plant adaptation by improving nutrient acquisition, modifying root architecture, regulating physiological responses and enhancing tolerance to environmental stresses. However, the effectiveness of such biological approaches must be evaluated within realistic environmental and farming conditions. Combining microbiome-based interventions with stress-tolerant varieties, precision management and predictive digital technologies could provide more robust solutions than any individual intervention. Against this background, the keynote proposes an integrated "Plant-Microbiome-Soil-Technology Framework" for the future of sustainable agriculture. The framework places the plant at the centre of a dynamic biological system while recognizing the critical contributions of microorganisms, soil processes, environmental factors and emerging technologies. At the biological level, it emphasizes plant physiology, genetics, plant-microbe interactions and microbiome functions. At the technological level, it integrates genomics, microbiome profiling, spectroscopy, sensing, artificial intelligence, machine learning and precision agriculture. At the application level, it focuses on improved nutrient-use efficiency, climate resilience, soil health, sustainable crop productivity and reduced environmental impacts.

Ultimately, the transition towards sustainable agriculture will require a shift from input-intensive agriculture to knowledge-intensive, biology-driven and technology-enabled agriculture. The convergence of plant biology, microbiome science and emerging technologies offers an unprecedented opportunity to understand agricultural systems more deeply and manage them more intelligently. By integrating fundamental biological discoveries with advanced analytical and digital tools, it will be possible to develop innovative solutions that are productive, resilient, resource-efficient and environmentally responsible. The future of agriculture will therefore not be defined simply by producing more, but by producing better, using fewer resources and working more intelligently with biological systems. The challenge before the scientific community is to transform this growing body of knowledge into reliable, affordable and scalable innovations that can benefit farmers, consumers and the environment.

Keywords: sustainable agriculture, plant biology, plant-microbe interactions, plant microbiomes, plant growth-promoting microorganisms, microbiome engineering; climate-resilient agriculture, precision agriculture

Integrating plant biotechnology and nanotechnology for sustainable plant health

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Invited abstract

The increasing incidence and complexity of biotic and abiotic stresses pose major challenges to sustainable crop production and global plant health. Addressing these challenges requires integrated strategies that combine sensitive and rapid diagnosis, molecular characterization of pathogens, epidemiological understanding, and environmentally responsible disease-management approaches. Plant biotechnology and nanotechnology offer complementary tools for strengthening these components of integrated plant-health management. In this study we explore the integration of plant biotechnology and nanotechnology, using plant virology as a central case study. The biotechnology component focuses on molecular approaches for the detection, identification, genetic characterization, and diversity analysis of plant viruses, with particular emphasis on begomoviruses and their associated whitefly vectors. Molecular and epidemiological

approaches provide critical insights into virus diversity, host–virus interactions, vector-mediated transmission, disease distribution, and patterns of pathogen emergence and spread. Such information is essential for understanding disease epidemiology and developing evidence-based management strategies. The study further examines the emerging role of nanotechnology in plant disease management, with particular emphasis on biologically synthesized nanoparticles and their potential applications against diverse phytopathogens, including viruses, bacteria, fungi, and nematodes. Selected examples will illustrate how nano-enabled approaches may interfere with pathogen infection and development, enhance plant defense responses, and potentially reduce dependence on conventional chemical inputs. By integrating molecular diagnostics and epidemiological knowledge with emerging nano-enabled disease-management strategies, this study highlights the potential of interdisciplinary approaches to improve the precision, efficiency, and sustainability of plant-health management. Such integration can contribute to the development of resilient crop-production systems capable of responding to evolving pathogen pressures and environmental stresses while supporting more sustainable agricultural practices.

Keywords: Pant biotechnology, nanotechnology, plant viruses, begomoviruses, whitefly vectors, molecular diagnostics, biologically synthesized nanoparticles, sustainable disease management

Effects of silver nanoparticle-mediated seed priming on germination performance and seedling quality of asparagus (*Asparagus officinalis* L.)

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Abstract

Asparagus (*Asparagus officinalis* L.) is a perennial vegetable of the family Asparagaceae, with considerable economic and medicinal importance worldwide. Commercial asparagus production is often hindered by slow, low, and asynchronous seed germination, which limits the efficient production of vigorous and uniform seedlings for subsequent field establishment. The silver nanoparticles (AgNPs) priming method has proven to be a beneficial pre-sowing treatment to ensure uniform, rapid germination and enhance seedling quality. Therefore, the current study was conducted to evaluate the effect of AgNPs on the seed germination and seedling quality of asparagus. Seeds were primed with AgNPs solutions (0, 1, 2, and 4 mM) for 12 h and subsequently evaluated under laboratory conditions using a Completely Randomized Design. Primed seedlings were transplanted to the field to observe seedling growth and quality using a Randomized Complete Block Design with 4 replications. AgNPs seed priming significantly improved germination and subsequent seedling performance, with the most pronounced responses observed at 2 mM AgNPs. At this concentration, seedling weight, seedling length, plant height, stem girth, number of branches, chlorophyll content, and carotenoid content were superior to those recorded under the other treatments. The 2 mM AgNPs also markedly enhanced secondary metabolite accumulation, as reflected by increased total flavonoid content and total phenolics, along with elevated activities of the antioxidant enzymes superoxide dismutase and catalase, including an improved antioxidant defense response. The 1 and 4 mM treatments with AgNPs were found to have different effects on germination, morphological traits, biochemical characteristics, metabolic activity, and oxidative stress response as compared to the control. Based on these findings, a 2 mM concentration could be an effective seed priming treatment for promoting germination and early seedling growth in asparagus.

Keywords: Silver nanoparticles, germination, asparagus, seedling quality, seed priming

Influence of nano-urea and conventional nitrogen fertilization on growth, physiological traits and yield of rice (*Oryza sativa* L.)

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Abstract

Conventional urea is the primary nitrogen source in rice cultivation, but low nitrogen-use efficiency can result in nutrient losses and environmental concerns. Nano-urea may improve nitrogen-use efficiency and reduce such losses. However, its combined use with conventional urea remains insufficiently studied. A field experiment was conducted

from December 2023 to April 2024 at the research field of the Department of Agricultural Chemistry, Sylhet Agricultural University, Bangladesh, to evaluate the effects of combined nano-urea and conventional urea application on rice growth, physiological traits, yield components, and profitability. Among the treatments, T6, comprising 50% of the recommended fertilizer dose (RDF) as basal guti urea (81.7 kg ha^{-1}) with two foliar applications of nano-urea (1.5 ml L^{-1}), showed the best overall performance. T6 produced the highest leaf number per hill, biomass accumulation, effective tiller number, chlorophyll b content, DPPH radical-scavenging activity, and crude fiber content. It also recorded the highest number of filled and total grains per panicle, thousand-seed weight, grain yield, and benefit-cost ratio. These results indicate that integrating nano-urea with reduced conventional urea improves physiological performance, yield formation, and economic returns in rice. Thus, the combined application of nano-urea at an optimal dose of 1.5 ml L^{-1} with guti urea may provide an efficient and cost-effective nitrogen management strategy for rice production. However, multi-location and long-term studies are required to validate these findings and assess the agronomic, economic, and environmental implications of nano-urea based nitrogen management under diverse field conditions.

Keywords: Nano-urea, nitrogen efficiency, rice growth, productivity, economic profitability

Cloud-connected catalytic GPS sensor tracking on biodiversity health to cause digital disease leading to fatalities

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Abstract

Advanced sensor technologies provide powerful tools for biodiversity monitoring but may also introduce ecological and physiological risks when improperly deployed. This study developed the ISNAPHO (Impact of Sensor Networks on Animals, Plants, Humans, and Objects) framework as a non-invasive approach for assessing physiological and environmental responses to sensor-based monitoring. A four-year longitudinal investigation (2014–2018) was conducted at the Institute of Biodiversity and Environmental Conservation (IBEC), Universiti Malaysia Sarawak (UNIMAS), involving 21 subjects comprising seven tropical plant species, seven domestic cats (*Felis catus*), and seven domestic dogs (*Canis lupus familiaris*). Photoreceptor- and magnetoreceptor-associated responses were monitored at designated GPS locations, while signal intensity, microenvironmental conditions, biophotonic outputs, thermal variation, and physiological responses were recorded over 48 months. Data were analyzed using the ISNAPHO framework to evaluate stress responses, structural stability, and response variability. The framework demonstrated applicability across all 21 subjects and identified species-specific variations in physiological and environmental responses. Plant specimens exhibited changes in physiological energy distribution and transpiration dynamics during sensor exposure, whereas animal subjects showed associations between environmental fluctuations and localized thermal responses. Canine subjects demonstrated greater responsiveness to external stimuli than feline subjects. The diagnostic metrics showed high long-term reproducibility (>92%) across the investigated species. However, claims regarding respiratory obstruction, “digital disease,” digital eradication, and sensor-induced ecological fires require independent experimental verification and should not be interpreted as established biological effects without controlled evidence. Overall, the ISNAPHO framework provides a potentially useful basis for integrated, non-invasive biodiversity monitoring and early detection of physiological stress. Further research should incorporate controlled exposure experiments, standardized protocols, independent physiological measurements, and appropriate controls, with validation extended to wild rainforest species and broader Southeast Asian ecosystems.

Keywords: ISNAPHO effect, biodiversity conservation, sensor networks, bio-signals, ecological monitoring

Nanotechnology in sustainable agriculture: opportunities, benefits, challenges and future strategies

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Abstract

Nanotechnology is an emerging scientific field involving the manipulation and application of materials at the nanoscale, generally within the range of 1–100 nm. Its unique physicochemical properties, particularly high surface-area-to-volume ratio, increased reactivity and enhanced nutrient or active-ingredient delivery, have created new opportunities for improving agricultural productivity and resource-use efficiency. Nanotechnology in Agriculture identify nano-fertilizers, nano-pesticides, nano-sensors, nano-carriers, seed treatments, soil and water remediation, and post-harvest packaging as major areas of agricultural application. Particular attention is given to nano-urea because it is among the most commercially advanced nano-fertilizer technologies. The reviewed evidence shows that nano-urea may improve nitrogen-use efficiency and, under appropriate conditions, permit partial reduction of conventional urea while maintaining crop yield. Bangladesh studies provide examples from rice and mustard and report promising results from urea-nanohydroxyapatite formulations, foliar liquid nano-urea, integrated conventional urea plus nano-urea management, and optimized spray timing. For example, one pot experiment reported nitrogen-use efficiency of about 71% with 75% co-precipitation nano-urea compared with about 36% for conventional urea, while a multi-location study found that 66% recommended prilled urea plus foliar nano-urea could produce yields comparable with full recommended urea at several locations. Another study reported 9.3 t ha⁻¹ grain yield with 50% conventional urea plus 50% nano-urea and the remaining recommended fertilizers. It was also found from a study on mustard that 50% replacement of N by nano urea was the best foliar feeding practice for higher yield contributing characters and yield of mustard. However, the evidence is not uniform. Responses vary with formulation, crop, dose, timing, soil, agro-ecological conditions and experimental scale. The materials also emphasize uncertainties concerning nanoparticle fate, non-target effects, food-chain exposure, regulation, production cost and long-term soil health. Therefore, nanotechnology should be considered as a component of integrated and precision nutrient management rather than a universal replacement for conventional fertilizers. Future strategies should prioritize long-term, multi-season and multi-location field trials; standardized assessment of nitrogen-use efficiency and yield; nitrogen-loss and greenhouse-gas measurements; economic evaluation; and farmer adoption research. Such an evidence-based approach is necessary to realize the potential benefits of nanotechnology while minimizing environmental and food-safety risks.

Keywords: Nanotechnology, nano urea, crop productivity, sustainable agriculture

Effects of foliar spray of nano fertilizers on the growth and yield of rice (*Oryza sativa*)

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Abstract

Rice (*Oryza sativa*) is one of the most important cereal crops and plays a vital role in global food security. To enhance rice productivity sustainably, nano-fertilizers have emerged as an advanced nutrient delivery system that improves nutrient use efficiency while reducing environmental impacts. This study was conducted to evaluate the effects of nano-fertilizers on the growth, photosynthetic pigments, and yield performance of rice at the research field and laboratory of the Department of Agroforestry and Environmental Science, Sylhet Agricultural University, Sylhet. The experiment was laid out in a Completely Randomized Design (CRD) with three replications. The treatments included control (recommended dose of fertilizer, RFD), RFD with plant growth regulator (PGR), nano urea with RFD except urea with or without PGR, and nano DAP with RFD except DAP with or without PGR. Results revealed that foliar application of nano-fertilizers significantly improved crop performance compared to the control. At 60 days after sowing, tillers hill⁻¹ increased from 7.00 in the control to 33.33 in nano urea + RFD + PGR treatment. Panicle number, filled grains, total grains, and 1000-grain weight were also markedly higher under nano-fertilizer treatments, particularly nano DAP + RFD + PGR and nano urea + RFD + PGR. Photosynthetic pigments, including chlorophyll a, chlorophyll b, and carotenoids, were highest under nano DAP combined with PGR. Overall, the integration of nano-fertilizers with conventional fertilization enhanced rice growth, pigment concentration, and yield potential, indicating that nano-based nutrient management is a promising strategy for sustainable rice production.

Keywords: Nano-fertilizers, nano urea, photosynthetic pigments, grain yield

Isolation and characterization of silicon nanoparticles (Si-NPs) derived from rice husk

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Abstract

Rice husk, a major agricultural by-product generated in large quantities in Bangladesh, is commonly disposed of through open burning or uncontrolled accumulation, contributing to environmental pollution and resource loss. Because rice husk contains substantial amounts of silica, it offers a promising and locally available feedstock for producing value-added silica nanomaterials. This study aimed to develop a low-cost synthesis route for silica nanoparticles (Si-NPs) from rice husk ash (RHA) and characterize the resulting material in terms of its structural, morphological, elemental, surface, and thermal properties. Rice husk was washed with distilled water, air-dried, and combusted at 900°C for 5 h to produce RHA. A 30 g portion of RHA was refluxed with 500 mL of 3 M NaOH at 90°C for 4 h to produce sodium silicate. Silica was subsequently precipitated by dropwise addition of concentrated H₂SO₄. The precipitate was centrifuged at 5,000 rpm for 15 min and washed repeatedly for seven cycles until the supernatant reached pH 6.67, followed by drying at 105°C for 8 h and high-energy ball milling to obtain the final Si-NP powder. FTIR spectroscopy revealed characteristic Si–O–Si asymmetric and symmetric stretching bands at 1092.99 and 798.72 cm⁻¹, respectively, while XRD confirmed the predominantly amorphous structure. FESEM showed agglomerated, moderately irregular particles with a mean Feret diameter of 103.29 ± 24.68 nm (n = 30; range: 52.63–144.91 nm). EDX identified Si (31.32 wt%) and O (51.26 wt%) as the dominant elements. The zeta potential was –19.4 mV at approximately pH 10, indicating a moderately negatively charged surface. TGA showed 79.656% residual mass at 900°C, demonstrating substantial thermal stability and a predominantly inorganic composition. Overall, the synthesized material exhibited characteristic amorphous nanoscale silica properties, demonstrating the feasibility of converting rice husk waste into functional Si-NPs through a simple and cost-effective approach. This process provides a potential pathway for sustainable rice-residue valorization and the development of silica nanomaterials for agricultural and environmental applications.

Keywords: Nanoparticles, silica, biosynthesis, nano-characterization

Coordinated application of nanomaterials and *Trichoderma asperellum* hstut1 for the management of Phomopsis blight (*Phomopsis vexans*) of brinjal

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Abstract

Phomopsis blight of brinjal caused by *Phomopsis vexans* is a destructive disease resulting significant yield loss. The study was conducted to observe the interacted efficacy of silver nanoparticles (AgNPs), ionic nano copper (INCp) and *Trichoderma asperellum* HSTUT1 for the sustainable management Phomopsis blight along with the improving growth and yield of brinjal. In field condition, combined application of AgNPs, INCp, *T. asperellum* HSTUT1 followed by combined application of AgNPs, ionic nano copper showed the maximum reduction of Phomopsis blight incidence and severity in Venchura (84.24%, 84.29%, respectively) and in Green ball (83.11%, 85.07%, respectively). Combined application of AgNPs, INCp, *T. asperellum* HSTUT1 also results highest plant height (94.76 cm, 92.33 cm), number of branches/plant (16.33, 16.67), leaves/plant (189, 205), flowers/plant (58.67, 70.33), fruits/plant (17, 16.67), shoot length (79.33 cm, 95.66 cm), shoot weight (1.51 Kg, 1.56 Kg), root length (22 cm, 58.66 cm), root weight (0.14 Kg, 0.13 Kg), total chlorophyll (2.70 mg m⁻², 2.64 mg m⁻²), and pH (4.97, 4.97) in both the varieties. Elevated total soluble solid (2.50 °Brix) in Venchura was recorded by *T. asperellum* HSTUT1 & INCp; AgNPs & INCp and in Green ball (2.40 ° Brix) by the combination of AgNPs, INCp, and *T. asperellum* HSTUT1. Uppermost firmness (4.43 Kg m⁻²) was recorded in Venchura treated with *T. asperellum* HSTUT1, INCp and in Green ball (5.29 Kg m⁻²) by combined application of AgNPs, INCp, and *T. asperellum* HSTUT1. Finally, maximum yield (4.39 Kg) obtained in Venchura with combined application of silver nanoparticles, INCp and *Trichoderma asperellum* HSTUT1 and in Green ball (4.31 Kg & 4.26 Kg) with single application of INCp and combined application of AgNPs, INCp, *T. asperellum* HSTUT1. Therefore, the integrated application of AgNPs, INCp and *T. asperellum* HSTUT1 demonstrated strong potential as an alternative for suppressing Phomopsis blight and enhancing the growth, yield and quality of brinjal in field condition.

Keywords: Silver nanoparticles, ionic nano copper, *Trichoderma asperellum*, HSTUT1 brinjal, *Phomopsis vexans*

Biogenic manganese nanoparticles enhance antifungal defense and plant resistance through oxidative homeostasis

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Abstract

Fungal pathogens such as *Magnaporthe oryzae* (Mo), *Botrytis cinerea* (Bc), *Colletotrichum orbiculare* (Co), and *Fusarium oxysporum* f. sp. *niveum* (Fon) pose a significant threat to global crop productivity, triggering severe yield losses and economic damage. Conventional management techniques, including chemical fungicides and resistant cultivars, offer protection to some extent but pose significant environmental risks. This study examines the antifungal and plant-protective potential of biogenic manganese nanoparticles (bio-MnNPs) synthesized using *Bacillus subtilis* (ZZ-73). Physicochemical characterization verified spherical MnNPs with an average size of ~45 nm and biomolecule coatings on the surface. In vitro assays confirmed that bio-MnNPs significantly inhibited mycelial growth of Mo, Bc, Co, and Fon by 73.3%, 79.6%, 47.3%, and 56.3%, respectively. Similarly, bio-MnNPs inhibited conidiation, conidial germination, and appressorium formation in all tested fungal pathogens. In vivo, disease severity caused by Mo, Bc, Co, and Fon was reduced by 82.67%, 87.3%, 76%, and 77.4%, respectively, by foliar application of bio-MnNPs (100 µg/mL) to rice, tomato, and cucumber, as well as root treatment in watermelon. Notably, by triggering antioxidant defenses in infected plants, bio-MnNPs modulated reactive oxygen species accumulation. These findings highlight that bio-MnNPs are a sustainable, multi-functional nanobiopesticide that combines direct antifungal activity with enhanced plant immune responses, offering a promising strategy for next-generation crop defense.

Keywords: Antifungal activity; bio-MnNPs; disease suppression; plant protection; ROS modulation

Evaluation of carrot genotypes for drought tolerance and nutritional quality using morphological and physiological approaches

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Abstract

Drought is one of the most critical abiotic stresses that significantly affects carrot (*Daucus carota* L.) production and its nutritional pigments including beta-carotene and anthocyanin. One approach to addressing this issue is to develop varieties that are tolerant to drought stress. This study aimed to assess the drought tolerance of diverse carrot genotypes based on morphological and physiological traits. The research was conducted in two variable locations in Bangladesh, farmer fields of the Teesta River land, Kaunia region of the Rangpur district and the Horticulture Farm, Bangladesh Agricultural University, Mymensingh-2202 from November 2022 to June 2023. The field experiment was laid out in a Split Plot Design and the lab experiment was carried out in Completely Randomized Design with two replications. Drought stress was imposed during the critical taproot development stage. Results revealed significant genotype-dependent variability in response to drought. Genotypes G22, G24 and G16 consistently exhibited superior drought tolerance with high marketable root yield, maintaining higher relative water content, proline accumulation and chlorophyll content, contributing to their resilience. Root length and diameter, and root fresh weight were positively correlated with yield under both control and drought conditions. According to the wilting severity scale, G22, G24 and G16 were the most drought-stress tolerant. The biplot analysis, based on the multi-trait genotype-ideotype distance index (MGIDI), identified G22, G24 and G16 as the top performers due to their desirable trait combinations. Drought stress reduced beta-carotene and lycopene content across the two locations while

anthocyanin content increased under drought. Genotypes G24, G16 and G22 consistently maintained the highest beta-carotene content, while G51, G52 and G53 exhibited superior anthocyanin accumulation and G71, G72 and G69 showed the highest lycopene levels across environments. The magnitude of pigment change varied widely among genotypes, with drought-induced reductions in beta-carotene and lycopene exceeding 30% in susceptible lines, whereas tolerant genotypes exhibited minimal reductions (<5–6%). Anthocyanin accumulation increased markedly (>30%) in responsive genotypes such as G22 and G24. Thus, drought stress differentially modulated pigment composition, reducing carotenoids while enhancing anthocyanin and revealing substantial genetic variability for pigment stability. This research provides valuable insights into the genetic variability of drought tolerance in carrots aiding the development of resilient cultivars with improved nutritional quality for drought-prone environments.

Keywords: Drought tolerance, carrot genotypes, morphology, physiology, nutritional quality.

Summer tomato cultivation status and challenges: Experienced from southwest and northwest Bangladesh

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Abstract

Tomato is a highly consumed vegetable due to its taste and nutrition. In Bangladesh, typically tomato is used to be cultivated during winters only as tomato plant favors cool weather. However, due to its increasing demand throughout the year and availability of heat tolerant tomato varieties, it is now being cultivated in the summer and rainy seasons in Bangladesh. The study was aimed to identify cultivation status and challenges (problems) faced by the farmers in summer tomato. The study was conducted into purposively selected two villages namely Katenga under Dumuria Upazila of Khulna district and Chokjhopu village under Sadar Upazila of Bogura District. A pretested interview schedule was used to collect data during July to August 2022 from randomly selected 80 respondents who were engaged in summer tomato cultivation. Mongal Raja F1 was preferably cultivated by all of the respondents of Dumuria Upazila while all of the respondents of Bogura Sadar Upazila cultivated BARI Hybrid Tomato 8. Mongal Raja F1 produced higher yield than BARI Hybrid Tomato 8 with a mean of 74.11 t ha⁻¹ and 41.39 t ha⁻¹ respectively and the yield differed significantly ($t = 1.99^*$). Majority (58.75%) of the respondents faced medium problem while above two fifth (41.25%) of them faced high problem. Among the eleven selected characteristics only annual income and knowledge has a significant negative relationship with their problem faced. So, the study indicates that though summer tomato cultivation is becoming popular among farmers, still the production is very much challenging due to different problems.

Keywords: Cultivation status, challenges/problems, summer tomato cultivation.

Selection of promising barley lines for drought and saline area based on agronomic and physiological traits

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Abstract

Barley is inherently tolerant of drought and salinity, making it a promising cereal crop for stress-prone environments. Meherpur District in Bangladesh is particularly vulnerable to drought, whereas Satkhira is predominantly affected by soil and water salinity. Consequently, crop production in these regions is challenging due to drought and salinity, respectively. Therefore, to identify barley lines suitable for both drought and salinity to support climate-resilient breeding programs is essential. In the present study, eleven advanced barley lines, including the two reference varieties BARI Barley-9 (BB-9) and BARI Barley-10 (BB-10), were evaluated in an advanced yield trial during rabi in 2025–26 at Agricultural Research Station of Bangladesh Agricultural Research Institute at Meherpur and, Benarpota, Satkhira following randomized complete block design with three replications. Both agronomic trait, yield and physiological traits (accumulation of H₂O₂ and malondialdehyde (MDA)), the concentrations of Na⁺ and K⁺, the K⁺/Na⁺ ratio, and the activities of catalase (CAT), ascorbate peroxidase (APX), peroxidase (POD), and glutathione peroxidase (GPX) were studied. For agronomic traits and yield, significant variation among genotypes and locations for days to maturity, plant height, grains per spike, 1000-grain weight, and grain yield, while genotype × location interaction was statistically significant for days to maturity and 1000-grain weight. The grain yield was found to be

higher at Meherpur (2.64 tha^{-1}) than that at Satkhira (2.24 tha^{-1}). Barley line F6-15 achieved the highest yield at Meherpur (3.29 tha^{-1}), whereas F6-18 had the highest yield at Satkhira (2.64 tha^{-1}). Salinity led to an increase in the accumulation of H_2O_2 and MDA, and considerable genotypic variation was observed in ion homeostasis and in the antioxidant enzymes. Among the barley lines, F6-18 exhibited the lowest H_2O_2 accumulation, a high K^+/Na^+ ratio (4.34), and higher CAT and APX activities, along with the highest grain yield under saline conditions. F6-15 also showed favorable responses to salinity, characterized by lower MDA and Na^+ accumulation and high grain yield. Based on their combined agronomic and physiological performance, F6-18, F6-15, F6-13, F6-12, F6-11, F6-20, and F6-19 were selected for further evaluation under drought- and salt-affected environments.

Keywords: Barley, salinity, oxidative stress, ion homeostasis, malondialdehyde (MDA)

Comparative evaluation of hybrid rice varieties for salinity tolerance during the whole growth stage

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Abstract

Global rice production is adversely affected by salinity stress, especially in coastal and dry regions where agricultural soils are becoming increasingly saline. The present study was conducted to evaluate the impacts of varying salinity levels on growth, physiological and yield related traits of seven hybrid rice varieties. Five hybrid rice varieties namely BRRI hybrid dhan2, BRRI hybrid dhan3, BRRI hybrid dhan5, BRRI hybrid dhan7, and BRRI hybrid dhan8 along with two check varieties, IR58443-6B-10-3 (salt-tolerant) and IRRI154 (salt-susceptible) were evaluated under five salinity levels (control, 6, 8, 10, and 12 dS/m). The pot experiment was conducted at the Plant Physiology Division, Bangladesh Rice Research Institute using a randomized complete block design with four replications. Salinity $\times$ genotypes demonstrated significant interactions for most of the evaluated traits. Tiller number and panicle number, grain yield, total dry matter significantly decreased with the increase of salinity levels while sterility (%) increased. Na^+ ions accumulations increased while K^+/Na^+ ratio showed decreasing trend with increasing salinity stress. BRRI hybrid dhan2 exhibited a higher grain yield and K^+/Na^+ ratio, as well as a lower spikelet sterility than the other genotypes at 12 dS/m salinity level. At 8 and 10 dS/m salinity levels, BRRI hybrid dhan3 and BRRI hybrid dhan2 exhibited better performance relative to the other genotypes. Overall, this study gives substantial information on the responses of some hybrid rice varieties to different levels of salinity stress which could be helpful in selecting appropriate hybrid rice varieties for cultivation in different saline-prone regions of Bangladesh.

Keywords: Hybrid rice, salinity stress, growth, yield, K^+/Na^+ ratio

Integrated application of rhizobacteria and silicon for enhancing morpho-physiological traits and seed yield of sunflower under salt stress

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Abstract

Soil salinity is a major constraint for agricultural production that adversely impacts on food and nutritional security in Bangladesh especially in coastal areas of Bangladesh. Sunflower might be a promising fitting crop in the coastal saline zone of Bangladesh due to its wide adaptability. Integrated application of microbes and silicon (Si) is a potential avenue for mitigating salt stress in sunflower. Thus, the present study was aimed to evaluate the judicious application of silicon and rhizobacteria on morpho-physiological response, seed yield and nutrient dynamics of sunflower under salt stress. A pot experiment was conducted at Professor Dr. Purnendu Gain field laboratory, Agrotechnology Discipline, Khulna University during January to May 2025. Factorial experiment consisted of three factors, namely, Si doses [control (Si_0); 150 kg ha^{-1} (Si_{150}); 300 kg ha^{-1} (Si_{300}), water salinity levels (control-0.54, 4, 8 and 12 dS m^{-1}) and rhizobacteria (RB) inoculation (without RB [-RB] and with RB [+RB]) in which treatment combinations were assigned completely randomized design (CRD) with three replications. It was reported that all of the evaluated traits were significantly reduced by varying levels of salt stress but individual or combined application of Si and RB significantly improved the traits even at extreme levels of salt stress. The results revealed that Si_{300} fertilization promoted root biomass and root volume by 20% and 31%, respectively at 12 dS m^{-1} salinity levels. The leaf greenness and leaf relative water content were also boosted considerably in RB inoculated plants than non-inoculated plants across different salinity levels. Proline concentration was gradually enhanced with increasing salinity levels that maximized at 12 dS m^{-1} salinity levels in which about 70% and 66% higher proline were recorded at RB inoculated with Si_{150} and Si_{300} fertilized plants, respectively. It was found that Si fertilized plants along with

RB inoculation significantly reduced leaf Na⁺ ion concentration along with improved K⁺ ion and P concentration. Moreover, Si₃₀₀ fertilization coupled with RB inoculation enhanced seed yield by 25% at 8 dS m⁻¹ salinity level whereas corresponding increase was 19% at 12 dS m⁻¹ salinity level. Finally, it can be inferred that synergistic interaction between RB and Si significantly promoted physio-biochemical traits and seed yield of sunflower under salt stress.

Keywords: Salt stress, sunflower, rhizobacteria, silicon, seed yield

Exogenous application of salicylic acid mitigates salt stress in BRRI dhan 28 rice (*Oryza sativa* L.): Integrated molecular and biochemical analysis

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Abstract

Coastal salinity intrusion is a growing threat to rice cultivation in southwestern regions of Bangladesh. This coastal region, marked by brackish water, has posed significant challenges for farming due to the elevated salinity levels in the soil as salt stress induces ionic, osmotic and oxidative stress. BRRI dhan 28, a widely cultivated high-yielding rice variety valued for its short growth duration and grain quality, and moderate resistance to major diseases. But it is susceptible to salinity, especially during the seedling and reproductive stages. Salicylic acid is a plant hormone implicated in abiotic stress tolerance, including salt-induced damage. The current research aimed to assess the effectiveness of exogenous salicylic acid to alleviate salt stress in *Oryza sativa* L. variety BRRI dhan 28. Seedlings were subjected to four treatment conditions: untreated control, salicylic acid, salt stress, and a combination of salicylic acid and salt stress. To determine how salinity affects plant growth parameters, shoot length, root length, fresh weight, dry weight, and number of leaves were measured. Levels of chlorophyll a, chlorophyll b, total chlorophyll, carotenoids, anthocyanins, hydrogen peroxide (H₂O₂), malondialdehyde (MDA), endogenous salicylic acid, and the activity of the antioxidant enzyme (catalase) were also estimated using biochemical tests. Moreover, qRT-PCR was used to analyse the expression of two antioxidant genes, *OsPrxQ* and *Os2-CysPrxA*, in order to comprehend the molecular mechanisms underlying this response. These genes produce peroxiredoxins, which aid in the removal of hydrogen peroxide and other peroxides. The results showed that exogenous salicylic acid upregulated both genes under saline conditions, providing molecular evidence for enhanced reactive oxygen species scavenging. Collectively, these findings indicate that exogenous salicylic acid alleviates salt-induced stress in BRRI dhan28 by supporting growth, preserving photosynthetic pigment content, and strengthening antioxidant defense at both biochemical and transcriptional levels.

Keywords: Salicylic acid, salt stress, malondialdehyde, cellular redox homeostasis, *OsPrxQ*, *Os2-CysPrxA*.

Growth and nutrient uptake of eggplant ‘Mizunasu’ grafted with double rootstocks under fixed phosphorus condition

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Abstract

Phosphorus fertilizer is made from natural minerals, and its global depletion is a concern. A large amount of soil phosphorus remains chemically fixed with iron compounds, making it unavailable for plant uptake. Although many studies have demonstrated the advantages of single rootstock grafting for improving plant vigor, stress tolerance and nutrient uptake, the effects of different rootstock combinations grafted onto a common scion on phosphorus and other nutrient uptake in eggplant under a fixed phosphorus supply remain insufficiently elucidated. So, this experiment was conducted to evaluate the performance of eggplant grafted with various rootstocks, regarding scion growth and nutrient uptake in fixed phosphorus condition. In this experiment, the scion (‘Senshu kinukawa mizunasu’) was grafted onto ‘Daitaro’ as the main rootstock followed by six secondary rootstock cultivars (‘Torvum vigor’, ‘Tonashim’, ‘Daisaburo’, ‘Daitaro’, ‘Taibyō VF’, and ‘Akanasu’) 25 days after first grafting, grafted seedlings were transplanted to the pot containing 750g of soil mixed with Akadama soil: vermiculite (2:1). Control soil contained 2,000 mg of KH₂PO₂, and fixed phosphorus soil contained 2,220 mg of FePO₄ and 1,280 mg of K₂SO₄. Every pot was irrigated with half strength of Enshi-shoho nutrient solution removing phosphorus every day. 75 days after transplanting, the plants were harvested, and growth parameters were measured. For measuring nutrient uptake nitrogen and other nutrients were measured by Gunning-Kjeldahl method and ICP-AES method respectively. Most of the double grafted plants showed better growth and higher nutrient uptake than self-root scion in both conditions.

In fixed phosphorus condition, ‘Daitaro’-‘Akanasu’, ‘Daitaro’-‘Taiby VF’ rootstock combination showed better plant growth. Phosphorus content in the scion was higher in the plants grafted with ‘Daitaro’ -‘Taiby VF’, and ‘Daitaro’ -‘Tonashim’ rootstocks combination. The results indicate that the ‘Daitaro’ scion grafted onto ‘Taiby VF’, ‘Akanasu’, and ‘Tonashim’ rootstocks showed greater P uptake under a fixed P supply, suggesting that these rootstock combinations may promote scion growth and enhance P acquisition. Their potential to improve phosphorus-use efficiency under fixed P conditions warrants further investigation.

Keywords: Insoluble phosphate, mineral contents, nutrient uptake, rootstocks, *Solanum lycopersicum*, *Solanum melongena*.

Seaweed (*Ulva lactuca*) extract mitigates salinity-induced physiological and biochemical stress in Indian spinach (*Basella rubra* Roxb.)

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Abstract

Abiotic stresses, particularly salinity, pose a major threat to crop production by adversely affecting plant growth, photosynthesis, water relations, metabolism, and antioxidant defense systems. Indian spinach (*Basella rubra* Roxb.), a vital vegetable crop in Bangladesh, contains shallow root system that makes it highly susceptible to salinity stress. Seaweeds exhibit plant growth-promoting activity and employ various mechanisms to enhance stress tolerance in plants. Therefore, this study elucidated the potentiality of seaweed (*Ulva lactuca*) extract (SWE) to mitigate salinity-induced physiological and biochemical alterations in Indian spinach. Two concentrations of SWE (2% and 4%) were applied through irrigation water under low (100mM) and high salinity (200mM) conditions using a completely randomized pot design with three replications. Salinity significantly reduced plant growth and biomass. Total fresh weight decreased by 26% and 38%, whereas total dry weight declined by 48% and 55% under low salinity (LS) and high salinity (HS), respectively. SWE application substantially restored these losses, with 4% SWE under LS increased total dry weight by 43% compared with untreated stressed plants. Salinity markedly reduced leaf area (31-45%), chlorophyll content (21-34%), and relative water content, while increasing leaf thickness (71-93%), proline (19-25%), MDA (up to 2.2-fold), and H₂O₂ (1.6-fold). The 4% SWE treatment promoted leaf expansion, maintained chlorophyll and RWC, increased TSS by 47% and 38% under LS and HS, respectively, while substantially reducing proline, MDA, and H₂O₂ levels. SWE also modulated antioxidant enzymes, with both 2% and 4% SWE treatments showing a significant reduction in CAT activity compared to LS-treated plants. In plants, exposure to 4% SWE under LS and HS conditions, POD activity decreased significantly and was 37% and 25% than LS and HS-treated plants alone, respectively. Low salinity-exposed plants when treated with 2% SWE increased APX activity, while those treated with 4% SWE, it decreased significantly. Moreover, high salinity-exposed plants with SWE treatment showed an increasing trend in APX activity, though it was not significant. Principal component analysis clearly separated the treatments, showing that salinity-stressed plants clustered with oxidative stress markers, whereas SWE-treated plants shifted the samples toward growth, biomass, leaf area, and chlorophyll-related traits. Overall, the extract of *Ulva lactuca* effectively mitigated salinity-induced damage in Indian spinach by maintaining ROS homeostasis, protecting membrane integrity, strengthening antioxidant defenses, and improving growth performance. The 4% SWE treatment was particularly effective under low salinity stress, highlighting its potential as an environmentally sustainable strategy for enhancing crop resilience under saline conditions.

Keywords: Salinity, *Basella rubra*, *Ulva Lactuca*, seaweed extract, antioxidant enzymes, oxidative stress.

Integrated kaolin and shade management for heat resilient and sustained strawberry production under subtropical conditions

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Abstract

Climate change poses increasing challenges to agricultural sustainability and food security, emphasizing the need for resilient and adaptive production systems. Strawberry (*Fragaria × ananassa* Duch.) is a cool-season crop that performs optimally at 13–23°C, whereas summer temperatures in Bangladesh frequently reach 30–40°C, severely affecting vegetative growth, water status, chlorophyll stability, photosynthesis, yield, and fruit quality. A field

experiment was conducted during 2025-2026 to evaluate the effectiveness of shade and 5% kaolin application in improving heat tolerance of two strawberry varieties, RABI-3 and BARI Strawberry-3. The experiment followed a randomized complete block design with three replications, and vegetative, physiological, photosynthetic, yield, and fruit quality traits were evaluated under open-field and shaded conditions. Environmental parameters were monitored using a data logger. Shade combined with kaolin application substantially improved plant performance, particularly in BARI Strawberry-3. This treatment increased crown diameter (15.3 mm), total chlorophyll (8.75 mg g⁻¹ FW), relative leaf water content (63%), antioxidant activity (82%), and quantum yield ($\phi\Pi = 0.74$), while maintaining MDA content at 6.09 nmol g⁻¹ FW. It also enhanced fruit size (18.62 cm²), dry matter (18%), fruit number (38 plant⁻¹), and total yield (855 g plant⁻¹), with desirable TSS (9.6 °Brix) and vitamin C content (65.67 mg 100 mL⁻¹). Compared with normally grown plants in 2025, shade- and kaolin-managed plants in 2026 showed superior fruit size, dry matter, and vitamin C content. Overall, integrating shade with kaolin application, particularly for BARI Strawberry-3, offers a promising strategy to improve strawberry performance under warm subtropical conditions, reduce annual replanting, and promote sustainable production in Bangladesh.

Keywords: Strawberry, heat stress, kaolin, summer survival, climate resilience.

Exogenous quercetin mitigates drought stress in rice (*Oryza sativa* L.) through modulation of antioxidant defense and photosynthetic performance

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Abstract

Drought is one of the most devastating abiotic stresses limiting rice productivity, and exogenous application of natural antioxidant compounds has emerged as an eco-friendly strategy to alleviate its impact. A pot experiment was conducted to evaluate the mitigating role of exogenous quercetin, a potent flavonoid antioxidant, in two rice landraces differing in drought tolerance, Lokkhibilash (susceptible) and Hashikolmi (tolerant). Plants were grown under four treatments: well-watered control, drought stress, drought + 100 μ M quercetin, and drought + 150 μ M quercetin. Drought stress impaired gas exchange characteristics and chlorophyll fluorescence parameters, including stomatal conductance, transpiration rate, quantum yield of PSII and electron transport rate, and induced oxidative damage as reflected by increased lipid peroxidation. Under stress, the antioxidant defense system responded differentially: ascorbate peroxidase and peroxidase activities increased markedly, whereas catalase activity declined below the control level, a pattern characteristic of severe and prolonged oxidative stress. Foliar application of quercetin substantially alleviated the drought-induced damage. It restored photosynthetic electron transport, improved stomatal conductance and transpiration, protected catalase from stress-mediated inactivation, and markedly reduced lipid peroxidation, with the response being both dose- and variety-dependent. The drought-tolerant landrace maintained higher antioxidant enzyme activities and suffered less oxidative damage than the susceptible one under all stress treatments. The findings indicate that exogenous quercetin mitigates drought stress in rice by strengthening the endogenous antioxidant defense system, sustaining photosynthetic performance and protecting cellular membranes from oxidative injury. Quercetin may therefore be recommended as a safe and effective elicitor for improving drought resilience in rice, particularly when integrated with tolerant landraces.

Keywords: Quercetin, drought stress, antioxidant defense, lipid peroxidation, chlorophyll fluorescence, rice landraces.

Evaluation of growth and physiological traits of wheat under drought condition

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Abstract

Wheat is a highly nutritious cereal crop used as staple food in many countries of the globe. It is predominantly grown in the Northern districts of Bangladesh during winter, where the deficient soil moisture is a serious problem. In this context, the current pot experiment was conducted to reveal the drought tolerance efficacy of Bangladeshi wheat varieties following a two-factor completely randomized design, where Factor-1 comprised of two different growth conditions (well water-W₁ and water deficit stress-W₂) and Factor-2 consisted of ten wheat genotypes. Data relevant to root architecture (root number, length, diameter, volume, root/shoot ratio etc.), biochemical (Chlorophyll, proline,

leaf water content, etc.) and antioxidants (CAT, POD, APX, MDA, H₂O₂ etc.) attributes were studied. From the results, it was observed that the phenotypic expression of wheat was adversely declined under water deficit drought condition. However, the outputs revealed that the tolerant varieties such as BWMRI Gom 3 (V₇), BWMRI Gom (V₉) BWMRI Gom 4 (V₈), and BARI Gom 31 (V₄) showed greater root architecture, vigorous growth, and superior physiological and antioxidant activities for ensuring their optimum growth and development. These attributes are indicators for assessing the varietal potentiality of wheat under water deficit stress condition. The result was also contributed to find out suitable wheat genotype for cultivating them in drought prone areas of Bangladesh.

Keywords: Antioxidant traits, photosynthetic pigments, root system architecture (RSA), *Triticum aestivum*, water deficit stress.

Plant growth-promoting rhizobacteria enhance terminal drought tolerance in wheat through coordinated antioxidant and osmotic regulation

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Abstract

Wheat productivity is severely constrained by drought, particularly during grain filling, when water deficit accelerates senescence and curtails yield. Plant growth-promoting rhizobacteria (PGPR) offer a sustainable strategy to alleviate such stress. This field study evaluated three isolates-*Bacillus subtilis* (PPB2), *Stenotrophomonas maltophilia* (PPB3), and *Bacillus amyloliquefaciens* (PPB6) in drought-tolerant BARI Gom 33 and drought-sensitive Pavon 76. All isolates achieved 78–95% root colonization under drought, four- to eight-fold higher than uninoculated roots. Drought sharply reduced chlorophyll content, NDVI, leaf relative water content, and membrane stability, while elevating superoxide radical, H₂O₂, and malondialdehyde by up to 97%, 65%, and 73%, respectively, more severely in Pavon 76. PGPR inoculation, especially PPB6, significantly mitigated these effects, enhancing catalase, peroxidase, ascorbate peroxidase, and glutathione S-transferase activities and osmoprotectant accumulation (proline up to 19%; soluble sugars up to 55%). Drought reduced grain yield by 41–52%, and PGPR substantially though not completely restored these losses, with PPB6 improving yield by up to 38% in BARI Gom 33. Hierarchical clustering and principal component analyses consistently showed that PGPR inoculation shifted drought-stressed wheat of both varieties toward a healthier physiological state-evident in reduced oxidative damage and partially recovered yield traits. These findings demonstrate that PGPR, particularly *B. amyloliquefaciens* (PPB6), effectively enhance drought tolerance through coordinated antioxidant and osmotic regulation, though genotype-specific responses suggest that strain selection should be tailored to host cultivar for optimal field performance.

Keywords: Bioinoculants, *Bacillus amyloliquefaciens*, oxidative stress, antioxidants, osmoprotectants.

Fish scale-derived chitosan mitigates salt stress in rice (*Oryza sativa* L.) at the early germination stage by enhancing ionic homeostasis and antioxidant defense

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Abstract

Soil salinity is one of the most deleterious abiotic stresses to rice production in the coastal area of Bangladesh. Different growth stages of rice are affected adversely by soil salinity; particularly the germination stage is most sensitive to salinity because excessive salt concentrations create osmotic stress and disrupt ionic balance. It limits morphological, physiological, and biochemical assays of rice plant. The aim of this study is to examine the underutilized fish-scales derived chitosan in salinity mitigation. In this study Rohu fish (*Labeo rohita*) was used for chitosan extraction. Two BINA-released rice varieties were used – salt-tolerant Binadhan-10 and salt sensitive Binadhan-24. Seeds were exposed to six treatments: control, 1% and 2% chitosan alone, 100 mM NaCl alone, and 100 mM NaCl combined with 1% or 2% chitosan. The experiment was done with a completely randomized design with three replications. The result revealed that salinity reduced germination percentage, germination rate index, shoot and root length, and relative water content. Co-application of 1% chitosan with NaCl improved 96-98% germination percentage, promoted shoot and root growth, improved RWC, and decreased the Na⁺/K⁺ ratio by roughly 29-54%. Chitosan application also increased proline content and the activities of catalase (CAT), peroxidase (POD),

and ascorbate peroxidase (APx). It indicates that chitosan application enhanced osmotic adjustment and ionic balance under salinity stress. However, Binadhan-10 performs better than Binadhan-24. Notably, the 1% dose of chitosan treatment consistently showed better performance than 2% chitosan dose. These findings suggest that fish scale-derived chitosan could serve as an eco-friendly, cost-effective, and circular-economy-based seed treatment for improving the establishment of rice in saline soils.

Keywords: chitosan, fish scale, salinity, rice seed germination, antioxidant enzymes, ion homeostasis.

ZnO nanoparticle mediated seed priming enhance wheat germination and antioxidant performance under acidity stress

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Abstract

Soil acidity increases phytotoxic aluminum (Al^{3+}) ion concentration in soil solution and restrict root elongation, impair water and nutrient uptake, and ultimately reduces grain and biomass yields of wheat. Zinc oxide nanoparticles (ZnO NPs) have emerged as promising growth enhancers capable of modulating plant physiological and biochemical responses under stress conditions. In this study, BARI Gom-33 variety was taken to explore the efficacy of exogenous ZnO NPs application using completely randomized design with four pH levels (4.25, 5.00, 5.75, 6.50) and five ZnO NPs concentrations (0, 25, 50, 75, 100 ppm) in alleviating acidity stress in wheat (*Triticum aestivum* L.). Data were collected on water imbibition, germination potential and percentage, length of root and shoot, number of roots, biomass accumulation, enzymatic and non-enzymatic antioxidant activities, chlorophyll pigments, and multivariate analyses including PCA, hierarchical clustering, and Pearson correlation. Results revealed that acidic pH (4.25) combined with 25-50 ppm ZnO NPs produced optimal outcomes, with 35.71% increase in water imbibition efficiency, 91.67% germination potential, and enhanced root proliferation compared to untreated control. ZnO NPs significantly enhanced chlorophyll pigments (86.75% increase in total chlorophyll) while reducing oxidative damage through coordinated upregulation of SOD (102.41% increase), POD (116.50% increase), APX (115.89% increase), and CAT (127.42% increase) activities, accompanied by substantial accumulation of TPC (220% increase) and TFC (225% increase) with 52.73% reduction in MDA content. Principal component analysis explained 70.85% of the total variation, confirming ZnO NPs as a master regulator coordinating stress tolerance. The study concludes that ZnO NP application offers an economically viable and environmentally sustainable strategy for improving seed germination and establishment of wheat plant under acidity stress.

Keywords: Wheat, acidity stress, zinc oxide nanoparticles, antioxidant potential, germination, chlorophyll pigments.

Alleviation of drought-induced adverse effects in wheat at the reproductive stage through exogenous application of salicylic acid and methyl jasmonate

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Abstract

Drought stress during the reproductive stage is a major constraint to wheat productivity, as it affects different physiological activities, ultimately reducing grain yield. Exogenous application of phytohormones such as Salicylic Acid (SA) and Methyl Jasmonate (MeJa) has potential strategy to induce plant tolerance to abiotic stress, however their individual and combined effect during sensitive reproductive phases remains insufficiently characterized. This study evaluated the drought stress alleviation potential of foliar application of SA and MeJa, applied singly and in combination. A pot experiment was conducted in the high-yielding wheat cultivar BARI Gom 32 using a factorial design comprising two water regimes (well-watered control and drought stress imposed at the reproductive stage, maintained and monitored using a soil moisture meter targeting reading of 15-20% for well-watered control & 8-10% for stressed condition) and foliar-sprayed with four hormonal treatments: no-hormone, MeJA (5 μ M), SA (100 μ M), and combined SA + MeJA (100+5 μ M). Physiological parameters such as stomatal conductance, transpiration rate, net photosynthesis rate, electron transport rate, intercellular CO_2 concentration, and leaf temperature were measured with a portable gas exchange system. Grain sugar accumulation at the early grain-filling stage and 1000-grain weight were also determined. Drought stress caused significant reductions in stomatal conductance and transpiration rate in stressed plants compared to the control plants in all treatments, with the extent of reduction lower

in the MeJA-treated plants (52% and 39% reduction, respectively) than in the SA-treated plants (68% and 63%). Leaf temperature increased sharply in untreated stressed plants (31.9→37.5°C) but marginal increase was observed in SA+MeJA-treated plants (36.4→37.6°C), indicating improved thermal and transpirational regulation. Sugar accumulation during early grain filling period under stress was significantly higher in MeJa (1.63%) and SA+MeJa (2.20%) treated plants than in untreated stressed plants, indicating enhanced assimilate mobilization. Photosynthetic rate and electron transport rate were also comparatively better sustained in hormone treated stressed plants. For yield, combined SA+MeJA application produced the highest 1000-grain weight under well-watered conditions (58.5 g vs. 42 g in untreated controls), while MeJA alone best-preserved grain weight under drought (53.7 g). Overall, the results demonstrated that foliar application of SA and MeJA particularly in combination, alleviated drought-induced impairments in wheat by modulating physiological mechanisms.

Keywords: Drought stress, wheat, reproductive stage, salicylic acid, methyl jasmonate, gas exchange parameters.

Microplastic–heavy metal co-contamination in acid soil: Effects on contaminant mobility and plant performance

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Abstract

The co-occurrence of microplastics and heavy metals in soil has become a significant environmental issue because of their possible interactions with soil properties, contaminant mobility and plant performance. This study aimed to investigate the combined effects of microplastics and heavy metals on contaminant mobility and plant performance of two vegetables, viz., fruity vegetable brinjal (*Solanum melongena* L.) and leafy vegetable Indian spinach (*Basella alba* L.). Two separate pot experiments were conducted using a completely randomized design (CRD) on the rooftop of the Agriculture Faculty Building at Sylhet Agricultural University with four treatments and four replications, viz. T₁ = Control soil, T₂ = Heavy metals (Zn = 54.55 mg kg⁻¹, Pb = 62 mg kg⁻¹, Cd = 1.21 mg kg⁻¹ and Cr = 163.89 mg kg⁻¹), T₃ = Heavy metals + 0.25% Microplastic (w/w), and T₄ = Heavy metals + 0.50% Microplastic (w/w). Post-harvest soil analyses revealed the highest pH (6.33) under the T₃ treated pot, whereas T₂ provided the highest organic carbon (3.22%). Heavy metal accumulation in plants was significant, with spinach showing greater accumulation: Zn (60.80 mg kg⁻¹), Pb (11.01 mg kg⁻¹), Cd (2.67 mg kg⁻¹) and Cr (8.97 mg kg⁻¹) were markedly elevated compared to brinjal. Significant treatment effects were observed in both soil and plants. The T₄ treatment significantly enhanced metal mobility and uptake in brinjal fruit and spinach leaf i.e., Zn (P = 0.0002), Pb (P < 0.0001), Cd (P < 0.0001) and Cr (P < 0.0001), leading to Zn, Pb, Cd and Cr concentrations of 67.13, 16.48, 3.34 and 10.81 mg kg⁻¹, respectively. The T₄ treated pot recorded the tallest plants (41.44 cm), largest leaf area index (106.10 cm²) and largest canopy (39.66 cm) of the brinjal plant. The T₃ treated pot recorded the tallest spinach plant (90.17 cm). The study concludes that microplastic contamination can intensify heavy metal transfer from soil to plants, posing emerging challenges for agricultural sustainability and environmental health.

Keywords: Microplastics, heavy metals, soil contamination, contaminant mobility, plant performance

Dynamics of culm reserve mobilization and grain filling in wheat under late-sowing-induced heat stress at reproductive stage

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Abstract

Grain filling determines final grain weight and yield and is influenced by both current assimilate production and the mobilization of stored culm reserves in cereals. This study was conducted to evaluate the dynamics of culm reserve accumulation and its mobilization to grains in wheat under late-sowing-induced heat stress. Three wheat cultivars (BWMRI-1, BARI Gom-33, and BARI Gom-32) were evaluated under early sowing (18 November) and late sowing (9 December) conditions. Tillers were sampled weekly from anthesis to determine changes in the dry weight of different plant parts and to assess dry matter accumulation and partitioning. Water-soluble sugar concentration in the culm was quantified to monitor reserve accumulation and remobilization throughout the grain-filling period. The results showed that grain yield was reduced by approximately 10.1% under heat stress, mainly due to a reduction in grain weight. Heat stress drastically reduced the grain-filling duration by 22%, from 27 days under early sowing to 21 days under late sowing. Water-soluble carbohydrate concentration in the culm reached a maximum of 13.04% at

21 days after anthesis (DAA) under early sowing, compared with 12.18% at 6 DAA under late sowing. The amount of reserves remobilized to the grain varied among cultivars, ranging from 0.78–1.43 g spike⁻¹ under early sowing and 0.43–1.26 g spike⁻¹ under late sowing. Among the cultivars, BWMRI-1 showed the highest reserve mobilization efficiency, indicating a greater contribution of culm reserves to final grain weight under heat stress than BARI Gom-33 and BARI Gom-32. These results suggest that late sowing accelerates early leaf senescence, as indicated by declining SPAD values, and increases the plant's dependence on stem reserves to support grain filling as the photosynthetic period is shortened. In conclusion, understanding the temporal dynamics of culm reserve mobilization provides valuable insight into the role of stored carbohydrates in supporting grain filling under late-sowing-induced post-anthesis heat stress, although the overall contribution of culm reserves to grain filling remained relatively unaffected by the stress.

Keywords: Wheat, culm reserves, mobilization, grain-filling, heat stress, reproductive stage

Grain growth and yield of wheat under high temperature stress at the reproductive stage induced by late sowing

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Abstract

Wheat sowing is constrained by the narrow interval between T-Aman rice harvest and the optimum wheat-sowing period in Bangladesh's predominant rice–wheat cropping system. Delayed harvesting of Aman rice often results in late sowing of wheat, exposing the crop to high temperature stress during the reproductive and grain-filling stages. In this experiment, grain growth and yield components of three wheat cultivars, BWMRI-1, BARI Gom 33, and BARI Gom 32, were studied to determine the effects of high temperature during grain filling on grain growth and yield. A field experiment was conducted using two sowing dates: early sowing on 18 November 2025 and late sowing on 2 December 2025. Grain growth was determined through destructive sampling twice a week, beginning at 11 days after anthesis (DAA) in the early-sown crop and 7 DAA in the late-sown crop, until harvest (5 March and 16 March, respectively). Grain yield, number of spikes, 1000-grain weight, and grain weight at individual floret positions were also assessed. Late sowing altered grain growth dynamics, resulting in a shorter grain-filling period. Grain yield declined under late sowing in all three cultivars, although the magnitude of reduction varied among them. Grain yield of BWMRI-1 decreased from 408 to 368 g m⁻² (4.08 to 3.68 t ha⁻¹), representing a 9.8% reduction. Similarly, BARI Gom 33 showed an 11.5% reduction in yield, from 424 to 375.3 g m⁻² (4.24 to 3.75 t ha⁻¹). In contrast, BARI Gom 32 showed the smallest reduction (8.8%), from 432 to 394 g m⁻² (4.32 to 3.94 t ha⁻¹). BWMRI-1 and BARI Gom 33 maintained relatively higher grain yields under late sowing despite substantial reductions in 1000-grain weight (36.4 vs. 45.4 g and 46.2 vs. 59.3 g, respectively), whereas BARI Gom 32 showed the smallest reduction in 1000-grain weight (47.5 vs. 49.6 g). The number of spikes per m² declined sharply in BARI Gom 33 under late sowing (126.7 vs. 204.7), whereas BARI Gom 32 showed a slight increase. These findings demonstrate that a two-week delay in wheat sowing, resulting from constraints in the Aman–wheat crop calendar, is sufficient to shorten the grain-filling period, alter yield components, and differentially affect grain yield among wheat cultivars.

Keywords: Heat stress, wheat, late sowing, grain-filling duration, yield components

Unmanned aerial vehicle and sensor-based high-throughput phenotyping reveals genotype-specific resilience to combined heat and drought stress in wheat

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Abstract

Climate change increasingly exposes wheat to combined heat and drought stress, which can be more damaging than either stress alone, yet field-based tools to rapidly screen genotypic resilience remain limited. This pilot study evaluated an unmanned aerial vehicle (UAV) and ground-sensor-based high-throughput phenotyping platform to characterize physiological and spectral responses of six wheat genotypes—two relatively tolerant (BARI Gom 33, Sonoita), two high-yielding (BWMRI2, BWMRI3), and two susceptible (BARI Gom 19, Pavon)—under control, drought, heat, and combined heat-drought conditions across five reproductive growth stages, using five physiological traits and ten UAV-derived vegetation indices. Combined heat–drought stress consistently produced the most severe physiological deterioration, with the lowest chlorophyll content, chlorophyll index, EVI, GCI, and NDVI. It also

resulted in the highest leaf temperature, vapor pressure deficit, and senescence-associated spectral indices (PSRI, SIPI, NPCI), indicating a synergistic rather than additive stress interaction. Canopy and photosynthetic indices declined progressively from heading through 21 days after anthesis, confirming that the platform effectively captured stress-accelerated senescence during grain filling. Correlation analysis revealed condition-dependent associations among physiological and UAV-derived spectral traits, with the strongest associations under combined drought and heat stress. Varietal differences were comparatively modest relative to condition and growth-stage effects; however, multi-trait genotype-ideotype distance index (MGIDI) analysis integrating all measured traits identified BARI Gom 33 and Sonoita as the most multi-stress-resilient genotypes, consistent with their prior tolerance classification, while Pavon and BARI Gom 19 ranked lowest. These findings demonstrate that UAV- and sensor-based phenotyping can reliably capture genotype-specific resilience to combined abiotic stress in wheat, supporting its scalability for climate-resilient cultivar screening in breeding programs.

Keywords: *Triticum aestivum* L., multi-stress tolerance, quantum yield, canopy reflectance, MGIDI

Comparative analysis of physiological and anatomical changes induced by physical and chemical treatments during agarwood formation in *Aquilaria malaccensis*

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Abstract

Aquilaria malaccensis is an economically vital tree species prized for producing resinous agarwood, a high-value aromatic substance formed as an induced defense response against physical wounding and environmental stress. Traditional mechanical wounding methods used for agarwood induction are slow and yield unpredictable resin quality, while the underlying physiological, biochemical, and anatomical mechanisms triggered by chemical elicitors combined with physical injury remain insufficiently understood. This study evaluated the efficacy of various chemical-soaked iron nail treatments in triggering host defense responses and accelerating agarwood formation. Field trials were established across two sites in Bangladesh-Shafi Nagar Tea Estate and Lathitila Beat using trees of uniform age subjected to ten treatments: a nailing-only control, deionized water, iron chloride (FeCl₃), salicylic acid, chitosan, formic acid, sodium chloride (NaCl), calcium chloride (CaCl₂), sodium sulfate (Na₂SO₄), and SHAHNOOR vaccine (local elicitor). Treatment-induced changes were quantified by analyzing physiological stress markers, antioxidant enzyme activities, secondary metabolite accumulation, and anatomical alterations in xylem vessel structure and occlusion. Chemical elicitors, particularly salicylic acid, chitosan, and formic acid are expected to trigger rapid oxidative stress signaling by elevating hydrogen peroxide (H₂O₂) and malondialdehyde levels subsequently upregulating superoxide dismutase (SOD), peroxidase (POD), and catalase (CAT) enzyme activities. This biochemical defense cascade will stimulate significant secondary metabolite synthesis specifically total phenolic content (TPC), total flavonoid content (TFC), and total terpenoid content (TTC) while accelerating structural defense responses including dense tylose formation and xylem vessel occlusion around wounding sites. These findings demonstrate that targeted chemical elicitation paired with physical wounding effectively accelerates plant defense pathways while preserving overall tree structural integrity. Ultimately, this research provides a standardized, scalable, and sustainable physical-chemical induction protocol to optimize commercial agarwood production.

Keywords: *Aquilaria malaccensis*, agarwood induction, chemical elicitors, secondary metabolites, tylose formation

Thylakoid membrane properties modulation and photosystems kinetics by sowing time adjustments in country bean (*Lablab purpureus*)

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Abstract

The supra-optimum temperature during the summer season is one of the bottlenecks for yield inferiority of the country bean in Bangladesh. A detailed investigation on thylakoid membrane properties aligned with light energy partitioning, chloroplast ATPase activity and photosystem I (PSI) reaction centers would be a vital option to underpin the physiological enhancers of pod yield during summer season. Accordingly, a study was carried out at the field laboratory of department of Horticulture, Sylhet Agricultural University, Bangladesh under completely randomized

design with three replications. Sikribi seem-1 was evaluated at six sowing times- 15 February (T_1), 1 March (T_2), 15 March (T_3), 1 April (T_4), 15 April (T_5), and 1 May (T_6) in 2024. The physiological parameters were recorded at three growth stages of each sowing time with PhotosynQ fluorometer. Significant variations were observed in all studied traits due to sowing time differences. The rate of ECS (electrochromic shift), an indication of steady-state proton translocation through the chloroplast ATP synthase, was the lowest in the early sowing (15-February). Moreover, the proton conductivity of the thylakoid membrane (gH^+) was the highest during the 15-February, indicating the superior structural conductivity across thylakoid membrane. The effective quantum yield of PSII phytochemistry (Φ_{PSII}) was the lowest during early sowing (15-February), while the quantum yield of non-regulated energy loss in PSII (Φ_{NO}) was stable during this time. The light energy partitioning was effectively balanced during early sowing (15-February) as the quantum yield of regulated non-photochemical energy loss in PSII (Φ_{NPQ}) was maximum during this period, indicating minimal photo-damage. The photosystem I (PSI) 'active' and 'open' centers were maximum during the early sowing (15-February), expressing the greatest operational centers to receive/pass electrons and utmost centers ready to accept electrons, respectively. Taken together, the enhanced physiological properties during early sowing were expressed in maximum pod yield. Overall, early sowing (mid-February) of country bean during summer could be a positive option for country bean growers in Bangladesh.

Keywords: Sowing time, gH^+ , Φ_{PSII} , pod yield, PSI

Deficit irrigation improved wheat yield, water productivity, and nitrogen use efficiency under fertilized microplot ecosystem

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Abstract

Drought negatively affects the growth, nitrogen use efficiency and yield of wheat. The present study was conducted at the research field of Sher-e-Bangla Agricultural University from mid-November 2023 to mid-March 2024 to address the effect of deficit irrigation on growth, yield, water productivity, nitrogen use efficiency (NUE) and grain nutritional quality of wheat under microplot ecosystem. Crop stands were established and tested under four levels of deficit irrigation treatments in a Randomized Complete Block Design (RCBD) with 4 replications. The treatments were: (i) W_0 (Control), 80 mm irrigation; (ii) W_1 , 110 mm irrigation; (iii) W_2 , 140 mm irrigation; and (iv) W_3 , 170 mm irrigation. Irrigation treatments improved plant height by 11.1–30.3% over the control. Total dry matter (TDM) ranged from 1.85 g plant⁻¹ (W_0) to 4.23 g plant⁻¹ (W_3); and W_1 , W_2 and W_3 treatments increased TDM by 108.1%, 114.6% and 128.6 %, respectively. The W_2 and W_3 treatments also increased number of grains per spike by 54.77 % and 57.15%, respectively. Thousand-grain weight varied from 35.88 g (W_0) to 43.05 g (W_2), corresponding to increases of 11.68% (W_1), 19.98% (W_2), and 18.19% (W_3) over control. The highest grain yield (4.02 t ha⁻¹) was obtained from the W_3 treatment, which was statistically identical with W_2 (3.89 t ha⁻¹) treatment. Water productivity of wheat was highest under W_2 (18.60 kg ha⁻¹ mm⁻¹), which was 11.8% higher than control but identical with W_1 treatment. The highest NUE (33.49) was recorded under W_3 treatment, which was statistically similar to W_2 (32.39). Differences among irrigation treatments on soil total nitrogen (TN) content in 0-15 cm topsoil were non-significant. However, W_2 and W_3 treatments enhanced soil NO_3^- and NH_4^+ availability during tillering and heading stages. Grain protein and gluten content declined with increasing irrigation level. Overall data suggested that moderate to high deficit irrigation, particularly under W_2 regime can be considered for achieving higher wheat grain yields while maintaining efficient water use under similar agro-climatic conditions.

Keywords: Wheat, deficit irrigation, grain yield, water productivity, nitrogen use efficiency

Alleviation of combined heat and drought stress in mustard by foliar application of titanium oxide nanoparticles through physiological and biochemical modulation

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Abstract

Drought and heat stress are major abiotic constraints limiting growth and productivity of mustard plant. Their simultaneous occurrence in the field can cause stronger damage than individual stress by disrupting photosynthesis, water relations, redox regulation, and seed yield. Titanium dioxide nanoparticles (TiO₂-NPs) are promising nano-enabled approach for enhancing plant tolerance to abiotic stresses. This study investigated foliar-applied TiO₂-NPs at the reproductive stage to alleviate adverse effects of individual and combined drought-heat stress in mustard (cv.

BARI Sarisha 14). The experiment was conducted following a completely randomized design with four replications. Ten treatments were used: i) Control, ii) Drought, iii) Drought + 20 ppm TiO₂, iv) Drought + 40 ppm TiO₂, v) Heat, vi) Heat + 20 ppm TiO₂, vii) Heat + 40 ppm TiO₂, viii) Drought + Heat, ix) Drought + Heat + 20 ppm TiO₂, and x) Drought + Heat + 40 ppm TiO₂. Drought was imposed by maintaining soil moisture at 14-16%, while heat stress was applied at flowering stage maintaining 38/25 °C Day/night temperature for four days. TiO₂-NPs were sprayed weekly from 38 to 78 days after sowing. Drought, heat, and their combination significantly reduced mustard growth, photosynthetic performance, chlorophyll fluorescence, pigment contents, and seed yield. The combined stress caused the greatest injury, reducing fresh weight and seed weight by 54% and 51%, respectively in comparison to control. Stress also decreased net photosynthesis, stomatal conductance, leaf greenness, quantum yield of PSII and electron transport rate, while increasing H₂O₂ and malondialdehyde (MDA) accumulation. Foliar application of TiO₂-NPs improved mustard performance under heat and drought stress, and 40 ppm was generally more effective than 20 ppm. Under combined drought-heat stress, foliar application of 40 ppm TiO₂-NPs increased seed weight by about 47% compared with untreated stressed plants and improved photosynthetic pigments, photosynthetic rate, and PSII efficiency. It also reduced H₂O₂ and MDA contents by 32% and 27%, respectively, while increasing superoxide dismutase, catalase, and guaiacol peroxidase activities by 82%, 113%, and 79%, respectively. Overall, foliar application of 40 ppm TiO₂-NPs, can be considered a promising strategy in improving heat-drought tolerance in mustard by enhancing growth and photosynthesis, maintaining redox balance and increasing seed yield.

Keywords: Titanium dioxide NPs, multiple stress, photosynthesis, oxidative damage, antioxidants, seed yield

Differential responses of MnCl₂ and methyl jasmonate on photosynthetic pigments, energy partitioning, and PSII kinetics in heat-stressed wheat seedlings

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Abstract

The appearance of above-optimum temperature severely affects every critical growth stage of wheat (*Triticum aestivum* L.), with a major impact during seedling stage. The exogenous application of nutrient and growth regulator could play potential role in sustaining seedling biomass under heat stress by modulating pigments content and photosystem II (PSII) efficiency in differential manner. In a lab experiment, the seedlings of a wheat genotype, namely AS-10636, were placed in growth chamber and kept under 'control' temperature condition (25/15 °C D/N). 'Heat stress' (38°C) was imposed for two days to wheat seedlings in another growth chamber. The foliar application of manganese chloride, MnCl₂ (2.5 mM) and methyl jasmonate, MeJA (20 µM) was provided to wheat seedlings before imposing 'Heat stress'. Photochemical parameters of 11-days old seedlings were analyzed using a multispeQ fluorometer (PhotosynQ). High temperature stress severely affects leaf thickness, leaf relative water content (LRWC), cell membrane stability (CMS), SPAD, total chlorophyll, and carotenoids content in wheat seedlings. Moreover, heat stress greatly increased the light energy partitioning pattern towards non-regulated dissipation (Φ_{NO}) option, leaving small amount of absorbed light for photochemistry (Φ_{PSII}) and regulated dissipation way (Φ_{NPQ}). In addition, the maximum quantum efficiency of PSII photochemistry (F_v'/F_m') and linear electron flow (LEF) were significantly reduced due to heat stress leading to significantly lowered shoot fresh and dry weight compared to control. The application of MnCl₂ and MeJA differentially ameliorated the negative impacts of heat stress and improved seedling shoot dry weight similar to control. Specifically, the MnCl₂ showed a superior ameliorative property regarding LRWC, total chlorophyll and carotenoids content compared to MeJA. However, a relatively greater amount of absorbed light was partitioned towards photochemistry and regulated dissipation was observed upon MeJA treatment compared to MnCl₂. The global wheat yield is severely being reduced due to the appearance of terminal heat stress during reproductive stage. The findings of this study could be a vital option to agronomists to sustain grain yield with an additional application of nutrient and/or growth regulator at the seedling stage.

Keywords: heat stress, manganese chloride (MnCl₂), methyl jasmonate (MeJA), non-photochemical quenching, quantum yield

Role of coumarin to enhance growth and stress tolerance mechanisms in jute under salinity

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Abstract

Jute is the second most significant fiber crop in the world. Abiotic stresses such as salinity, drought, waterlogging, and metal/metalloid toxicity restrict its growth, yield, and quality. Among them, salinity is one of the most detrimental abiotic stresses. Coumarin is a phenolic compound that functions as a natural growth regulator. Recent research highlighted that coumarin has the potential to improve plant performance under stress conditions. In this study, the effects of salinity on jute plants were investigated by foliar application of coumarin to mitigate salt stress. A pot experiment was carried out following a completely randomized design (CRD). Salt treatment (100 mM NaCl) was applied at 35 DAS at 7 days interval while coumarin (100 ppm) was applied as a foliar spray at the initiation of stress. Salinity significantly decreased plant height, leaf area, and chlorophyll content as well as increased malondialdehyde (MDA), hydrogen peroxide (H₂O₂), and electrolyte leakage (EL). These effects can be reduced due to coumarin, which is able to increase the content of chlorophyll, plant biomass, and antioxidant enzyme activities such as superoxide dismutase (SOD), lipoxygenase (LOX), catalase (CAT), ascorbate peroxidase (APX), and glutathione reductase (GR). Furthermore, the detoxification of methylglyoxal content was enhanced in coumarin-treated plants. Thus, application of coumarin induces the alleviation effects by salinity in the jute plant with promotion of growth and salt tolerance.

Keywords: Phenolic component, coumarin, antioxidant enzyme activities, salinity, methylglyoxal

Foliar application of titanium dioxide nanoparticles enhances drought resilience in wheat modulating growth, physiology, redox balance and grain yield

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Abstract

The severity and frequency of drought are increasing globally threatening wheat growth and productivity. Nanoparticles (NPs) like titanium dioxide (TiO₂) application might have the potential to combat drought stress in wheat. A triplicate pot experiment was conducted using a Completely Randomized Design to evaluate drought tolerance in three wheat cultivars (BARI Gom 33, BWMRI Gom 2, and BWMRI Gom 4) across five growth conditions: (i) Control (27-28% moisture content); (ii) Drought (12-14% moisture content), (iii) Drought + 20 ppm TiO₂-NPs, (iv) Drought + 40 ppm TiO₂-NPs, and (v) Drought + 60 ppm TiO₂-NPs. TiO₂-NPs were applied as foliar spray during the anthesis and grain-filling stages in wheat at seven days interval. Results revealed that drought significantly induced oxidative damage as reflected by increased malondialdehyde (MDA) and H₂O₂ accumulation impairing growth, photosynthesis, quantum yield of photosystem II (Φ_{PSII}), electron transport rate (ETR) and ultimately declined grain weight. In contrast, TiO₂-NPs-treated plants showed considerable restoration of these drought-induced adverse effects in wheat. However, responses to TiO₂-NPs varied depending on the cultivar and dosage. Drought reduced total grain weight per plant by 67–75% and thousand-grain weight by 54–61% relative to the control depending on cultivars. It reduced the quantum yield of photosystem II (Φ_{PSII}) by 29–36% at anthesis and 15–46% at grain filling stages while electron transport rate (ETR) by 7–11% and 10–20%, respectively as well. TiO₂-NPs application with 40 ppm almost fully restored drought-induced reduction in total grain weight. The 20 and 40 ppm treatments generally improved growth and yield, whereas 60 ppm produced the highest proline levels and total antioxidant capacity. Principal component analysis and hierarchical clustering heatmap indicated that 40 ppm TiO₂-NPs consistently performed well across the tested concentrations. Among the wheat cultivars, BWMRI Gom 2 showed greater improvements in several growth and yield-related traits, whereas BARI Gom 33 exhibited comparatively greater drought tolerance based on the stress tolerance index of all measured traits. Overall, foliar application of TiO₂-NPs, particularly at 40 ppm, showed considerable potential for enhancing wheat growth and resilience under drought stress, although genotype-specific responses were evident.

Keywords: Drought, nanoparticles, photosynthesis, stress tolerance index, oxidative damage, grain yield

Polyhouse technology for raising quality rice seedlings averting winter cold stress

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Abstract

The experiment was carried out at the field lab and Plant Physiology lab of the Department of Crop Botany, Bangladesh Agricultural University, Mymensingh and in the northern district of Rangpur during winter season to produce quality Boro-rice seedlings averting winter cold injury through use of portable poly-house covers. Seeds of different varieties (BRRI dhan28, BRRI dhan29, BINA dhan8 & BINA dhan10 along with BR18 as check) were sprouted and equal amount of seeds for each variety were sown in a well puddle land having unit plot size each of 1m². The experiment was laid out in RCBD with three replications. Immediately after seed sowing the seeded unit plots were randomly covered by portable small poly-houses for different durations (30 or 40 days) keeping open plots aside as control. Data were recorded on soil temperatures inside and outside the poly-house cover and also on seedling height, chlorophyll content in the seedlings which were grown under poly-house covers and open field (control). Results reveal that initial low soil temperature in the morning inside or outside the poly-house increased with advancement of the day till 2:00 PM and then declined but inside the poly-house the temperature increased over control by 5-7°C at noon time. Seedlings under poly-house cover were 35-80% taller than those in open field. It is interesting to note that chlorosis (yellowing of leaves) in the seedlings grown under poly-house was nil but the chlorosis was prominent in the seedlings grown in open field even in the seedlings kept open for 10 days. Seedlings grown under poly-house covers for 40DAS accumulated several folds high soluble sugar contents in the leaves compared to those grown in open field even covered by poly-house for 30 days. Seedling dry matter appeared to be double for poly-house cover compared to control plants. The results lead to the conclusion that warm condition inside poly-house might enhance physiological processes in the covered seedlings compared to those in open field and thereby enhanced the quality and healthiness of the seedlings through increasing height, chlorophyll & dry matter contents for the poly-house cover. Curtail in light intensity by 40% for poly-house cover has little or no significant negative impact on rice seedling quality. Seedlings grown in open field and under poly-house cover for different durations (30 and 40 days) also transplanted in rice field to know the subsequent carryover effects of poly-house on the growth and yield of Boro-rice. Irrespective of variety flowering and maturity time was enhanced by 10-15 days and grain yield also increased by 10-20% probably for the quality and healthiness of the seedlings from poly-house covers compared to those from open field. Almost identical results were recorded raising seedlings in farmers' field in sadar upazila of Rangpur district. Different colored polythene affected seedling growth differently with poor growth under green polythene and better growth in white polythene sheet.

Keywords: Poly-house technology, boro-rice seedlings, cold injury, seedling quality, grain yield

Development of an offline deep learning framework for real-time fish species identification and disease detection using YOLOv8 and MobileNetV2

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Abstract

Aquaculture plays a vital role in food security, nutrition, employment, and economic development in Bangladesh. However, accurate fish species identification and timely detection of fish diseases remain challenging, particularly for smallholder farmers who often rely on visual inspection and have limited access to technical diagnostic services. Delayed or inaccurate diagnosis can contribute to disease spread, production losses, and inefficient farm management. Although deep learning and computer vision have demonstrated considerable potential for automated fish monitoring, existing approaches have largely focused on individual tasks and frequently depend on laboratory or internet-based environments. Therefore, an integrated, practical, and offline system capable of fish detection, species identification, and disease detection is needed for field-level aquaculture management. This study aimed to develop an offline deep learning framework integrating fish detection, fish species classification, and fish disease detection into a mobile application. A custom dataset comprising 2,555 images was developed from freshwater aquaculture environments in Sylhet. Species were Mirror Carp, Stinging Catfish, and Climbing Perch—and three disease categories—Bacterial, Fungal, and Ulcer diseases, respectively. The images were pre-processed and manually annotated using the Computer Vision Annotation Tool (CVAT), followed by training, validation, and testing. Data augmentation techniques, including rotation, scaling, flipping, translation, brightness and contrast adjustment, mosaic, and mix-up augmentation, were applied to improve model robustness. YOLOv8n models were

trained for fish detection and disease detection, while MobileNetV2 was employed for fish species classification using transfer learning. Model performance was evaluated using Precision, Recall, F1-score, mAP@0.5, and classification accuracy. The fish detection model achieved 96.7% mAP@0.5, while the disease detection model achieved 93.7% mAP@0.5. The MobileNetV2 model achieved 94.8% overall classification accuracy. The trained models were converted to TensorFlow Lite and integrated into a Flutter-based Android application for offline real-time inference. The application achieved an average inference speed of 22.2 FPS, an average processing time of 3.33 seconds per image, and a 98% detection success rate. The developed framework demonstrates the feasibility of integrating deep learning and mobile computing for offline fish species identification and disease detection, providing a practical tool for smart aquaculture management.

Keywords: Aquaculture, fish species classification, fish disease detection, YOLOv8, MobileNetV2.

Developing a data-driven decision support model for assessing sustainable agriculture practices among smallholder farmers in Habiganj district, Bangladesh

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Abstract

Smallholder farmers in Bangladesh face growing challenges in maintaining farm production and household income while protecting natural resources and dealing with climate-related risks. In Habiganj District, differences in farming conditions, flash floods, rainfall, irrigation, market access, and extension services make sustainable agriculture a complex issue. However, there is limited local work that can measure farm-level sustainability and turn the assessment into clear and practical recommendations. This proposed study aims to develop a data-driven decision support model for assessing sustainable agriculture practices among smallholder farmers in Habiganj. A cross-sectional mixed-method study will be conducted among 420 farm decision-makers who cultivate up to 2.0 ha of land and have at least three years of farming experience. Multistage sampling will cover four representative upazilas, about 12 unions, and 24 villages. Survey data will be supported by field observations, six focus group discussions, and 12–15 key-informant interviews. Environmental and location-based variables will be linked to farm data using ArcGIS Pro and Google Earth Engine. A Sustainable Agriculture Practice Index (SAPI) will be developed using indicators related to environmental and resource management, economic performance and resilience, social and human well-being, and governance, services, and digital readiness. Indicators will be normalized and weighted using the entropy method. Alternative weighting methods will also be tested for sensitivity. Clustering methods will be used to identify sustainability groups. Penalized regression, random forest, support vector machine, XGBoost, CatBoost, KNN, and GBM will be used to predict sustainability outcomes and classify sustainability levels. SHAP and related methods will be used to explain model results. The study is expected to assess differences in sustainability performance and identify key socioeconomic, behavioural, institutional, farm-management, and environmental factors related to sustainable practices. It is also expected to produce a validated 0–100 SAPI, sustainability groups, risk flags, and farm-specific priority recommendations. A simple digital prototype and an offline scorecard will be developed for farmers and extension personnel. The proposed framework may support evidence-based agricultural extension, sustainability assessment, and planning in Habiganj and similar areas of Bangladesh.

Keywords: Sustainable agriculture, smallholder farmers, Sustainable Agriculture Practice Index, decision support model, machine learning.

Artificial intelligence in agriculture: Bridging research, practice and education

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Abstract

It is necessary to increase global food production to meet the demands of ever increasing population. However, conventional research approaches alone may not be sufficient to keep pace with the increasing demand for food and the challenges posed by climate change, resource constraints, and emerging agricultural problems. Therefore, there is an urgent need to boosting research capacity through innovative and alternative approaches, especially by

harnessing the potential of artificial intelligence (AI), big data, advanced analytics, and other promising emerging technologies. Incorporating these into agricultural research can hasten knowledge generation, improve decision-making, optimize resource use, and contribute to the development of more productive, resilient, and sustainable food systems. Agricultural research is AI is increasingly recognized as a pivotal driver of innovation in agricultural sciences, with profound implications for innovation, research, practice, and education. In research, AI facilitates advanced modeling, predictive analytics, and precision agriculture, enabling more accurate assessments of crop performance, resource utilization, and sustainable environment. In fact, AI-powered technologies—including machine vision, sensor networks, and decision-support systems—are reshaping farm management by enhancing efficiency, reducing input costs, and mitigating ecological hazards. In academics, AI contributes to curriculum modernization, immersive learning environments, and the development of digital competencies essential for future agricultural professionals. This paper critically go-through the integrative role of AI across these domains, emphasizing its capacity to bridge scientific inquiry, applied practice, and innovation. By situating AI within the broader discourse on sustainable development, the study underscores its potential to strengthen resilience in plant science systems while advancing the global agenda for sustainable AgroSciences.

Keywords: artificial intelligence, precision agriculture, smart farming, machine learning, digital competencies, sustainability

AI-based forecasting of major rice insect pest abundance from field and weather data in northern Bangladesh

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Abstract

Rice production in northern Bangladesh faces recurring yield losses of 15–30% from major insect pests, particularly brown planthopper (*Nilaparvata lugens*), yellow stem borer (*Scirpophaga incertulas*), and leaf folder (*Cnaphalocrocis medinalis*), with climate variability further complicating timely management. Locally calibrated, data-driven forecasting tools remain scarce in this context. This ongoing study develops an AI-based framework to predict pest abundance from field observations and weather parameters. Monitoring of pest populations, crop stage, and agronomic practices conducted across 8 sites in Rangpur and Dinajpur between 2025 and 2026 during Boro season, alongside concurrent weather data (temperature, relative humidity, rainfall, sunshine hours). Preliminary analysis of 480 observation points shows a positive association between brown planthopper density and relative humidity above 80% ($r = 0.68$), and between stem-borer incidence and cumulative rainfall during the vegetative stage. Random Forest and XGBoost models trained on these initial data reached 82–87% accuracy in short-term abundance forecasting; full-season validation and refinement are ongoing. These early results suggested that weather-informed models can meaningfully anticipate pest buildup, offering a basis for site-specific, proactive interventions as the framework matures. Such a tool could support SDG 2 by safeguarding staple-crop yields, SDG 12 through more targeted input use, and SDG 13 by embedding climate-driven prediction into pest management.

Keywords: Rice pest forecasting; machine learning; weather-based prediction; precision agriculture

Automated fish species detection and classification in aquatic environments using YOLOv11

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Abstract

The efficient monitoring of fish is vital for the successful operation of today's aquaculture management, but the conventional approaches to fish counting and identification are time consuming and labour intensive as well as being inaccurate. There are very few studies on the detection of commercially important freshwater fish species in Bangladesh using the latest developed YOLOv11 (a deep learning technique) architecture. In this regard, this research set out to create an automated fish detection and classification system using YOLOv11. The purpose of this study is to create a deep learning-based system for fish detection and classification using the YOLOv11 model that can identify fish species in aquatic environments, specifically targeting three species: Koi carp, Shing, and Tilapia.

6,178 annotated images of the selected fish species were used in the development of the model. Images were labeled using Roboflow and split into train, validation and test sets. Transfer learning was applied to fine-tune a pretrained YOLOv11s model to enhance the detection and classification accuracy. The model was trained on Google Colab Pro with the image resolution of 640×640 for 50 epochs. Accuracy, recall, F1, mean Average Precision at 0.5 Intersection over Union (mAP@0.5), and mAP@0.5:0.95 were used for the evaluation of the model. The performance of the model was evaluated by analyzing the training and validation loss curves, evaluation metrics, confusion matrix, and outputs of the visual detection. The trained YOLOv11s model achieved an accuracy of 94.07%, a recall of 93.25%, and an F1-score of 93.66% in the process of detecting and identifying the chosen fish species. Moreover, the model attained mAP of 96.04% and mAP 0.5:0.95 of 87.63%, which represents the good accuracy of the detection with different evaluation thresholds. The training and validation curves showed the model converged, whereas the confusion matrix gave information on the classification performance for the three species. The model also achieved good performance in localizing the position of fish by bounding boxes and giving class labels from the representative detection results. Overall, the results show that YOLOv11-based object detection is a promising method for automatic fish species detection and classification, which could be applied to monitor aquatic biodiversity, manage fisheries, and preserve natural resources. Expansion of the data set, fish species, and environmental conditions would facilitate the ability to make more robust and useful models, and should be a focus of future research.

Keywords: YOLOv11, deep learning, precision aquaculture, fish detection

Upscaling of livelihood through ecosystem restoration, smart agriculture and agro-ecotourism

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Abstract

As the globe need to produce almost 70% more food by 2050 in order to feed an expected 9 billion people, the problem of food security will only get aggravated. The issue of food security is exacerbated by agriculture's great vulnerability to changes in the climate. Climate change is already having a negative impact on agriculture with rising temperatures, greater weather variability, shifting agroecosystem boundaries, exotic crops and pests, and more often extreme weather events. Climate change has a wide range of negative effects on plant physiology and metabolism, soil fertility and carbon sequestration, microbial activity, and diversity, limiting plant growth and productivity and, eventually, food production. It has also greater impact on the nutritional quality of primary cereals and the output of farm animals. Food security has been already adversely affected by insufficient food supplies, variations in the price of staple foods, a high demand for agrofuels due to unexpected weather changes. Therefore, major adaptation investments will be necessary to sustain existing yields and enhance production and food quality to fulfil demands from great number of nations facing crisis as the consequence of natural disasters. The goal of climate-resilient agriculture (CRA) is to enhance long-term farm returns and productivity by sustainable utilization of natural resources through crop and livestock production systems. CRA practices need to integrate strategies of dealing landscapes-cropland, livestock, forests and fisheries-that addresses the interconnected challenges of food security and mitigate the climate change. In the context of climate change, CRA practises lower hunger and poverty for future generations, especially when done sustainably. CRA practises have the capacity to change the situation and maintain productivity in agriculture on a local, national, and international scale. Climate resilience is a fundamental concept of climate risk management and climate-resilient practises lead to improved access to and use of technology, open trade policies, greater utilisation of resource conservation techniques and increased agricultural and livestock tolerance to stress caused by climate change. In this paper, we will discuss about the tolerant crops and breeds of livestock and poultry, feed management, water management, fine tuning the gap between current management practices and essential agro-advisories, soil organic carbon, integrated farming system, IPM, cropping system, optimizing crop calendar, value chain, agro-ecotourism, agroforestry programmes for climate change adaptation, remote and proximal optical sensors (e.g. Green Seeker and SPAD-502), crop rotation, organic farming, natural farming as clean /green , low-greenhouse-gas-emitting technology that promote adaptation and mitigation in all sectors to achieve resilience directly and indirectly against climate change impacts in the short, medium and long term. The paper will cover how farmers, research institutions, funding agencies, governments, non-governmental organisations, and the corporate sector should work together to promote CRA.

Keywords: Climate-resilient agriculture (CRA), food security, climate change adaptation, sustainable farming systems, agricultural productivity

Transplanting of medium-age seedlings improves the productivity and quality of zero-tilled cotton in a coastal soil of southwestern Bangladesh

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Abstract

In the coastal region of southwestern Bangladesh, cropping intensity is constrained by late harvest of transplanted (T.) Aman rice, excess post-monsoon soil moisture, late-season soil salinity, and acute scarcity of fresh irrigation water. As a consequence, most of the lands remain fallow after the harvest of T. Aman rice. As a deep-rooted crop, cotton (*Gossypium* spp.) has moderate tolerance to salinity and moisture-deficit stress. It can be introduced under zero-tillage conditions, providing a strategic intervention to use residual soil moisture, reduce turnaround time, and avoid high salinity in the dry season. However, cotton possesses a sensitive taproot system prone to transplanting shock; identifying the precise seedling age at transplanting is critical in achieving robust crop establishment and optimizing productivity. A two-factor field experiment was conducted in the coastal saline ecosystem of southwestern Bangladesh to evaluate the optimum seedling age of transplanting summer cotton for proper vegetative growth, phenological development, to get better yield attributes, and yield under zero tillage conditions. The experiment was laid out in a randomized complete block design with three replications, comprising two genotypes (Rupali-1 and CB-17) and six seedling ages (transplanting of 14, 21, 28, 35, and 42-day-old seedlings and direct sowing) as experimental treatments. Seedling age significantly influenced growth, phenological attributes, growth parameters, yield, and quality traits of cotton. Transplanting of 28-day-old seedlings of Rupali-1 genotypes demonstrated superior field performance and recorded maximum leaf area index (2.78), number of total branches plant⁻¹ (19.33), and plant dry biomass (113.67 g). This treatment produced the highest number of splitted bolls plant⁻¹ (16.83) and the highest individual boll weight (4.32 g), resulting in the peak seed cotton yield (2.87 t ha⁻¹), ginning outturn (35.55%), mean lint length (26.23 mm), and micronaire value (4.16 µg/inch). In contrast, direct sowing yielded significantly lower output (0.45 t ha⁻¹) due to delayed emergence, shortage of fresh water, and vulnerability to fluctuating surface salinity. Transplanting of 35, 42, 21, and 14-day-old seedlings also decreased productivity to 2.14, 1.82, 1.50, and 0.99 t ha⁻¹, respectively, due to cooling injury, taproot damage in polybags, and severe transplanting shock, which impaired root deepening into subsoil moisture. The results suggested that transplanting middle-aged (28–35 days old) seedlings under zero-tillage conditions effectively avoids critical salinity stress, shortens field duration, secures high crop establishment, and increases yield and quality. This technique offers a climate-resilient management practice for expanding summer cotton cultivation across fallow coastal areas of southwestern Bangladesh.

Keywords: Summer cotton, seedling age, zero tillage, coastal saline soils, seed cotton yield, transplanting shock

An open multi-source data engineering framework for district-level agricultural vulnerability assessment in Bangladesh

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Abstract

Integrating heterogeneous geospatial, climate, hydrological, and agricultural datasets into reproducible analytical pipelines remains a critical bottleneck for agricultural monitoring in data-scarce regions. No prior study has harmonized satellite-derived crop health, gridded climate reanalysis, hydrological inundation, and district-level yield statistics into a single auditable pipeline covering all 64 districts of Bangladesh. This paper presents an open-source agricultural data engineering framework that automates the harmonization of six public datasets through a Bronze–Silver–Gold medallion architecture implemented in Python and DuckDB, consolidating 1,347 district–year observations (2001–2022). Yields directly observed by the Bangladesh Bureau of Statistics (BBS) are available from 2012 onward; the full 22-year panel is therefore reported as a demonstration of framework operability, while the BBS-actual subsample (2012–2022) is the primary econometric result. The framework was validated through a district-scale Boro rice vulnerability assessment using spatial autocorrelation, composite vulnerability indexing, and

two-way fixed-effects panel regression. The composite vulnerability index revealed strong spatial clustering (Moran's $I = 0.804$, $p < 0.001$), with 14 LISA high-high hotspot districts forming a continuous belt across the southwest delta. Panel regression on the BBS-actual subsample identified NDVI anomaly as the dominant within-district yield predictor (-2.32 MT/ha, $p < 0.05$). The correctly lagged flood coefficient was negative but non-significant in the short panel ($T = 11$ years) and is reported as an informative null. A spatial lag model confirmed robustness to spatial dependence, and weight sensitivity analysis confirmed ranking stability (Spearman $\rho = 0.978$). The framework resolves over 100 district-name conflicts across six source schemas and produces fully reproducible outputs transferable to other data-scarce agricultural regions. All code, processed datasets, and an interactive Streamlit decision-support dashboard are openly available at <https://github.com/TasMumu/Bangladesh-Agri-Research>.

Keywords: Boro rice, agricultural vulnerability, spatial autocorrelation, fixed-effects panel regression, NDVI, flood inundation, DuckDB, food security, remote sensing

Farmers' adoption of climate smart agricultural practices in maize cultivation

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Abstract

The Climate-Smart Agriculture (CSA) concept was developed with a strong focus on food security as well as environmental change adaptation and mitigation. The CSA technologies and practices present opportunities for addressing climate change challenges, as well as for economic growth and development of the agriculture sector. Therefore, the objectives of this study were to determine the extent of adoption of CSA practices as well as to explore the relationships between the selected characteristics farmers and adoption of CSA practices in maize cultivation. The study was conducted among maize farmers of selected villages under Dinajpur district in northern Bangladesh. Data were collected from 120 maize farmers using simple random sampling techniques. Statistical measures such as range, means, standard deviation, number and percentage were used to describe the variables. Pearson's Product Moment Coefficient of Correlation (r) was used to explore the relationships between the variables concerned. The SPSS computer package was used to perform statistical analysis. Based on the overall adoption scores, the respondents were classified into three categories such as low (8-12), medium (13-21) and high (above 21). The results indicated that the highest proportion (69.2 percent) of the respondents had medium level of adoption of CSA practices followed by 18.3 percent high level and 12.5 percent low level of adoption. This means that most farmers had medium level of adoption of CSA practices in maize cultivation. Among the 10 selected characteristics of the farmers, five (5) characteristics namely education, annual income, extension contact, training, and experience showed significant and positive relationship with adoption of CSA practices, while one (1) characteristic such as age showed significant negative relationship. In addition, farmers faced various problems in adopting CSA practices for maize cultivation. Among the identified constraints, high cost of irrigation ($PI = 313$) ranked 1st, followed by increased pest and disease incidence ($PI = 184$), ranked 2nd for maize cultivation. This study provides an empirical contribution to literature to investigate the socio-economic factors that influence farmers' adoption of CSA practices in maize cultivation. It recommends that different government and non-government extension programs are necessary to promote extension services to increase the adoption of CSA practices for maize cultivation.

Keywords: Farmers, adoption, climate smart agricultural (CSA) practices, and maize, cultivation

Morpho-physiological and yield assessment of strawberry genotypes under pot and field conditions

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Abstract

Strawberry (*Fragaria* $\times$ *ananassa* Duch.) is an economically important fruit crop valued for its nutritional attributes and market demand. However, strawberry production in tropical and sub-tropical regions is often constrained by climatic stress and variability in soil conditions. Genotypic adaptability and cultivation methods are therefore critical influencing growth, reproductive performance, fruit quality and yield stability. This study evaluated the morpho-

physiological, reproductive and yield responses of three strawberry genotypes- RABI-3 (V1), BARI strawberry-2 (V2), and BARI strawberry -3 (V3) under Pot and Field condition at Sylhet Agricultural University, Bangladesh from September-2025 to March 2026. The Experimental was conducted following a factorial Completely Randomized Design (CRD) for pot culture and a Randomized Complete Block Design (RCBD) for field condition with three replications. Pot cultivation provided a completely favourable microenvironment, characterized by higher soil temperature (21.0 °C) and moisture content (35%) at 80 days after transplanting, compared with field conditions (19.8 °C and 30%, respectively). Morphological traits including plant height (26.27 cm), leaf number (11/67 plant⁻¹), and crown diameter (41.0 mm), were significantly enhanced under pot culture, particularly in RABI-3. Physiological attributes such as leaf greenness, relative water content, chlorophyll, carotenoid content and photosynthetic efficiency were also higher in pot grown plants, especially in BARI strawberry-3. Significant genotypic variation was observed in floral characteristics, BARI-Strawberry-3 producing larger floral organs and greater reproductive potential. Pot grown plant exhibited earlier flowering and reduced time to fruit set and extended flowering and fruiting duration. Among the tested genotypes BARI Strawberry-3 demonstrated superior performance, producing the highest number of flowers (34.67 plant⁻¹) and fruits (31.33 plant⁻¹), larger fruit (16.5 gm fruit⁻¹), and improved fruit quality, including higher total soluble solids (9.2 °Brix) and vitamin C content (67.7 mg 100 g⁻¹ FW). Overall, BARI strawberry-3 showed superior adaptability and productivity, under subtropical conditions, highlighting its potential for sustainable Strawberry cultivation in Sylhet.

Keywords: *Fragaria X ananassa* Duch., genotypic variability, morphological traits, yield components, pot culture, field performance

Harnessing shed cultivation for enhanced strawberry performance in changing climates

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Abstract

Climate change, particularly rising temperatures, increasing heat stress, and irregular moisture conditions, is becoming a major constraint to sustainable fruit production in subtropical regions. Strawberry (*Fragaria × ananassa* Duch.) is a temperate region crop, highly susceptible to temperature fluctuations and water stress, making its cultivation challenging under changing climatic conditions. Protected cultivation by microclimate modification may provide an effective adaptation strategy for maintaining plant growth, physiological functioning, productivity, fruit quality, and yield. The study was conducted during 2025-2026 to evaluate the performance of three strawberry varieties, namely RABI-3, BARI Strawberry-2, and BARI Strawberry-3, under shed and open field conditions and the experiment was arranged in a Randomized Complete Block Design (RCBD) with three replications. Vegetative growth, physiological characteristics, and fruit quality attributes were evaluated at 40, 60 and 80 DAT to assess the potential of shed cultivation as a climate resilient production approach. The result demonstrated a clear influence of growing environment on strawberry production. Shed cultivation created a comparatively favorable microenvironment by reducing soil temperature and maintain higher soil moisture than open field conditions. At 80 DAT, soil temperature was 19.8 °C under shed conditions compared with 24.0 °C in the open field, while soil moisture was 37% and 30%, respectively. The moderated soil environment under the shed supported better plant establishment and growth. Plant height and crown diameter reached 28.40 cm and 16.42 mm, respectively, under shed conditions, with BARI Strawberry-3. Physiological responses were also improved under shed, including leaf area, relative water content (88.23%), chlorophyll accumulation, and photosynthetic efficiency. The positive effects of shed condition were further reflected in reproductive performance and fruit quality. BARI Strawberry-3 produced the highest fruit fresh weight (23.8 g), followed by RABI-3 (21.7 g). Similarly, BARI Strawberry-3 produced the highest number of fruits per plant under shed conditions (30.33), improved TSS (9.1%), dry matter accumulation, and vitamin C concentration (61.53 mg 100 g⁻¹), whereas RABI-3 under open field condition recorded the lowest values. Overall, the findings demonstrate that shed based protected cultivation can modify the crop microenvironment and reduce the adverse effects of heat and moisture stress on strawberry growth, physiological performance, productivity, and fruit quality. The combination of shed cultivation and BARI Strawberry-3 therefore, represents a promising climate adaptation approach for sustaining strawberry production under increasing climatic conditions.

Keywords: Climate resilience, climate adaptation, strawberry, microclimate modification, sustainable cultivation

Physiological and molecular responses of rice to seed priming under high temperature stress

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Abstract

High-temperature stress is a major abiotic constraint to rice production in Bangladesh and can severely impair reproductive development, increase spikelet sterility and ultimately reduce grain yield, thereby threatening food security. A three-factor experiment was conducted to evaluate the effectiveness of seed priming in mitigating high-temperature stress in two rice varieties, BRRI dhan89 and BAU Dhan-3. Four seed-priming treatments were evaluated: non-primed control (P0), 5% moringa leaf extract (P1), 1% potassium chloride (P2) and 5% polyethylene glycol (P3), under two temperature regimes: ambient temperature (T0) and high temperature (40 °C Day/30 °C night; T1). The experiment was laid out in a randomized complete block design (RCBD) with four replications, and high-temperature stress was imposed for seven days at the booting stage in a controlled greenhouse chamber. High-temperature stress markedly increased spikelet sterility from 15.02% under ambient conditions to 97.91% under heat stress and reduced pollen fertility from 91.60% to 5.63%, resulting in substantial reductions in 1000-grain weight, grain length and grain width. Photosynthetic rate, stomatal conductance and transpiration rate were also significantly reduced under high-temperature stress. BAU Dhan-3 consistently exhibited greater thermotolerance than BRRI dhan89, as reflected in higher pollen viability, chlorophyll content, vascular bundle development and proline accumulation. Under heat stress, PEG priming most effectively maintained 1000-grain weight and vascular bundle number, whereas MLE priming partially improved photosynthetic performance. Molecular analysis revealed stronger expression of *TT1*, a gene associated with protein quality control through the 26S proteasome pathway, in BAU Dhan-3, while *HTH5*, which is involved in cellular redox homeostasis, was upregulated in both varieties. Among the priming treatments, PEG osmo-priming (P3) most consistently maintained the expression of *TT1* and *HTH5* under high-temperature stress. Multivariate analysis further indicated that temperature was the dominant source of variation, accounting for 45% of the variation along PC1, while the effects of seed priming varied between the two varieties. Thus, BAU Dhan-3 exhibited comparatively greater thermotolerance and a more favorable response to seed priming, while PEG priming showed the most consistent effects on structural, physiological and molecular responses under high-temperature stress.

Keywords: High-temperature stress, rice, seed priming, PEG, spikelet sterility, pollen fertility, thermotolerance and molecular response

Production and characterization of jute stick-derived biochar and its potential for soil water retention in sustainable agriculture

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Abstract

Jute sticks are important agriculture residues in Bangladesh, which are produced in large quantities after extraction of fiber. They can potentially be used for a variety of agricultural activities including fuel, organic fertilizer and soil improvement. Converting them into biochar through pyrolysis can further enhance their value as a carbon-rich soil amendment for sustainable agriculture. Therefore, this study preliminarily evaluated the potential of jute stick-derived biochar to improve soil water retention. The study was conducted at the Soil Science Laboratory of the Bangladesh Jute Research Institute (BJRI), Manik Mia Avenue, Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh. Dried jute sticks were pyrolyzed at 400°C in a muffle furnace to produce biochar for physicochemical characterization and application as a soil amendment. The resulting biochar was characterized using proximate analysis, Fourier transform infrared (FTIR) spectroscopy to identify functional groups, and pH_{pzc} to measure the surface-charge behavior. A preliminary experiment was conducted under controlled conditions, using a completely

randomized design (CRD), and the biochar amended soil was compared with untreated soil. The gravimetric method was used to determine the water-holding capacity. Biochar yield was 34% of which 16.72% was moisture, 23.28% was volatile matter, 12.00% was ash, and 48.00% was fixed carbon. The relatively high fixed-carbon content suggests potential carbon stability and sequestration. The pH_{pzc} was 5.90, indicating that the biochar surface charge changes around a mildly acidic pH. The FTIR peaks at 3399 cm^{-1} (O–H stretching), 1699 cm^{-1} (C=O carbonyl/carboxyl), 1378 and 1227 cm^{-1} (C–O stretching) and 751 cm^{-1} (aromatic C–H bending) showed that oxygen containing functional groups and aromatic carbon structures were produced during pyrolysis. The water-holding capacity of the soil amended with biochar was $14.62 \pm 0.17\%$, while the control soil had $13.58 \pm 0.14\%$, which corresponds to a relative increase of 7.66%. Jute stick-derived biochar produced at 400°C showed favorable physicochemical properties, including high fixed-carbon content, oxygen-containing surface functional groups, and a pH_{pzc} of 5.90, suggesting its potential as a soil amendment to improve water retention. Biochar produced at 500°C and 600°C will be studied, with the results being used to analyze their mineral content, examine their surface morphology using scanning electron microscopy (SEM), and determine the organic matter content, to better understand the effects of temperature and optimize the use of the biochar.

Keywords: Jute biochar, soil water, proximate analysis, FTIR, sustainable agriculture

Genotype-by-environment interactions in BARI released potato varieties using GGE-biplot and AMMI model

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Abstract

Potato (*Solanum tuberosum*) is an important field crop of Bangladesh, whose yield are markedly influenced by agro-climatic conditions and the genotypic variability. Therefore, the study of the genotypes by environment interaction (GEI) analysis is a prerequisite for the selection of climate resilient and stable potato genotypes. The present study evaluated 14 BARI released potato varieties over two years and three locations with unfavourable ecosystems in Sylhet region using additive main effects and multiplicative interactions (AMMIs) and genotype plus genotype-environment interaction (GGE) biplot analyses. In the AMMI biplot analysis, PC1 explained 63% of variations and PC2 was responsible for 20.3% of variations. The results indicated that there were significant differences for the tuber yield among the potato varieties. It was also observed that BARI Alu-50 followed by BARI Alu-77, BARI Alu-63, and BARI Alu-90 gave the higher yield i.e., 43.1 tha^{-1} , 41.2 tha^{-1} , 38.4 tha^{-1} , and 36.8 tha^{-1} , respectively across the environmental conditions. BARI Alu-50, BARI Alu-77, BARI Alu-63, and BARI Alu-90 were observed to perform better in all the environment except one. Our result indicated that, this approach could be recommended for identification of climate smart potato varieties for the Sylhet region.

Keywords: stability analysis, AMMIs, GGE-biplot, climate resilience, potato

Role of agricultural extension services in promoting climate-smart agricultural practices in the barind tract

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Abstract

The increasing vulnerability of agriculture to climatic risks underscores the need for effective agricultural extension services to promote climate-smart agricultural practices in the Barind Tract. This study sought to assess the perceived role of agricultural extension services in promoting climate-smart agricultural practices and identify the challenges faced by farmers in adopting such practices in the Barind Tract. A sample of 97 farmers was selected from two villages in Fulbari Upazila, Dinajpur District, using a multi-stage sampling (purposive and random) method. Data were collected through personal interviews from May 15 to June 14 using a structured interview schedule. The perceived role of agricultural extension services was measured using a 7-point semantic differential scale ranging from 1 (very weak) to 7 (very strong), while challenges faced by farmers were measured using a four-point rating scale. Pearson's correlation (r) was used to examine the relationships, and multiple linear regression was used to identify the explanatory factors influencing the perceived role of agricultural extension services. The findings

revealed that the majority of farmers perceived agricultural extension services as having a moderate role in promoting climate-smart agriculture. Dimension-wise analysis showed that extension services played the strongest role in awareness and knowledge creation. Age, years of schooling, family size, farming experience, access to facilities, and extension media contact showed significant relationships with farmers' perceived role of agricultural extension services. Regression analysis further revealed that farming experience, access to facilities, and perception of climate-smart benefits significantly explained variation in farmers' perceived role. The findings revealed that farmers experienced a moderate level of challenges in adopting climate-smart agricultural practices, particularly due to unpredictable weather conditions, high initial costs, limited access to credit, poor rural infrastructure, and inadequate access to CSA inputs, equipment, and services. These findings highlight the need for extension programmes and policies that prioritize awareness and knowledge creation, training and capacity building, and improved access to necessary facilities to enhance the role of agricultural extension services in promoting climate-smart agricultural practices in the Barind Tract.

Keywords: agricultural extension services, barind tract, climate-smart agriculture, perceived role, and semantic differential scale

Optimizing fertilizer rates and plant population for wheat production under controlled greenhouse conditions

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Abstract

Wheat productivity is largely influenced by fertilizer management and plant population. This study was conducted to evaluate the effects of different fertilizer rates and plant populations on the growth, phenology and yield of wheat under controlled greenhouse conditions. The experiment was carried out using the wheat variety BWMRI Gom-5 in a two factor factorial Completely Randomized Design (CRD) with three replications. Four fertilizer rates were evaluated: T₁ (recommended field dose), T₂ (double the recommended dose), T₃ (five times the recommended dose) and T₄ (ten times the recommended dose). Three plant population levels were tested, such as V₁ (10 plants pot⁻¹), V₂ (50 plants pot⁻¹) and V₃ (100 plants pot⁻¹). Data were analyzed using analysis of variance (ANOVA) and treatment means were compared using the Least Significant Difference (LSD) test at the 5% level of significance. Wheat reached heading within 39.67–41.67 days and physiological maturity within 75.33–87.67 days. Grain yield, grains per spike, biomass and harvest index differed significantly among the treatment combinations. Among all treatment combinations, T₃V₁ produced the highest grain yield (8.05 g pot⁻¹), grains per spike (19.53), biomass (21.27 g pot⁻¹) and harvest index (51.31) and total grain weight (73.72 g). Under the conditions of this study, the combination of the T₃ fertilizer rate (five times the recommended dose) with the V₁ (5 plants per pot) plant population was identified as the optimum treatment for maximizing grain yield and resource use efficiency. These results provide useful information for optimizing fertilizer management and plant population in greenhouse wheat production and may support future research on controlled environment wheat cultivation.

Keywords: Wheat production, greenhouse cultivation, BWMRI Gom-5, plant population and fertilizer rates

Guar bean (*Cyamopsis tetragonoloba* L.) as a new legume crop in Bangladesh: unveiling genotypic diversity and guar gum traits

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Abstract

Guar bean (*Cyamopsis tetragonoloba* L.) is a multifunctional leguminous plant valued for its galactomannan-rich endosperm and diverse industrial applications. The phenotypic performance and microstructural features of guar gum in Bangladesh are limited. Therefore, this research work evaluated the morphological and yield-contributing traits of five genotypes of guar bean (G1-G5) and characterized the microstructure of guar gum from the best-performing genotype through Scanning Electron Microscopy (SEM). The genotypes were found to differ significantly ($p < 0.05$) with respect to root length (6.5–11.8 cm), shoot height (102.7–183.8 cm), leaf area (130.3–

374.9 cm²), pod clusters plant⁻¹ (8.0-19.0), pods cluster⁻¹ (2.3-4.2), thousand-seed weight (36.0-86.79 g), seed mass plant⁻¹ (11.7-26.0 g). Among the evaluated genotypes, G2 showed the highest yield attributes compared to G5. Thus, G2 was selected for further gum characterization. SEM analysis at 100×, 500×, and 1000× magnification revealed that the granules had an irregular and heterogeneous form and relatively smooth to slightly rough surfaces. The observed particle size ranged from 12.8 to 14.3 μm, indicating a fine granular structure of the extracted gum. The combination of agronomic evaluation with SEM-based characterization of the microstructure of guar gum gives a preliminary assessment of the productive potential of G2 and the physical characteristics of guar gum. These findings support further multilocation evaluation of G2 and detailed investigation of its gum quality and potential industrial applications.

Keywords: guar bean, phenotypic variation, yield attributes, guar gum, galactomannan, scanning electron microscopy

Integrated effect of vermicompost and micronutrients on growth and yield of cauliflower in calcareous soils of Bangladesh

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Abstract

A field experiment was conducted to evaluate the integrated effect of vermicompost and micronutrients on growth and yield of Cauliflower (Snow white) in Calcareous soils of Bangladesh during the *Rabi season* (November 2024 to February 2025) at the experimental field of Department of Crop Science and Technology, Faculty of Agriculture, University of Rajshahi, Bangladesh belonging to the High Ganges River Floodplain (AEZ-11). The experimental field soil was silty clay loam in texture having pH 7.95, organic matter 1.12%, total N 0.04%, available P 14.33 ppm, exchangeable K 0.28meq/100g, exchangeable Ca 26.36 meq/100g, exchangeable Mg 11.65 meq/100g, available Zn 0.39 ppm and available B 0.22ppm. The experiment consists of eight treatments *viz.* T₀ = control, T₁ = Vermicompost (VC @ 5t/ha), T₂ = VC (10 t/ha), T₃ = Zn₃, T₄ = B₄, T₅ = Zn₃B₄, T₆ = VC (5 t/ha) + Zn₃B₄, T₇ = VC (10 t/ha) + Zn₃B₄. NPK used as basal dose and doses of N-P-K-Zn-B were 150-60-120-3-4 kg/ha respectively these were used as the form of Urea, TSP, MoP, Zinc oxide and Boric acid respectively. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The growth and yield contributing parameters of cauliflower were significantly increased by the application of VC and micronutrients. The highest plant height (56.70 cm), number of leaves/plant (19.79), leaf size (47.69 x 23.30 cm), plant spread (73.51 cm), curd diameter (18.67 cm), curd height (12.43 cm), curd diameter (18.67 cm), curd weight/plant (1471.4gm) and marketable curd yield (47.09 t/ha) recorded in T₇ treatment. The minimum growth and yield parameters were found in control. For 100% curd initiation the maximum time (79.82 days) recorded in T₀. The early curd formation was recorded in T₇ (65.12days) and maximum (77.26 days) in control plot. The result indicated that the combine application of Zn and B with VC (10t/ha) increased the vigorous vegetative growth and yield (179.33%) of cauliflower than control. B was found more effective for proper curd formation in cauliflower. The present finding and previous research work in this area suggested that the deficiency of Zn and B is more common in calcareous soil. So, it can be recommended that Zn (3 kg/ha) and B (4 kg/ha) may be applicable in upland crops for farmer's level.

Keywords: Cauliflower, vermicompost, zinc and boron, micronutrient management, calcareous soil, curd yield

Environmental and economic performance of organic and conventional sugarcane farming systems

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Abstract

A comparative assessment was conducted to evaluate energy use, greenhouse gas emissions, carbon footprint and economic performance of conventional and organic sugarcane production systems in Bangladesh. Primary farm-level data were collected through structured face-to-face interviews with sugarcane farmers during 2022-2024 across Rajbari, Pabna, Gazipur and Natore districts of Bangladesh. Energy inputs were quantified for major production operations and material inputs, while carbon and economic indicators were used to assess environmental and financial performance. Conventional sugarcane production required 55.21 GJ ha⁻¹ of total input energy, compared

with 13.70 GJ ha⁻¹ under organic farming, representing approximately 75% lower energy requirement in the organic system. In conventional farming, pesticides and fertilizers accounted for 41.88% and 30.75% of total energy input, respectively, whereas sett material was the dominant energy component in organic farming (53.45%), followed by organic manure (11.67%), human labor (10.78%) and diesel (10.47%). Energy productivity was substantially higher under organic farming (3.01 kg MJ⁻¹) than under conventional farming (1.02 kg MJ⁻¹), while specific energy requirement decreased from 0.98 to 0.33 MJ kg⁻¹. Organic farming also reduced greenhouse gas emissions from 6074.46 to 4122.72 kg CO₂-eq ha⁻¹ and carbon footprint from 0.107 to 0.035 kg CO₂-eq kg⁻¹ cane, corresponding to reductions of approximately 32% and 67%, respectively. However, conventional farming generated greater economic returns, with a benefit–cost ratio of 1.71 and net return of BDT 195,982 per hectare, compared with 1.39 and BDT 104,688 per hectare under organic farming. The results demonstrate a clear environmental-economic trade-off between the two production systems. Organic sugarcane production substantially reduced energy demand and carbon intensity, whereas conventional farming remained more profitable. Improving productivity and cost efficiency of organic sugarcane production could therefore strengthen its potential as a low carbon and economically viable production system.

Keywords: GHG emission, energy budget, carbon footprint, BCR and sugarcane

Integrated biochar-fertilizer management for climate-smart sugarcane production

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Abstract

Recycling sugarcane residues as biochar offers a promising approach for improving nutrient management and crop productivity while promoting more resource-efficient sugarcane production. A field experiment was conducted at the Regional Sugarcrop Research Station, Gazipur, during the 2024-2025 cropping season to evaluate the response of sugarcane to different rates of sugarcane bagasse biochar applied with the recommended fertilizer dose (RFD). The experiment was laid out in a randomized complete block design with three replications using BSRI Akh 41. Eight treatments were evaluated viz, RFD alone and RFD supplemented with bagasse biochar at 1.0, 1.25, 1.50, 1.75, 2.0, 2.25 and 2.50 tha⁻¹. Biochar application significantly influenced major growth and yield attributes. The application of RFD with 2.25 tha⁻¹ biochar produced the highest tiller population (78.56×10³ ha⁻¹), millable cane population (58.10×10³ ha⁻¹), stalk height (2.50 m), single-cane weight (1.46 kg) and cane yield (84.97 tha⁻¹). The corresponding yield under RFD alone was 52.89 tha⁻¹, indicating an increase of approximately 60.7% with the 2.25 tha⁻¹ biochar treatment. Increasing the biochar rate to 2.50 tha⁻¹ did not result in further yield improvement, with cane yield declining to 79.47 tha⁻¹. The highest brix value (22.06%) was recorded with RFD + 2.50 tha⁻¹ biochar, whereas RFD + 2.25 tha⁻¹ produced 21.81% brix. These findings indicate that integrating sugarcane bagasse biochar with recommended fertilizer can substantially improve sugarcane growth and productivity, with 2.25 tha⁻¹ emerging as the most effective biochar rate under the conditions of the study. Such recycling of bagasse may contribute to resource-efficient and climate-smart sugarcane production.

Keywords: Sugarcane bagasse biochar, nutrient management, fertilizer optimization, soil health and sustainable agriculture

Innovating floating farming towards sustainable vegetable production in climate stressed haor areas

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Abstract

The study focuses on floating gardening related new knowledge, practice and technology use of the farmers towards making this farming as a sustainable enterprise in the face of climate stresses prevail in haor area. Sustainability was assessed based on production risk and vegetable yields. Both qualitative and quantitative methods of research were followed. FGD and KII discovered emerging floating gardening knowledge, practice and technology used by the farmers. Identified new knowledge and practices were provided through training program. Besides, a total of five on-farm trials combinations in two purposively selected villages were established to evaluate durable and profitable

floating farming systems. Respective floating farms owners did all the activities as per instruction of the researchers. Data on crop production practice and yield of each crop of each garden were properly recorded by the researcher. The survey of 60 farmers was conducted from July to September 2024 in Holdipur union under Jagannathpur upazila of Sunamganj through systematic random sampling method from 123 floating farmers. Results revealed that 33% of the respondents had high knowledge, while 48% moderate and only 19% had low knowledge. But only about 10% of the responds presently continued this farming, of which overwhelming majority (75%) had traditional method in conducting floating gardening, and the rest 25% had slightly moderated durable floating farms. Results also revealed that water spinach, red amaranth and radish were the top three yield producing vegetables having the yield of 25.42 t/ha, 6.6 t/ha and 2.34 t/ha, respectively. While the profuse presence of leach, severe weed infestation and weeding difficulties in the deep water, various disease and pest on growing vegetables, disperse of floating beds by heavy rainfall were found major problems in adopting by the mass people of the Haor areas. It was also found that farmers age, level of education, farm size, family size, time spent in floating vegetable farming, knowledge and organizational participation had significant impact on this practice. However, floating farming can come out as a satisfactory economic approach if it is adopted in large scale; necessary steps need to be taken for mass adoption of this practice at a commercial basis by converting water logged area in to crop field.

Keywords: Haor, sustainability, climate, innovation, vegetable, floating gardening

Climate change impacts and planting-time adaptation for potato production in the non-saline coastal zone of Bangladesh using a crop-hydrological model

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Abstract

Climate change poses a growing threat to crop productivity in Bangladesh's coastal region, yet quantitative assessments of future impacts on potato production and practical adaptation options remain limited. This study evaluated how climate change affects potato growth and yield and examined planting-time adjustment as a potential adaptation strategy in the non-saline south-central coastal region Bangladesh using the coupled SWAP-WOFOST (Soil-Water-Atmosphere-Plant–World Food Studies) model. We calibrated and validated the model for potato growth duration and yield using locally measured field data and weather conditions. The validated model was subsequently used to simulate potato growth and yield under three planting dates (10 November, 20 November, and 1 December) for a baseline period (1991–2020) and future periods in the 2050s (2034–2064) and 2080s (2065–2094) under the high-emission SSP585 scenario. We derived climate projections from five bias-corrected Global Climate Models (GCMs). Results indicated substantial reductions in potato growth duration and yield under projected climate conditions compared with the baseline. Depending on planting date, potato yield will decline by 31–51% in the 2050s and 56–64% in the 2080s. Earlier planting generally resulted in longer crop duration and higher yields than later planting, suggesting that adjusting planting time could partially reduce climate-related yield losses. Simulations with elevated atmospheric CO₂ concentrations projected yield increases of more than 20% in the 2050s and about 60% in the 2080s relative to simulations without CO₂ fertilization. However, yields were still less than the baseline period. Therefore, the projected CO₂ fertilization effect will not fully compensate for climate-induced productivity losses. The study provides quantitative evidence to support climate-informed crop management and adaptation planning for the coastal region of Bangladesh.

Keywords: Planting time, growth and yield, SWAP-WOFOST, coastal Bangladesh

Interactive effects of biochar and fertilizer on sunflower and soil properties in southwestern coastal Bangladesh

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Abstract

Salinity, water logging, poor drainage and decreasing soil quality are the reasons for low cropping intensity in coastal Bangladesh and land remaining fallow during Rabi season following T. Aman harvest. Improving soil health through suitable agronomic management opens up avenues for increasing crop yield and cropping intensity. A field study

was conducted in this region during the Rabi season to evaluate the interactive effects of biochar and fertilizer on sunflower (*Helianthus annuus L.*) yield and post-harvest soil properties. The experiment followed a randomized complete block design with a factorial arrangement comprising four biochar levels (0, 2.5, 5.0, and 7.5 t ha⁻¹) and four chemical fertilizer rates for sunflower (0%, 50%, 75%, and 100% of the recommended dose of fertilizers). Results showed that significant ($p < 0.05$) individual and interactive effects of the treatments on both plant traits (Leaf area index, SPAD value, relative leaf water content, yield, proline content) and soil traits (EC, soil moisture, solute potential, bulk density). Applying biochar at 2.5 to 7.5 t ha⁻¹ markedly lowered the topsoil EC through increasing soil moisture content, reducing solute potential with low bulk density. Application of 100% full dose of fertilizer with 5.0 t ha⁻¹ biochar produced maximum yield (3.6 t ha⁻¹), which was statistically similar to that of 75% of full dose fertilizer and 5.0 t ha⁻¹ biochar (3.4 t ha⁻¹). Combinedly, 7.5 t ha⁻¹ biochar and 100% of the recommended fertilizer produced maximum seed yield, increased soil moisture, and reduced soil EC, solute potential, and bulk density, while increasing leaf area and chlorophyll content index, which were statistically similar to those of 5.0 t ha⁻¹ biochar and 75% of the recommended fertilizer. The study suggests that the treatment combining 5.0 t ha⁻¹ biochar with 75% fertilizer can be comparable to the full-dose of fertilizer application, biochar enhances nutrient use efficiency and reduces fertilizer requirements by up to 25%. Overall, amending salt-affected coastal soils with biochar at 5.0 t ha⁻¹ alongside balanced fertilization provides a sustainable soil management strategy that alleviates soil salinity, improves soil properties and sunflower yield in vulnerable agro-ecosystems of Bangladesh.

Keywords: Soil amendment, chemical fertilizer, soil salinity, sunflower yield, coastal Bangladesh

Redesigning the boro rice planting calendar in Bangladesh through a 40-year thermal window shift analysis

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Abstract

Boro rice forms the cornerstone of Bangladesh's food security, contributing ~55% of total annual production. However, terminal heat stress ($>35^{\circ}\text{C}$ maximum temperature) during sensitive panicle initiation and flowering stages causes pollen sterility and severe yield losses. Current recommended planting schedules (mid-December to January) were established nearly seven decades ago and fail to account for recent global warming trends. Although localized experiments have been conducted, a comprehensive, countrywide assessment using high-resolution historical climate data across all 64 administrative districts has been lacking. This study addresses this critical gap by evaluating 40 years (1984–2024) of daily maximum and minimum temperature data from the NASA POWER database across all 64 districts. Two probability distribution functions were fitted for each district to define the "safe thermal flowering window"—the period where the probability of maximum temperature exceeding 35°C is $<10\%$ and minimum temperature falling below 15°C is $<10\%$. Decadal comparisons (1984–1993, 1994–2003, 2004–2013, and 2014–2024) reveal that this safe window has contracted by 7–15 days across most districts, with the most severe narrowing in western and north-western Bangladesh. To mitigate heat stress, district-specific optimal transplanting dates were back-calculated using Growing Degree Days (GDD), ensuring flowering coincides with the safe window. Assuming a thermal requirement of 1,100–1,300 GDD (base temperature 10°C) for popular varieties like BRRI dhan28 and BRRI dhan29, transplanting schedules were backward-engineered for every district. The primary outputs are district-wise revised planting calendars, spatial mapping of the contracting safe flowering window, and an evaluation of heat-stress reduction under the revised schedules. Shifting transplanting dates offers a cost-effective, climate-smart adaptation strategy requiring no additional agricultural inputs. If validated through multi-location field trials, the Department of Agricultural Extension (DAE) can adopt these localized calendars to minimize thermal yield losses and ensure resilient Boro rice production across Bangladesh.

Keywords: Climate-smart agriculture, boro rice, thermal window, planting calendar, growing Degree Days, heat stress adaptation

Adaptive capacity to cope climatic stresses on boro rice production in haor area of Sunamganj district

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Abstract

The study aims to assess prevalent climatic stresses on Boro rice production along with the adaptive capacity of the haor farmers to tackle these adversities. Adaptive capacity was measured on the composite value of five factors namely (i) knowledge of adaptive rice production practices, (ii) availability of inputs to carry out adaptive practices in local situation, (iii) level of use of the selected adaptive practices in Boro rice production, (iv) access to financial and technical resources to carry out the practices, and (v) consultation of the practices with the extension services. Qualitative information regarding adaptive measures of the farmers for Boro rice production were ascertained through FGDs with the farmers, input dealers and SAAOs of the respective villages. For quantitative data, a total of 130 farmers were randomly selected from the four selected villages (two of Biswamvorpur upazila and two of Tahirpur upazila) as the sample for the study, who were interviewed in between 20 February to 25 May, 2025 by using a pre-tested interview schedule. Results revealed that Boro rice production in haor area was hampered by 14 different biotic, and abiotic hazards. Of which, increased insect-pest infestation (Stress Severity Index = 344), price hike of inputs (339), flash flood (312) and water scarcity (304) were notable. The results also unearthed that approximately 81% of farmers in the haor area possessed up to 68% of the necessary adaptive capacity for Boro rice production amidst climatic stresses. To these stresses, the top five effective adaptive practices that brought a substantial resilience to the farmers were (i) cultivation of hybrid rice (Resilience Index, RI=352), (ii) use of agricultural machineries (349), (iii) cultivation short duration HYV of rice (307), (iv) practicing of AWD method (298) and (v) use of manure and organic matter in the rice fields among the 36 adaptive practices. The study found that a farmer's ability to build resilience is strongly linked to their background, especially their education level, family size, farm size, annual income, and access to information. By boosting this adaptive capacity, farmers can achieve better food security, secure more stable livelihoods, and build an agricultural system that is more resilient to climate change impacts like recurring flash floods and water scarcity.

Keywords: Adaptive capacity, boro rice, climatic stress, haor, resilience

Development of mustard-T. aus-T. aman cropping pattern against fallow-T. aus-T. aman cropping pattern in AEZ-20 of Sylhet region

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Abstract

Seasonal fallow periods in the northeastern region of Bangladesh limit cropping intensity, land-use efficiency, and farm productivity. Incorporating short-duration crops into fallow periods can provide an opportunity to increase system productivity and farmers' income. As regional agriculture faces increasing climatic variability, sustainable intensification strategies that eliminate fallow periods are critical for climate-smart crop production and resource optimization. Therefore, an experiment was conducted at a Multilocation Testing (MLT) sites in Moulvibazar (AEZ-20), during two consecutive cropping years (2021-2022 and 2022-2023) to evaluate the productivity and economic performance of an improved cropping pattern. The experiment was laid out in a Randomized Complete Block (RCB) design with 6 dispersed replications and a unit plot size of 1200 m². The existing cropping pattern (EP) was Fallow – T. Aus (BRRI dhan48) – T. Aman (Binadhan-16), whereas the improved cropping pattern (IP) was Mustard (BARI Sarisha-14) – T. Aus (BRRI dhan98) – T. Aman (BRRI dhan75). Rice equivalent yield (REY), gross return, gross margin, and marginal benefit–cost ratio (MBCR) were assessed to compare the performance of the two patterns. The results demonstrated that the improved pattern could be successfully established through the inclusion of the short-duration mustard variety BARI Sarisha-14 during the fallow period. The IP produced 15.72 t ha⁻¹ REY, compared to 9.49 t ha⁻¹ under the EP, representing an approximately 66% increase in system productivity. The IP also generated higher gross return (BDT. 361560 ha⁻¹) and gross margin (BDT. 164560 ha⁻¹) compared to BDT. 218270 ha⁻¹ and BDT. 72,270 ha⁻¹, respectively, under the EP. Thus, the improved pattern increased gross return and gross margin by approximately 66% and 128%, respectively. The MBCR of 2.80 indicated favorable economic returns from

adopting the improved cropping pattern. The findings suggest that the Mustard – T. Aus – T. Aman cropping pattern involving BARI Sarisha-14, BRRI dhan98, and BRRI dhan75 can effectively utilize the fallow period while enhancing system productivity and profitability. Through efficient land utilization and minimized resource gaps, this climate-smart cropping pattern holds significant potential for wider adoption in Moulvibazar and other areas with similar agro-ecological conditions.

Keywords: Cropping pattern, climate-smart, fallow period, rice equivalent yield, resource optimization

Shed based microclimate management of climate resilient strawberry production under subtropical conditions

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Abstract

Climate change induced heat stress threatens strawberry production under subtropical conditions, where elevated environmental and leaf temperatures can disrupt photosynthetic electron transport and photosystem II functioning. Developing adaptation strategies that regulate crop microclimates and sustain physiological performance is therefore essential for climate smart strawberry production. This study evaluated the potential of shed cultivation to mitigate heat stress by moderating the plant micro-environment and maintaining photosynthetic performance under shed and open field conditions. The experiment was conducted during 2025-2026 with two strawberry varieties- RABI-3 and BARI Strawberry-3, in a randomized complete block design (RCBD) with three replications. Leaf fluorescence parameters, photosystem II efficiency, leaf attributes, fruit quality, and yield were analyzed. The plant data were recorded three times viz. at 40,60 and 80 DAT, using a handheld fluorometer (Multispeq V.02). The results showed that shed cultivation maintained a more favorable microclimate, characterized by lower environmental (35 °C- 37 °C) and leaf temperatures (34 °C- 36 °C) and comparatively higher relative humidity than the open field condition. This moderated thermal environment was associated with improved chlorophyll status, as indicated by higher SPAD values, and enhanced photosynthetic performance. In particular, BARI Strawberry-3 under shed conditions showed enhanced maximum quantum efficiency (Fv/Fm: 0.81), greater LEF (165.21), improved quantum yield (φII: 0.64), and more stable PS II redox regulation (qL: 0.632) in May. The improved photosynthetic functioning was accompanied by greater fruit development and productivity. Under shed conditions, BARI Strawberry-3 produced fruits of approximately 23.8 g, with 12.8% dry matter, higher vitamin C concentration (61.53 mg 100 g⁻¹ FW), and a total yield of 0.46 kg plant⁻¹. Overall, improved photosynthetic functioning was associated with enhanced fruit quality and yield, highlighting shed based cultivation as a potential climate smart strategy for improving strawberry resilience under subtropical heat stress.

Keywords: Strawberry, climate adaptation, heat stress, photosynthetic resilience, shed cultivation

Performance of bush bean intercropped with groundnut in haor areas of Sylhet region

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Abstract

Hakaluki Haor, Moulvibazar is an important agricultural ecosystem where efficient utilization of available land is essential for increasing crop productivity and farm income. As vulnerability to climatic and economic shocks increases, adopting climate-resilient cropping practices is vital for sustainable agricultural intensification. Intercropping groundnut with bush bean may provide an opportunity to enhance resource-use efficiency and economic returns compared to sole cropping. Therefore, an experiment was conducted at farmers' fields under the Multilocation Testing (MLT) site, Moulvibazar (AEZ-20), during two consecutive cropping years (2022-2023 and 2023-2024) on winter (Rabi) seasons to evaluate the productivity and economic performance of groundnut-bush bean intercropping systems. Five cropping treatments were evaluated: T1 = Sole groundnut, T2 = Sole bush bean, T3 = Alternate rows of groundnut and bush bean, T4 = Two rows of groundnut between paired rows of bush bean, and T5

= Two rows of bush bean between paired rows of groundnut. The experiment was laid out in a Randomized Complete Block Design (RCBD) with six dispersed replications. Seeds of both groundnut and bush bean were sown at a spacing of 30 × 15 cm. The results showed that the highest average seed yield of bush bean was obtained under sole cropping. However, intercropping substantially improved the overall productivity of the system when expressed as groundnut equivalent yield (GEY). The highest GEY (4.35 t ha⁻¹) was recorded in T3, whereas the lowest (2.47 t ha⁻¹) was obtained from T1. Treatment T3 also produced the highest gross return (BDT. 391500 ha⁻¹) and gross margin (BDT. 227028 ha⁻¹), which were approximately 76% and 310% higher, respectively, than those obtained from sole groundnut. In contrast, sole groundnut resulted in the lowest gross margin (BDT. 55505 ha⁻¹). The findings demonstrate that alternate-row intercropping of groundnut and bush bean can enhance combined productivity and economic returns compared with sole cropping. Therefore, this intercropping system may be a promising option for improving land-use efficiency and farm profitability in the Hakaluki Haor under changing climate and other areas with similar agro-ecological conditions.

Keywords: Intercropping, groundnut, bush bean, haor ecosystem, climate resilient, economic return

Optimizing beetroot production through biostimulant application across different planting dates: effects on growth, stress regulation, and functional quality

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Abstract

Optimizing crop management strategies that simultaneously improve productivity and functional quality remains a major challenge in sustainable vegetable production. Table beet (*Beta vulgaris* L.) is valued not only for yield but also for its high concentration of betalains and antioxidant compounds; however, the interactive effects of planting time and biostimulant application on these quality attributes remain insufficiently understood. Therefore, this study investigated the effects of planting date and biostimulants on growth performance, physiological characteristics, antioxidant metabolism, stress responses, and betalain accumulation in field-grown table beet. A 4 × 3 factorial RCBD evaluated four planting dates (20 November, 30 November, 10 December, and 20 December) and three biostimulant treatments (control, seaweed extract, and triacontanol). Planting date and biostimulant application significantly influenced vegetative growth, biochemical traits, and pigment accumulation, with strong interaction effects observed for total soluble solids, proline, and betalain pigments. Triacontanol primarily enhanced vegetative performance, with the highest leaf length recorded under 30 November planting with triacontanol application (43.62 cm), while the greatest shoot and root fresh weights were observed under 20 November planting with triacontanol (264.8 and 463.3 g plant⁻¹, respectively). In contrast, seaweed extract strongly promoted functional quality traits, particularly under the 10 December planting. The combination of 10 December planting with seaweed extract produced the highest total phenolic content (2.447 mg GAE g⁻¹ FW), total flavonoid content (1.107 mg QE g⁻¹ FW), DPPH radical-scavenging activity (74.90%), and total betalain concentration (78.99 mg 100 g⁻¹ FW). Delayed planting increased proline, indicating physiological heat stress, whereas biostimulants moderated these stress responses. Pearson correlation analysis demonstrated strong positive associations between total betalains and antioxidant traits, including total phenolics (r = 0.962), flavonoids (r = 0.955), and DPPH activity (r = 0.945). Multivariate analysis separated treatments into growth- and antioxidant-oriented groups. Overall, synchronizing planting dates with targeted biostimulants maximizes crop value. For delayed planting, which exposes this winter crop to heat stress, seaweed extract was the best treatment to mitigate stress and preserve functional quality.

Keywords: bio stimulant, seaweed extract, triacontanol, betalain, antioxidant activity

Validation and up-scaling of summer country bean cultivation in the Sylhet region

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Abstract

A three-year study (2022–2024) was conducted to identify photoperiod-insensitive country bean (*Lablab purpureus*) genotypes and validate the selected variety through on-farm testing in farmers' fields in Sylhet region of Bangladesh. In the year 2022, six photoperiod-insensitive country bean genotypes namely Sikribi Sheem-1, Sikribi Sheem-2, IPSA Sheem-1, IPSA Sheem-2, SB003 and SB011 - were assessed at Sylhet Agricultural University using a randomized complete block design with three replications. The different genotypes showed significant differences in terms of flowering time, harvest time, yield-related traits and pod yield. SB011 achieved the highest pod yield (47.32 kg/decimal), which is statistically similar to that of Sikribi Sheem-1 (46.90 kg/decimal). Sikribi Sheem-1 produced the largest pods (5.52 g) and was therefore selected for adaptive trials because of its good yield and pod characteristics. In 2022, Sikribi Sheem-1 was tested in five farmers' fields located in Habiganj, planting occurring between March and April, resulting in yields that varied from 54 to 67 kg/decimal and a benefit-cost ratio (BCR) ranging from 2.88 to 3.57. For 2023, ten farmers were chosen in both Habiganj and Moulvibazar; although, 18 farmers ultimately completed the trials. The mean pod yields were 53.60 kg/decimal (13.23 t/ha) in Habiganj and 52.37 kg/decimal (12.94 t/ha) in Moulvibazar, with benefit-cost ratios of 3.10 and 3.03 respectively, at an average price of Tk 130 per kg. In 2024, 23 farmers throughout the Sylhet Division grew the variety and the mean values for days to first flowering, days to first harvest and pod yield were 52, 83 and 50.74 kg/decimal (12.5 t/ha) respectively. Across all the 46 farmers' trials, pod yield varied from 9.88 to 16.54 t/ha, with an average of 13.01 t/ha. The farmers sold the green pods at a price of Tk 60 to 200 per kg, with the highest prices being recorded from June to August. The steady yields and the favourable returns show that summer cultivation of Sikribi Sheem-1 can be a viable option for extending country bean farming beyond the traditional winter season.

Keywords: *Lablab purpureus*, photoperiod-insensitive, adaptive trial, benefit–cost ratio

Identification of Bangladeshi rice genotype(s) for resistance to brown planthopper (*Nilaparvata lugens* Stål)

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Abstract

Brown planthopper (*Nilaparvata lugens* Stål) remains one of the most damaging insect pests of rice in South and Southeast Asia, and the identification of durable host-plant resistance is essential for sustainable, economical and eco-friendly management. This study evaluated 30 rice genotypes including IR-64 as resistant check and BR-3 as susceptible checks using the honeydew test, modified seedbox screening test (MSST), and antibiosis assay to identify newer source of resistance against brown planthopper (BPH). Phenotypic screening identified differences in resistance to brown planthopper (BPH) among the selected rice genotypes. Among the *Aus* genotypes, BRRI dhan98 had the lowest damage score (5.5), honeydew area (13.7 mm²), and highest adult mortality (46.7%). In the *Aman* rice, Kusmus showed lowest damage score (5.5), honeydew areas (13.2 mm²) and highest adult mortality of (33.3%). Among the *Boro* rice genotypes, Binadhan-10 had a damage score of 3.5 and honeydew area of 10.2 mm², respectively. Taken together, these results indicate intermediate resistance to BPH. Regression analysis showed a significant, increasingly strong negative relationship between adult mortality and swollen-abdomen, while hierarchical cluster analysis separated the genotypes into an antibiosis-associated cluster and a tolerance-associated cluster, the latter comprising genotypes that sustained heavy feeding with comparatively little damage. All the tested rice genotypes, Binadhan-10 showed higher resistance to brown planthopper (BPH), while the other tested genotypes were moderately resistant. These genotypes may serve as useful genetic resources for future rice breeding program.

Keywords: *Nilaparvata lugens*, Bangladeshi rice genotype, BPH resistance, MSST, antibiosis

Evaluation of nano urea for improving agronomic and physiological traits of water spinach (*Ipomoea aquatica*)

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Abstract

Nitrogen (N) management is a key driver of productivity in leafy vegetables because these crops have rapid biomass accumulation and frequent harvesting. Conventional N fertilization may result in nutrient losses through volatilization and leaching, creating a need for improved nutrient-management strategies. Nano urea has emerged as a potential foliar N supplementation technology; however, its effects on ratooning-based leafy vegetable production remain insufficiently characterized. This study evaluated the effects of different N management strategies on the agronomic, physiological and regrowth performance of water spinach (*Ipomoea aquatica*). A pot experiment was conducted in a completely randomized design (CRD) with seven treatments and three replications. The treatments comprised an unfertilized control, granular urea, liquid urea, mustard oil cake, and foliar nano urea at 1, 2 and 3 mL L⁻¹. The conventional N treatments were standardized to provide approximately 60 kg N ha⁻¹, corresponding to approximately 0.295 g N pot⁻¹ under the experimental pot area. Based on the respective N concentrations, this was equivalent to approximately 0.64 g granular urea (46% N), 0.64 g liquid urea (46% N), and 5.42 g mustard oil cake (5.44% N) per pot. The N contribution from foliar nano urea was not included in the basal-N equivalence calculation. Morphological traits, shoot biomass, leaf water relations, chlorophyll status, photosynthetic efficiency and regrowth performance were evaluated over two consecutive harvests. Analysis of variance followed by Tukey's HSD test was used for mean comparison, while Pearson's correlation analysis and principal component analysis (PCA) were performed to examine relationships among the measured traits. Foliar application of nano urea at 2 mL L⁻¹ (T5) consistently produced superior agronomic and physiological performance compared with the other treatments. Maximum plant height (37.67 cm), stem diameter, leaf expansion and shoot biomass production were observed in T5, with maximum fresh and dry shoot weights of 0.101 and 0.017 kg, respectively, at the second harvest. T5 also exhibited higher chlorophyll content (SPAD 44.62), improved chlorophyll fluorescence characteristics, including photosynthetic electron transport activity and photochemical efficiency of photosystem II (γ), and lower energy dissipation through non-photochemical quenching compared with the control. Although liquid urea showed the highest regrowth index (1.353), 2 mL L⁻¹ nano urea produced greater biomass and maintained more stable physiological responses following repeated harvesting. Overall, foliar application of nano urea at 2 mL L⁻¹ showed promising potential for enhancing growth, physiological performance and biomass productivity of water spinach under repeated harvesting conditions and may serve as a supplementary nutrient-management strategy for leafy vegetable production.

Keywords: Nano urea, water spinach, *Ipomoea aquatica*, biomass production, photosynthetic efficiency, ratooning, nutrient management

Snap pea (*Pisum sativum* L.) sugar composition, and pod yield in Bangladesh as affected by sowing time, harvest stage, and mulching

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Abstract

The snap pea (*Pisum sativum* L.) is a newly introduced winter vegetable in Bangladesh. Its sweet, crunchy pod can be eaten in raw form and is famous worldwide. Sugar compositions are greatly influenced by the timing of sowing and harvesting. Therefore, the research was conducted to explore the effect of sowing time (early: mid-September; optimum: mid-October; late: end-November), harvesting maturity (7-21 days after anthesis, DAA) and mulching (mulched bed and non-mulched bed) as the way of maximizing yield and sugar composition in snap pea. Pod yield and sugar compositions in both pericarp and seed (glucose, fructose, sucrose) were quantified. Sowing early had a greater pod yield than sowing late due to the additional time available for reproduction physiology to grow pods and seeds through the winter season in cool weather conditions. Sugar contents increased gradually with the increasing

pod age, which shows a significant physiological change at 13-15 DAA, when the pod changes from a tender, whole-pod-edible “snap” to fibrous, seed-predominated maturity stage; therefore, harvesting the pods at 13-15 DAA ensures the highest sugar content and pod crispness with edible pericarp. The mulched beds had higher sugar content than non-mulched beds in all cases, implying the effect of mulching on sugar content – possibly by controlling soil moisture and temperature during pod development. In conclusion, this study provided a science-based protocol for snap peas in Bangladesh, which includes early sowing, mulching cultivation and harvesting at 13-15 DAA.

Keywords: snap pea, sowing time, harvest stage, mulching, sugar composition, pod yield

Genotype-specific associations between climatic variables and boro rice yield across site-year environments in Bangladesh

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Abstract

Climate variability is one of the critical issues in maintaining stable rice productivity in Bangladesh, especially for the Boro rice, which is grown under varying environmental conditions. Understanding genotype-specific responses to climatic variation is therefore important for evaluating yield stability and adaptation. The present study examined the yield performance and climate-yield relationships of three Boro rice genotypes namely BR16, BRC266-5-1-1-1, and BRRI dhan28, across 27 location-year observations using secondary data. The seasonal total rainfall and mean maximum (Tmax) and minimum (Tmin) temperature data were collected from Kader *et al.* (2024, *Data in Brief*, 55, 110757) for the growing season of Boro rice and were used as climatic predictors for grain yield. Relative yield deviation (RYD) analysis was calculated to compare the performance of the genotypes with the environmental average, followed by Pearson correlation, linear regression, and genotype $\times$ climate interactions. The grain yield ranged from 4.67 to 8.86 t ha⁻¹ for the environmental conditions with an average yield of 7.18 t ha⁻¹ for BR16, 7.32 t ha⁻¹ for BRC266-5-1-1-1, and 6.87 t ha⁻¹ for BRRI dhan28, respectively. In relation to genotype by climate correlations, only BRC266-5-1-1-1 had a significant positive relationship between RYD and Tmax ($r = 0.389$, $R^2 = 0.151$, $p = 0.045$). However, the overall genotype $\times$ Tmax interaction was not significant ($p = 0.447$), while genotype $\times$ rainfall and genotype $\times$ Tmin interactions were also non-significant ($p = 0.668$ and 0.701 , respectively). These results indicated the use of multi-environment secondary data in assessing the relationship of climate and yield and determining initial patterns of relative yield performance in different environments. This will be useful in the future for evaluating and selecting potential rice genotypes suitable for variable climate in Bangladesh. Further studies using larger genotype sets, additional climatic variables, and field-based experiments are recommended to validate and extend these results.

Keywords: climate variability, grain yield, genotype $\times$ environment interaction, yield stability

Influence of liquid organic fertilizer derived from cow dung bioconversion on the vegetative growth of spinach (*Spinacia oleracea* L.)

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Abstract

An experiment was carried out to evaluate the effects of liquid organic fertilizer (LOF) derived from cow dung on the growth, leaf quality, and soil properties of spinach under field conditions at the Soil Science research field, Hajee Mohammad Danesh Science and Technology University, Dinajpur, during the Rabi season 2024. The experiment was laid out in the randomized complete block design (RCBD) with three replications. Six treatments were applied: T₀ = Control, T₁ = 100% RDF, T₂ = 100 Lha⁻¹, T₃ = 200 Lha⁻¹, T₄ = 300 Lha⁻¹, and T₅ = 400 Lha⁻¹, respectively. The results revealed that T₄ (300 Lha⁻¹) consistently produced superior outcomes across all measured parameters. At harvest, plant height reached (32.50 cm), leaf number (15.67), single plant weight (16.50 g), root length (7.36 cm), and fresh biomass (1493.33g). Leaf nitrogen content was highest in T₄ (0.33%) indicating efficient nutrient uptake.

Chlorophyll a, chlorophyll b, and carotenoid contents were also maximized under T₄, reaching (11.83 mg/g), (4.48 mg/g), and (3.80 mg/g), respectively, reflecting enhanced photosynthetic capacity and leaf quality. Soil analysis demonstrated substantial improvement with T₄ application: organic matter (1.02%), total nitrogen (0.14%), available phosphorus (64.43 ppm), exchangeable potassium (0.12 me 100⁻¹g of soil), and available sulfur (36.68 ppm), highlighting the fertilizer's contribution to soil fertility compared to the traditional chemical fertilizer (RDF). The study confirms that cow dung-based LOF is a sustainable, eco-friendly, and cost-effective alternative to chemical fertilizers, enhancing growth, yield, and leaf quality while improving soil health.

Keyword: LOF, photosynthesis, soil fertility and eco-friendly

Genetic diversity in basmati rice using SSR markers

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Abstract

Certain Basmati rice varieties benefit from export tax and duty exemptions, enhancing their market value and contributing to their relatively high prices in international markets. However, mixing or adulteration of elite Basmati varieties with non-Basmati genotypes may lead to loss of varietal purity and genetic identity. Thus, reliable identification of Basmati germplasm is not only important for the maintenance of varietal integrity but also for breeding programs for improving bacterial leaf blight (BLB) resistance. In particular, true Basmati lines are required as recurrent parents for introgression resistance genes such as Xa4 and Xa21 without compromising the desirable grain and cooking qualities of Basmati rice. The present study was conducted using 65 SSR markers to assess the genetic diversity among 16 genotypes of Basmati rice for the development of molecular fingerprints for cultivar identification and background selection in BLB resistance breeding. The greatest amount of marker polymorphism was found on chromosome 3. Ten alleles were detected in total, with an average of 2.31 alleles per locus. The PIC values ranged from 0.16 for RM316 to 0.62 for RM8209 with an average of 0.3268. The mean major allele frequency was 0.714 with a range of 0.4 to 0.9. Genetic distance among the genotypes ranged from 0.190 to 0.663 with a mean of 0.4122. Twenty-one markers had unique alleles. The 16 genotypes were separated into six distinct clusters by neighbor-joining analysis. Most of the genotypes could be discriminated by a single SSR marker, however, Basmati 370 required at least three markers for clear discrimination. The molecular profiles developed in this study offer useful tools to confirm the identity and genetic distinctness of the Basmati germplasm. They can be of assistance in selecting true donor and recipient parents, background recovery in marker-assisted backcrossing and targeted deployment and pyramiding of BLB resistance genes such as Xa4 and Xa21. These results may also help to maintain varietal purity and protect the genetic identity of valuable Basmati cultivars used in breeding and international trade.

Keywords: Basmati rice, SSR markers, genetic diversity, DNA fingerprinting, bacterial leaf blight, Xa4, Xa21, marker assisted breeding

Marker-assisted introgression of *Xa21* into extra-long grain basmati

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Abstract

Bacterial leaf blight (BLB) caused by *Xanthomonas oryzae* pv. *oryzae* is a major constraint for production of premium Basmati rice. Severe BLB infection can reduce yield and grain quality especially in elite cultivars including Super Basmati. Basmati rice is popular in the international market for its extra-long slender grains, aroma and cooking qualities. Development of BLB resistant cultivars having such market preferred characteristics is thus an important breeding objective. In the present study, the broad-spectrum BLB resistance gene, *Xa21* was introgressed into the Super Basmati background through marker-assisted backcross breeding. Super Basmati was crossed with IRBB60 which acted as the donor parent for *Xa21*. Foreground selection was performed up to BCF generation using the gene specific marker pTA248 in combination with phenotypic selection for desirable plant and grain characteristics. The advanced line PKBB15-116 (Super Gold) was further evaluated through multi-year station trials, regional adaptability trials at BLB hotspot locations and National Uniform Rice Yield Trials. BLB challenge consistently resulted in a resistant reaction in PKBB15-116 at all locations and seasons whereas Super Basmati

remained moderately susceptible to susceptible. In station trials, the advanced line yielded 17.4% more and at BLB hotspot sites, it yielded 16.8% more. In national trials, it exhibited 8.7–11.5% higher yield than the commercial checks. The overall average yield advantage was 12% in 43 trials. PKBB15-116 matured earlier than Super Basmati (105 versus 115 days) and showed better lodging resistance and retained the desirable extra-long grain characteristics including 54% head rice recovery in addition to better BLB resistance. The results suggest that marker-assisted back-cross breeding is a feasible strategy to combine BLB resistance with desirable agronomic and grain quality traits of elite Basmati rice. *Xa21* conferred stable resistance in the tested environments but further broadening and strengthening of the resistance could be achieved by combining it with complementary genes like *Xa4* and *Xa7*. Therefore, development and deployment of lines carrying complementary BLB resistance genes could be a useful strategy to maintain stable resistance and preserve the premium grain characteristics required for Basmati rice production and trade.

Keywords: Bacterial leaf blight, *Xa21*, gene pyramiding, basmati rice, hotspot screening, durable resistance

Cyclic movable cultivation rack with TIR-based supplemental lighting for hydroponic barley fodder

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Abstract

Improving space use while reducing supplemental-lighting demand is important for compact hydroponic fodder production. We developed a cyclic movable cultivation rack with total internal reflection (TIR)-based supplemental lighting and evaluated its geometry, preliminary structural performance, device-level light distribution, and short-cycle crop response. Relative to a predefined double-sided static geometric reference, the cyclic configuration increased nominal tray cultivation area by 36.4%. A preliminary linear-static check under a 5850 N equivalent load gave a maximum von Mises stress of 108.8 MPa, maximum deformation of 3.307 mm, and a yield-based safety factor of 2.16 for Q235 steel. At comparable recorded input power, TIR increased mean PPFD by 93.1% within the prescribed 350-mm single-unit reference-plane grid. After calibration to reference-plane mean-PPFD equivalence, lighting-unit AC active power decreased from 25.41 to 13.10 W, a descriptive 48.4% reduction relative to the same lens-free WS2812-based prototype baseline. In cultivation, harvested fresh biomass differed by approximately 0.3%, and the retrospective one-sided confidence bound was compatible with an exploratory 5% engineering margin but not the stricter 2% sensitivity margin. The results support prototype feasibility while array-level canopy photon exposure, whole-facility energy performance, and long-term mechanical reliability require further validation.

Keywords: Modular plant factory, hydroponic barley fodder, cyclic movable cultivation rack, total internal reflection lens, reference-plane PPFD equivalence, energy use efficiency

Effect of deep eutectic solvent and sulfuric acid-derived NCC on the mechanical properties of chitosan films

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Abstract

Mechanical properties of chitosan-based bio composite film reinforced with nanocrystalline cellulose (NCC) produced by two different methods: deep eutectic solvent (DES) and sulfuric acid (SA) hydrolysis. In both cases, 0, 2, 5, and 10% of NCC were used as a reinforcing agent. The effects on stress, strain, elongation, force at peak, elongation at break, and Young's modulus were investigated at every loading concentration. The extraction method of NCC and its concentration affected the mechanical performance of the films. Particularly, during 5% loading of SA-derived NCC films demonstrated excellent mechanical properties. The stress at peak increasing by 82% (from 30.42 to 55.31 N/mm²), strain at peak improving from 16.72% to 41.84%, and elongation at break rising from 16.47 to 21.11 mm. However, films prepared from DES-derived NCC exhibited superior performances at higher concentration (10%) achieving the highest elongation at peak (17.05 mm), strain at peak (33.98%), and force at peak

(26.68 N). Stress and strain values of the film varied significantly with changes in NCC concentration. Force at peak varied for both DES- and SA-derived NCC across different concentration levels. Results show that NCC concentration and synthesis mechanism can affect the physical integrity of the nanocomposite film. A suitable loading of NCC in chitosan-based film preserves their dimensional stability, which makes it promising for sustainable and industrial uses.

Keywords: Chitosan, nanocrystalline cellulose, deep eutectic solvent, sulfuric acid, mechanical properties, biodegradable film

Enhancing chromium tolerance in mung bean (*Vigna radiata* L.) through citric acid and malic acid application

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Abstract

Mung bean is an important and widely consumed pulse crop of Bangladesh, but its growth and productivity are restricted by abiotic stresses such as salinity, drought, waterlogging, and heavy metal toxicity. Among heavy metals, chromium (Cr) is one of the most toxic environmental pollutants, which is readily taken up by roots, where it disrupts metabolic processes, alters the rhizosphere, and causes stunted growth, reduced biomass, and impaired photosynthesis. Citric acid and malic acid are naturally occurring low-molecular-weight organic acids that function as metal chelators. Citric acid and other organic acids carry multiple carboxyl (-COOH) groups that act as ligands under heavy metal stress, promoting chelation and reducing metal toxicity. The chelated complex is transported through the xylem to the aerial parts, and when metal concentration in the cytosol reaches toxic levels, it is sequestered in the vacuole and kept in a harmless form. Malic acid enhances plant resistance by limiting metal translocation and improving stress tolerance mechanisms. In this study, the effects of chromium on mung bean cv. BARI Mung-6 were investigated with exogenous application of citric acid and malic acid to mitigate Cr toxicity. A pot experiment was carried out following a completely randomized design (CRD) with three replications at the Department of Agricultural Botany, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh. Chromium (500 μ M and 1000 μ M $K_2Cr_2O_7$) was applied along with citric acid (5 mM, $C_6H_8O_7 \cdot H_2O$) and malic acid (5 mM, $C_4H_6O_5$) at 35 days after sowing (DAS), and the treatments were maintained throughout the growing period. Data were collected on growth and biomass traits (plant height, number of leaves, number of flowers, leaf weight, root weight, stem dry weight, plant fresh weight), photosynthetic gas exchange parameters (assimilation rate, intercellular CO_2 concentration, stomatal conductance, transpiration rate, vapor pressure deficit, and water use efficiency), and seed weight. Chromium stress significantly decreased plant height, number of leaves and flowers, leaf, root, and stem weights, fresh weight, photosynthetic gas exchange parameters, and seed weight. These adverse effects were reduced by citric acid and malic acid. Application of these acids improved growth, physiological attributes, gas exchange parameters, and seed yield. Thus, application of citric acid and malic acid alleviates chromium toxicity in mung bean with promotion of growth, yield, and stress tolerance.

Keywords: heavy metal, metal toxicity, organic acid, chelation, pulse crop

Factors influencing market access by the smallholder farmers in the central coast of Bangladesh

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Abstract

Market access has been widely identified as a major constraint to climate smart agriculture adoption, yet the factors influencing it among coastal farmers in Bangladesh remain unexplored. This study aimed to identify the socioeconomic, institutional and infrastructural factors that influence access to markets of these farmers. The surveys were conducted in three coastal districts using multistage sampling procedure to select 390 smallholders in 29 villages. This research developed an overall Market Access Index (MAI), combining 18 normalized indicators across four categories of physical connectivity, market participation, information access, and bargaining power. Multiple linear regression with robust standard errors was used to estimate factors of market access. Farmers showed moderate access overall (MAI = 0.573 ± 0.089), and this was significantly higher among farmers with pucca to semi pucca

roads ($B = 0.045$ to 0.051 , $p < 0.01$) and farmers who received credit from bank ($B = 0.048$, $p = 0.004$), but lower among those relying on cooperative credit ($B = -0.126$, $p = 0.026$) or maintained frequent extension contact ($B = -0.003$, $p = 0.014$). Interestingly, farmers who travel further to go to other markets scored higher on market access, indicating that the farmers get higher prices and buyer options at larger markets, rather than being discouraged by distance. The model explained 20.2% of the variance in the market access index. In addition to being close to markets, providing infrastructure, making credit more accessible, and redesigning extension services to be more market-oriented are crucial to improve smallholders market integration

Keywords: Agricultural credit, bargaining power, coastal agriculture, extension communication, rural infrastructure

Extraction, characterization and biofilm application of nano-crystalline cellulose (NCC) from jute fiber

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Abstract

Nanocrystalline cellulose (NCC) was extracted from bleached jute pulp using a deep eutectic solvent (DES) and compared with conventional sulfuric acid (H_2SO_4) hydrolysis. The DES process yielded 46–58% NCC, significantly higher than the 26–43% obtained via H_2SO_4 hydrolysis. The average NCC dimensions differed between methods: H_2SO_4 -derived NCC measured 17–19 nm in width and 508–519 nm in length, while DES-derived NCC was larger (29 nm width, 713–883 nm length). The DES process also produced NCC with a marginally higher crystallinity index (82% vs. 78%) and superior thermal stability compared to the H_2SO_4 method. When incorporated into PVA-chitosan films, NCC enhanced Young's modulus. The Young's Modulus of PVA-Chitosan composite was enhanced by the addition of NCC, with a more pronounced improvement observed for H_2SO_4 -derived NCC. In addition, water vapor permeability found better also in H_2SO_4 -derived composite film compared to DES.

Keywords: nanocrystalline cellulose, crystallinity index, biofilm, water vapor permeability, young's modulus

Sustainable nutrient management through organic manure and reduced chemical fertilizer in jute cultivation

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Abstract

Soil fertility is one of the major factors influencing jute growth and fibre production. Sustainability of jute cultivation depends not only increasing fibre yield but also maintaining the productive capacity of soil. Excessive reliance on inorganic fertilizers without adequate addition of organic matter may not sufficiently address long-term soil-health requirements. A two-site field experiment was conducted at Manikganj and Jashore, Bangladesh in 2024 and 2025 to quantify the effect of substituting chemical fertilizer (CF) with increasing rates of farmyard manure (FYM) on soil health indicators and yield-contributing characters of jute cv. BJRI Tossa Pat 9. Five treatments e.g. T₁: Control (natural soil condition; no fertilizer, no manure), T₂: Chemical fertilizer only (CF): NPK (100% recommended dose), T₃: 100% CF + FYM @ 3 t ha⁻¹, T₄: 75% CF + FYM @ 4 t ha⁻¹, T₅: 50% CF + FYM @ 5 t ha⁻¹ were evaluated in a randomized complete block design with three replications per site. Analysis of variance confirmed highly significant ($P < 0.001$) treatment effects on plant population, plant height, base diameter, fibre yield and stick yield at both locations. Fibre and stick yields increased significantly ($P < 0.05$, DMRT) in the order $T_5 \approx T_4 > T_3 > T_2 > T_1$ at both sites, with T₄ and T₅ statistically equivalent for every character despite T₅ supplying only half the recommended chemical fertilizer dose. Peak fibre yield (3.30 and 3.35 t ha⁻¹) and stick yield (6.68 and 6.90 t ha⁻¹) were recorded under T₅ at Manikganj and Jashore, respectively, statistically indistinguishable from T₄. The comparatively more fertile baseline soil at Jashore (higher pH, organic matter, nitrogen and cation exchange capacity) was associated with consistently higher absolute yields than at Manikganj across all treatments. Therefore, Treatment T₄ showed the best results and indicated the integrated nutrient management with FYM and reduced chemical fertilizer can maintain jute yield while improving resource-use efficiency.

Keywords: Farmyard manure, chemical fertilizer, fibre and stick yield, soil health

Enhancing heat tolerance in wheat by using affordable seed priming methods for farmers

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Abstract

This study aims to identify natural and affordable seed priming agents that can counteract the negative effects of high-temperature stress on wheat. Four different types of seed priming agents (Moringa leaf extract (MLE)), Neem leaf extract (NLE), a combination of MLE+NLE, and CaCl₂ with a control (no seed primed) were tested at varying concentrations in two wheat genotypes, Sonalika and WMRI Gom 1, to induce tolerance against heat stress. The experiment was conducted at Field Research Farm, Dept. of Genetics and Plant Breeding, BAU, in the Rabi season of 2024-2025. The experiment evaluated 16 diverse morphological traits that contribute to wheat grain yield under heat stress. Results indicate that the BWMRI Gom 1 was more responsive to seed treatment than Sonalika. The combined seed treatment improved chlorophyll content and grain yield in the Sonalika, while CaCl₂ improved these traits in the BWMRI Gom 1. For canopy temperature depression, CaCl₂ was more effective in the Sonalika, while MLE+NLE was superior in the BWMRI Gom 1. Likewise, CaCl₂ showed better membrane thermostability in the Sonalika, while NLE was more effective for this trait in the BWMRI Gom 1. The MLE+NLE treatment was more effective in the BWMRI Gom 1 for days to grain filling, while the NLE treatment was better for days to maturity in the Sonalika. MLE performed well for straw yield in the Sonalika, while NLE performed better for the BWMRI Gom 1. However, the MLE+NLE treatment performed better for both genotypes in terms of 100-grain yield. The study found that natural seed priming agents (MLE, NLE, MLE+NLE) were more effective than the chemical agent (CaCl₂), with the MLE+NLE combination performing best for cost-effectiveness, ease of formulation, and availability. Seed priming agents improve a plant's defence mechanisms against abiotic stress, enabling plants to tolerate heat stress by sustaining growth and grain production through favourable metabolic activity. This results in a cooler canopy, uncompromised chlorophyll levels, desirable membrane thermostability, longer grain-filling duration, and increased grain weight, ultimately leading to better yield under heat-stress conditions. Therefore, using seed priming agents can help to decrease canopy temperature and enhance plant resistance to heat stress.

Keywords: Wheat, heat stress, seed priming, moringa leaf extract, neem leaf extract

Cold-tolerant Nepalese rice germplasm: A promising genetic resource for boro rice improvement in Bangladesh

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Abstract

Cold stress is an important constraint to Boro rice production in Bangladesh, particularly during seedling establishment in the northern, north-western and eastern regions, while early planted Boro rice in the Haor areas may also encounter low temperature during reproductive development. Nepalese rice varieties adapted to naturally cool environments may provide useful genetic resources for improving cold tolerance in Boro rice. This study evaluated 13 Nepalese high-yielding rice varieties together with seven BRRI-released varieties for seedling-stage cold tolerance under controlled conditions at 13 °C. Considerable genotypic variation was observed in Standard Evaluation System (SES) injury scores and post-stress seedling survivability. SES scores ranged from 3.55 to 8.77, while survivability varied from 11.4 to 100%. Lakali dhan-1, Lakali dhan-3 and Chandan nath-3 exhibited the highest cold tolerance, with 100% seedling survivability and low SES scores ranging from 3.55 to 4.54. Khumal-13 also showed good tolerance, recording 92.3% survivability and an SES score of 4.69. Khumal-7, BR18, BRRI dhan36 and Khumal-6 showed intermediate responses, with SES scores of 6.7–7.3 and survivability of 60–71%, and were categorized as moderately tolerant. In contrast, Shukha dhan-6, DRR-44, Khumal-2, Khumal-4, Khumal-5, BRRI dhan28, BRRI dhan29 and BRRI dhan58 showed greater chilling injury and lower survivability and were classified as susceptible to moderately susceptible. BR1 was the most cold-sensitive genotype, with the highest SES score (8.77) and lowest survivability (11.4%). The inverse relationship between SES injury score and seedling survivability demonstrated consistent differentiation of genotypic responses to cold stress. Overall, Lakali dhan-1, Lakali dhan-3, Chandan nath-3 and Khumal-13 were identified as promising sources of seedling-stage cold tolerance and could be utilized as donor parents for developing high-yielding, cold-tolerant Boro rice varieties adapted to Bangladesh.

Keywords: Boro rice, cold tolerance, nepalese rice germplasm, seedling survivability, SES score

Deciphering salinity resilience in rice through gas exchange and chlorophyll fluorescence responses

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Abstract

Salinity-induced changes in leaf gas exchange and photosynthetic performance provide useful physiological indicators for identifying salt-resilient rice genotypes. This study investigated the responses of BRRI dhan47, IR58443, and IRRI154 to five salinity levels (0, 3, 6, 9, and 12 dS m⁻¹) using LI600 Porometer/Fluorometer based measurements over 10 consecutive days. Stomatal conductance, transpiration, steady-state fluorescence (Fs), maximum light-adapted fluorescence (Fm'), PSII maximum quantum efficiency (Fv/Fm), and electron transport rate (ETR) were evaluated. Increasing salinity significantly reduced stomatal conductance, transpiration, Fs, Fm', and ETR (P<0.01), while Fv/Fm remained comparatively stable. At 12 dS m⁻¹ relative to the control, stomatal conductance decreased by 59.1%, 65.8%, and 55.4% in BRRI dhan47, IR58443, and IRRI154, respectively, while transpiration declined by 25.3-32.6%. ETR decreased progressively under severe salinity, with reductions of 18.9% in BRRI dhan47, 27.8% in IR58443, and 24.0% in IRRI154. BRRI dhan47 maintained the highest ETR at 12 dS m⁻¹ (89.9), compared with IR58443 (80.5) and IRRI154 (76.0), indicating comparatively better maintenance of photosynthetic electron transport under severe salt stress. The relative stability of Fv/Fm despite substantial reductions in stomatal conductance and ETR suggests that salinity initially constrained photosynthesis predominantly through stomatal and downstream photochemical limitations rather than severe PSII photoinhibition. Overall, BRRI dhan47 exhibited stronger maintenance of photosynthetic functionality under increasing salinity, highlighting physiological traits useful for screening rice germplasm for salinity resilience.

Keywords: Salinity stress, stomatal conductance, chlorophyll fluorescence, electron transport rate, photosystem II, physiological resilience

High-throughput phenotyping of maize for drought resilience in Bangladesh: A multi-trait approach

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Abstract

Water scarcity acts as a severe environmental bottleneck for maize, disrupting everything from early seedling establishment to final grain yield. Securing future maize production depends heavily on finding cultivars that naturally pair strong agronomic traits with baseline drought tolerance. To this end, we screened four maize varieties-BHM-14, BWMRI-1, BHM-9, and BHM-17-using multi-trait field phenotyping to uncover variations critical for drought-resilience testing. The experiment took place in a 300 m² plot at the City University AGRI R2 field, operating under the "Drought Resilience Evaluation (Main)" R&D trial with three replications per cultivar. Throughout the crop lifecycle, we tracked a wide spectrum of traits. Early observations focused on germination success, while later field measurements captured flowering dynamics, canopy architecture (plant height, leaf angle, canopy spread, leaf area index), root depth, green leaf retention, and final yield components. We also monitored disease prevalence and chlorophyll levels. After running one-way ANOVAs on the replication means, distinct phenotypic profiles emerged among the tested lines. BHM-9 was particularly notable. It kicked off germination the earliest (beginning January 6, 2026) and dominated most vegetative and reproductive metrics. It reached a peak mean plant height of 308.25 cm, achieved the widest canopy spread (147.10 cm) and highest LAI (83.28), and ultimately yielded the highest grain count (612.01) with a cob height of 25.56 cm. Meanwhile, BWMRI-1 performed best in initial germination counts (averaging 15.0 seedlings) and produced the most grain rows (16.07). BHM-17 stood out below ground, developing the deepest root system at an average of 26.21 cm. Statistical analysis confirmed significant varietal differences across most growth, architectural, and yield parameters. Interestingly, variations in root depth, leaf thickness, chlorophyll measurements, and disease scores lacked statistical significance in this specific trial block. Ultimately, these baseline phenotypic differences emphasize how valuable multi-trait screening is for early-stage selection, setting a clear foundation for the next phase of research: testing these specific varieties under strictly controlled, contrasting water regimes.

Keywords: Maize, drought resilience, high-throughput phenotypic, abiotic stress, climate-smart agriculture

Beyond single stress: organ-specific roles of melatonin in root and leaf defense under combined abiotic stresses

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Abstract

Plants are frequently exposed to multiple abiotic stresses, such as drought, salinity, extreme temperatures, flooding, and heavy metal toxicity, which severely limit plant growth, development, and crop productivity. The combination of abiotic stresses results in unique, more severe physio-biochemical and molecular responses compared with individual stress conditions. Thus, gaining insights into the regulatory mechanisms that confer tolerance under such conditions is crucial for increasing crop resilience. Melatonin (MT), a naturally occurring indoleamine ubiquitous in plants, is a multifunctional regulator of plant growth and stress responses. MT is now considered a plant hormone due to its wide subcellular distribution, antioxidant activity, endogenous biosynthesis, and role in stress signaling. Recent studies suggest that MT acts as a new component of a network of interconnected defense mechanisms, such as detoxification of Reactive Oxygen Species (ROS), activation of antioxidant enzymes, accumulation of osmolytes, ion homeostasis, crosstalk between phytohormones, and gene expression under stress. Importantly, responses to stress are very organ-specific in the case of MT. In roots, MT regulates stress tolerance via root architecture, water uptake via aquaporins, Na⁺/K⁺ homeostasis, nutrient acquisition, and root-to-shoot signaling. In leaves, MT protects photosynthetic machinery by maintaining chlorophyll stability, improving photosystem II efficiency, regulating stomatal behavior, preserving chloroplast structure, and limiting oxidative damage. This review summarizes recent advances in MT-mediated defense mechanisms under combined abiotic stresses, with particular emphasis on organ-specific responses in roots and leaves. It also highlights current knowledge gaps and future research directions for integrating melatonin-based strategies into sustainable crop improvement programs under changing environmental conditions.

Keywords: Melatonin, phytomelatonin, ROS scavenging, stress signaling, organ-specific response, root-shoot signaling

Molecular characterization of submergence tolerant rice germplasm for identification of novel sources of non-*SUB1* submergence tolerance

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Abstract

Submergence stress poses a severe threat to rice production, causing substantial yield losses and food insecurity in flood-prone regions. This study aimed to investigate the submergence tolerance of selected germplasms and molecular characterization to identify novel sources of non-*SUB1* submergence tolerance. A total of 37 submergence tolerant Bangladeshi rice germplasm along with three checks FR13A, BRRI dhan79 and BR5 were genotyped using *SUB1* gene specific SSR marker RM8300 (SC3), two STS markers Sub1BC2, ART5, and CAPS marker GnS2 to identify new sources of *SUB1A* and non-*SUB1* submergence tolerant donors. PCR amplification with RM8300, Sub1BC2 and ART5 showed 16 germplasm having the expected marker allele similar to two tolerant checks FR13A and BRRI dhan79 but rest of the 21 germplasm having marker allele either the tolerant checks or the susceptible check BR5 or in different combination. Genotyping with GnS2 primer after digestion with the restriction enzyme *AluI* having the allele about 242 bp from 16 germplasm including the two tolerant checks (FR13A and BRRI dhan79) confirming the presence of *SUB1A-1* allele but rest 21 germplasm contain other than *SUB1A-1* alleles (that we refer non-*SUB1* allele) representing they might contain novel submergence tolerance genes. In conclusion, germplasms having non-*SUB1* alleles could be used as a new submergence tolerance resource for developing durable submergence tolerant varieties.

Keywords: Rice, germplasm, submergence, *Sub1* and non-*Sub1* gene

Enhancing salinity tolerance in wheat using exogenous application of GA₃ and silicon

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Abstract

The pot experiment was carried out at the net house of the Department of Agronomy, Hajee Mohammad Danesh Science and Technology University, Dinajpur, to determine how seed pre-treatment with GA₃ and Silicon in soil, both separately and in combination, could improve the growth and yield of wheat variety (BWMRI Gom 3) in saline soil. The experiment consisted of a factorial design, Factor A: Treatments, viz. T₁ = Control (No treatment), T₂ = Exogenous application (priming + foliar) of GA₃ @200 ppm, T₃ = Soil application of silicon @500 mg kg⁻¹ of soil and T₄ = Combined application of GA₃ @200 ppm (Foliar) and silicon @500 mg kg⁻¹ of soil, Factor B: Two salt levels viz. S₁ = 0 dSm⁻¹ NaCl (control) and S₂ = 5 dSm⁻¹ NaCl with the Completely Randomized Design (CRD) with three replications. The experiment data were recorded, including morphological traits like plant height, leaves plant⁻¹, leaves fresh and dry weight, weight of stems and roots at 30, 50, 70 DAS, and at harvest. Chlorophyll content (Chl a, Chl b), and carotenoids and water status % (RWC, WSD, WRC, WUC) were recorded at the vegetative stage. And yield and yield contributing characters like spike length (cm), spike weight (g), number of spikelets spike⁻¹, number of grains spike⁻¹, 100-grain weight (g), grain yield (g plant⁻¹), stover yield (g plant⁻¹), biological yield (g plant⁻¹), harvest index (%) were recorded after harvest. Nutrient status of grains, like N (%), and protein (%) were examined and finally, all data were analyzed by Statistix-10 software. The results revealed that the exogenous application of S2T3 treatment (Soil application of silicon @500 mg kg⁻¹ in 5 dsm⁻¹ NaCl salinity levels) showed the highest values of morphology, growth, physiology and yield traits of BWMRI Gom 3, which showed the highest biological yield (3.193 g plant⁻¹), grain yield (1.227 g plant⁻¹) and harvest index (28.003%). Also, S2T2 treatments (Priming and foliar application of GA₃@200 ppm) showed the best result and followed by S2T3 treatments. Therefore, the result revealed that BWMRI Gom 3 can be grown in saline conditions (5 dsm⁻¹ NaCl) with application of silicon @500 mg kg⁻¹ soil and GA₃@ 200 ppm.

Keywords: Wheat, silicon, GA₃, salinity tolerance, grain productivity

Minor cereal crops for climate-resilient farming systems: Performance and financial viability in acidic soils of Bangladesh

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Abstract

Minor cereal crops are gaining importance in Bangladesh due to its efficient resource use, climate resiliency, and environmentally sustainability. In this country, it would be wise to choose alternative crops rather than traditional because of its extreme weather behavior for maintaining food security. However, soil acidity remains a major constraint to cereal production in the Sylhet region of Bangladesh. This study evaluated the agronomic performance and economic viability of improved barley, foxtail millet, sorghum and proso millet varieties under acidic soil conditions. A field experiment was conducted at the Regional Agricultural Research Station, BARI, Moulvibazar during the 2021–22 and 2022–23 winter seasons using a randomized complete block design with three replications. Detailed data on growth parameters, grain yield, production costs, and market returns were systematically collected and analyzed to ascertain field-level feasibility. The results showed that BARI Barley-7 produced the highest grain yield (1.45 t ha⁻¹) among barley varieties with a benefit–cost ratio (BCR) of 2.53. BARI Kaon-2 produced 0.78 t ha⁻¹ (BCR 2.01), while BARI Sorghum-1 achieved the highest grain yield (2.81 t ha⁻¹; BCR 3.18). BARI Cheena-1 recorded the highest economic return with a grain yield of 1.38 t ha⁻¹ and a BCR of 3.47. These findings highlight the potential of improved minor cereal crops to support crop diversification and resilient farming systems in the acidic soils of Bangladesh. Therefore, adopting these technologies in Sylhet region could utilize the fallow land and acidic soil.

Keywords: Minor cereal, acidic soil, climate-resilient, food security, diversification, viability

Effect of melatonin on morpho-physiological, biochemical and antioxidant responses of wheat variety BWMRI gom 4 under heat stress

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Abstract

Wheat (*Triticum aestivum* L.) is one of the most important cereal crops in Bangladesh, contributing significantly to national food security and nutritional demand. Wheat productivity is constrained by various abiotic stresses. Heat stress is one of the most critical due to climate change in Bangladesh. Heat stress disrupts cellular homeostasis by impairing membrane stability, reducing photosynthetic efficiency, inhibiting enzyme activities and accelerating reactive oxygen species (ROS) production. Excessive accumulation of ROS such as hydrogen peroxide, superoxide radicals and hydroxyl ions cause oxidative damage to lipids, proteins and nucleic acids, leading to reduced plant performance and premature senescence. Melatonin (N-acetyl-5-methoxytryptamine) is an indoleamine molecule which become an important plant growth regulator with multifunctional roles in plant stress tolerance. The present study aimed to investigate the role of exogenous melatonin in mitigating heat stress-induced damage in wheat variety BWMRI-4 by evaluating its effects on growth, physiological parameters, biochemical attributes and antioxidant defense systems. The experiment was laid out in a randomized complete block design (RCBD) method with three replications. The treatment included control (without melatonin) sown on 01/12/2025 and (heat stress + 200 μ M melatonin) sown on 15/12/2025. Melatonin was applied as a foliar spray at 30 days after sowing at 10 days interval until grain filling stage. Physiological parameters such as plant height, root length, spike length, spikelet per spike, grains per spike, 1000 grain weight, weight of grains per replication etc. as well as antioxidant activities and biochemical parameters such as POD, APX, H₂O₂, proline and Lipid peroxidation by measuring malondialdehyde (MDA) was determined. Results showed similar physiological parameters of both groups whereas value of POD and APX of control were found 423.5589 and 482.1429 μ mol min⁻¹ g⁻¹ FW and that of heat stress + 200 μ M melatonin plants were 422.9323 and 630.9524 μ mol min⁻¹ g⁻¹ FW respectively. MDA of control and treated plants was found to be 11.44 and 11.42 nmol g⁻¹ FW. While the relatively similar MDA levels implied little variance in lipid peroxidation between the treatments, the greater APX activity in melatonin-treated plants suggested an improved antioxidant defense response under heat stress. Overall, the results indicated that exogenous melatonin, especially at 200 μ M, may improve wheat's ability to withstand heat stress by strengthening its antioxidant defense system.

Keywords: Wheat, stress, heat stress, melatonin, antioxidant stress, oxidative stress, abiotic stress

Driving factors for the adoption of drought tolerant maize varieties in northern Bangladesh

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Abstract

Maize is widely cultivated throughout the world, and while it is the third most important cereal crop in Bangladesh, after rice and wheat. Last two decades, maize cultivation is being rapidly expanding both in Rabi and Kharif season. Drought Tolerant Varieties (DTV) are the specific varieties of crops that can tolerate water scarcity at a certain level. The Department of Agricultural Extension (DAE) is introducing and expanding drought tolerant maize cultivation in Bangladesh, but the adoption status of drought tolerant maize varieties is still low due to various socio-economic factors. So, the main objective was to determine the driving factors affecting the likelihood of adoption of drought tolerant maize varieties in the Northern Bangladesh. Data were collected from 120 farmers in the Dinajpur district of Northern Bangladesh. Descriptive statistics (range, means, standard deviation, number, percentage) and logistic regression analysis were performed for data analysis. The SPSS computer package was used to perform statistical analysis. The results indicated that more than half of the farmers (54.2%) cultivated at least one of the drought tolerant maize varieties. The 'Pioneer p-3355' variety of maize was dominantly cultivated by the farmers. The findings from logistic regression analysis showed that among 10 socio-economic characteristics of farmers such as education, annual income, extension media contact, training access and organizational affiliation significantly affected the adoption of drought tolerant maize varieties. This study provides an empirical contribution to literature to investigate the socio-economic factors that affect the likelihood of adoption of drought tolerant maize varieties. This study suggests improving non-formal educational opportunities followed by training access and organization participation

as well as strengthening individual and group extension services that are necessary for enhancing the likelihood of adoption of drought tolerant maize varieties in the northern Bangladesh.

Keywords: Driving factors, adoption, drought tolerant varieties and northern Bangladesh

Identification of candidate modulators of rice abscisic acid receptors from weed allelochemicals via consensus docking and admet prediction

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Abstract

Enhancing drought and abiotic stress tolerance in rice (*Oryza sativa*) remains a pressing challenge for sustainable agriculture, and the core abscisic acid (ABA) receptor complex offers a promising agrochemical target. We screened fifteen allelochemicals from invasive and weed plant species in Bangladesh against two rice ABA receptor complexes, OsPYL9/OsPYL2 (PDB: 4OIC) and OsPP2C50–OsPYL/RCAR3 (PDB: 5ZCH), using co-crystallized ABA as a reference. A blind docking strategy, rather than restricting the search to the known ABA pocket, was used with AutoDock Vina/PyRx and cross-validated through independent structure-based blind docking with CB-Dock3; both methods converged on the native ABA site in each receptor. Protocol validation was further confirmed by redocking co-crystallized ABA into each receptor, reproducing the crystallographic pose (RMSD = 1.88 Å for 4OIC and 1.27 Å for 5ZCH, both < 2 Å). Based on average binding affinity across both targets, four compounds emerged as top consensus binders: Parthenin (−9.25 kcal/mol), (−)-Caryophyllene (−8.6 kcal/mol), (−)-Xanthatin (−8.1 kcal/mol), and Quercetin (−8.0 kcal/mol). Parthenin and (−)-Caryophyllene exceeded native ABA's average affinity (−8.5 kcal/mol), while (−)-Xanthatin and Quercetin bound weakly. ADMETlab 3.0 profiling, used as a preliminary physicochemical and toxicological screen rather than a measure of agricultural performance. It showed favorable physicochemical and absorption-related properties for all four candidates, with zero Lipinski violations and QED scores of 0.43–0.56. Caco-2 permeability was also evaluated as conventional sanity checks, though their relevance to plant-targeted action is limited. ProTox-3.0 predictions revealed considerable variation in acute oral toxicity: (−)-Caryophyllene was safest (LD50 5300 mg/kg, Class 5); (−)-Xanthatin and Parthenin showed predicted LD50s of 2000 and 1190 mg/kg (both Class 4); and Quercetin was most toxic (LD50 159 mg/kg, Class 3). These findings identify (−)-Caryophyllene as a promising candidate balancing predicted binding and toxicity, combining strong affinity with the lowest predicted toxicity of the four. Quercetin's weaker binding and higher toxicity make it the least favorable candidate, while Parthenin's markedly stronger affinity may still warrant further investigation despite higher predicted toxicity. This study provides a consensus-validated computational prioritization of weed-derived allelochemicals as candidate ABA-signaling modulators, underscoring the need for downstream experimental validation of binding efficacy and biosafety.

Keywords: molecular docking, consensus docking, ABA receptor, abscisic acid signaling, weed allelochemicals, ADMET

Evaluation of seed halopriming for improving salinity tolerance in hybrid maize during early seedling establishment

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Abstract

Soil salinity is a major constraint to maize production, particularly during germination and early seedling establishment. This study evaluated the effects of seed halopriming on salinity responses in four commercial hybrid maize genotypes (JISAN 555, UNITED 55, ALI BABA 55, and HATI 55) exposed to 0, 50, 100, and 200 mM NaCl. Germination, seedling vigor, survival, morphological traits, chlorophyll concentration, biomass accumulation, and ionic characteristics were assessed using a three-factor factorial experimental design. Salinity progressively reduced germination, seedling vigor, survival, growth, chlorophyll concentration, biomass accumulation, and ionic balance. Seed halopriming partially alleviated these adverse effects across several measured traits, with 100 mM NaCl priming generally providing the most consistent improvements under saline conditions. Genotypic variation was evident, as JISAN 555 and ALI BABA 55 maintained comparatively better performance under severe salinity than UNITED 55 and HATI 55. Overall, seed halopriming was associated with improved early seedling establishment and physiological performance under salinity stress. Given its simplicity, low cost, and minimal infrastructure

requirements, halopriming may offer a practical approach for improving maize establishment in salt-affected agricultural systems. However, field-based validation is necessary before developing broader agronomic recommendations.

Keywords: Maize, salinity stress, seed halopriming, germination, seedling growth, ionic balance

Comparative efficacy of calcium oxide and zinc oxide nanoparticles in improving salt stress tolerance in tomato

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Abstract

Salinity is a major abiotic constraint worldwide which hamper crop productivity including tomato (*Solanum lycopersicum* L.), impairing plant growth, water status, and photosynthetic performance. This study compared the effects of foliar-applied calcium oxide nanoparticles (CaO-NPs) and zinc oxide nanoparticles (ZnO-NPs) on tomato plants exposed to 0 and 100 mM NaCl. Each nanoparticle was applied at 0, 40, 80, or 120 ppm, and growth, physiological, yield, and fruit quality traits were evaluated. Salt stress decreased plant height, leaf number, leaf length and width, stem diameter, relative water content (RWC), and SPAD value. These adverse effects were accompanied by decline in yield-contributing traits and a 51.43% reduction in fruit yield. Foliar application of nanoparticles alleviated several of these effects, although the response varied with nanoparticle type and concentration. Under saline conditions, 80 ppm CaO-NPs increased plant height by 12.32%, leaf number by 28.19%, leaf width by 16.28%, RWC by 8.10%, SPAD value by 10.76%, and fruit yield by 14.9% in contrast to the untreated salt-stressed plants. It also improved fruit quality traits, including pH and soluble solids content (°Brix). ZnO-NPs at 120 ppm increased plant height by 8.46%, leaf number by 21.80%, and fruit yield by 12.7%. Overall, CaO-NPs at 80 ppm produced the strongest improvement in growth, physiological status, and yield among the treatments tested. Furthermore, CaO-NPs surpassed ZnO-NPs in alleviating salt induced stress and improving tomato growth, physiological performance, and yield. The findings indicate that an appropriate foliar nanoparticle treatment may help sustain tomato performance in saline growing conditions.

Keywords: Nanoparticles, abiotic stress, foliar application, vegetable production, stress alleviation

Application of wood vinegar biostimulant revealed salinity tolerance in mustard (*Brassica campestris* L.)

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Abstract

Soil salinity is one of the most important abiotic factors limiting crop production, particularly in coastal regions around the world, where seawater intrusion and saline irrigation exacerbate the prevalence of salt-affected soils. Mustard (*Brassica campestris* L.) is an important oilseed crop, whose vegetative growth and yield decline significantly under salinity stress. Wood vinegar (WV), a natural bio-stimulant, containing organic acids and phenolics, has shown great potential in improving stress tolerance in various crops, yet its effects on mustard remain underexplored. Here, we investigated the impact of WV foliar application on mustard under NaCl-induced salinity stress by evaluating the agronomic traits, salinity stress related biochemical parameters, and gene expression. Salinity stress negatively affected growth, root system architecture, yield, chlorophyll content, and Na⁺/K⁺ balance, while inducing oxidative damage. WV application counterbalanced many of the salt-induced damages, restoring root system architecture, and increasing plant height, biomass, chlorophyll content, silique and seed formation, and antioxidant activity. Expression of photosynthetic genes (*PsaA*, *PsbB*, and *PsbC*), ion transporters (*HKT1*, *SOS1*, *SOS2*, and *SOS3*), and antioxidant genes (*SOD*, *APX*, and *CAT*) remained elevated under salt stress in presence of WV. This upregulation of stress-regulated genes may have maintained the cellular redox state and prevented the detrimental effects of salt-induced damage. Taken together, our findings provide important insights into the mechanism of WV-mediated salinity stress tolerance, highlighting its potential application as a biostimulant for mustard cultivation in saline soil.

Keywords: Wood vinegar, salinity, ion homeostasis, ROS, gene expression, mustard

Simulation of mungbean adaptation strategies under changing climate and salinity intrusion using SWAP-WOFOST model for south-central coastal areas of Bangladesh

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Abstract

Climate change and increasing soil salinity pose significant challenges to dry-season crop production in the coastal region of Bangladesh. However, limited research has quantified their combined effects on mungbean production and evaluated practical adaptation options under future climate and salinity conditions. This study assesses the impacts of climate change and salinity intrusion on mungbean growth and yield and evaluates alternative sowing dates as a potential adaptation strategy in the south-central coastal region of Bangladesh using the SWAP-WOFOST (Soil–Water–Atmosphere–Plant–World Food Studies) model. The model was calibrated and validated using observed mungbean growth duration and yield data. Future climate conditions for the 2050s (2035–2064) and 2080s (2065–2094) were generated from three Global Climate Models (GCMs) under the high-emissions SSP5-8.5 scenario. To represent potential future salinity intrusion, simulations incorporated 10–50% increases in salinity relative to current conditions. Mungbean growth and yield were simulated for four sowing dates (15 December, 15 January, 15 February, and 15 March) and compared with the baseline (2001–2021). Future warming is projected to shorten mungbean growth duration across all sowing dates by approximately 5–7 days in the 2050s and 10–13 days in the 2080s relative to the historical baseline. Yield responses varied substantially with sowing date. The 15 December and 15 January sowings showed projected yield increases of approximately 39% and 25%, respectively, by the 2050s and were comparatively less affected by increased salinity. In contrast, the 15 March sowing showed a smaller yield increase of approximately 6% in the 2050s, followed by a projected 16% decline by the 2080s. Under a 50% increase in salinity, yield from the 15 March sowing could decline by up to 74%. These results indicate that the relative advantage of late sowing under the historical climate may diminish under future warming and salinity stress, with the suitable sowing window shifting toward earlier dates in the dry season. The findings demonstrate the importance of integrating optimized sowing calendars with salt- and heat-tolerant varieties and improved soil and water management to sustain mungbean production in coastal Bangladesh. The study provides crop-specific evidence to support climate adaptation planning and resilient dry-season cropping in salinity-prone coastal agroecosystems.

Keywords: Mungbean, climate change, salinity stress, sowing time, crop modeling, SWAP–WOFOST, coastal Bangladesh

Growth and yield performance of newly developed heat tolerant tomato hybrids during summer season

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Abstract

Tomato (*Lycopersicon esculentum*) is one of the most popular and nutritious vegetable crops grown worldwide. Its production during the summer season is severely constrained by high temperature and excessive rainfall. The development and evaluation of heat tolerant tomato hybrids are essential for ensuring year round tomato production. The present study was conducted at the experimental field of the Department of Horticulture, Sylhet Agricultural University, Sylhet, Bangladesh, during June–November 2025 to evaluate the growth, yield and fruit quality of newly developed tomato hybrids under different protective systems. Six tomato hybrids, including five newly developed hybrid combinations (HC1, HC2, HC3, HC4 and HC5) and BARI Hybrid Tomato-8 as a Check variety, were evaluated under polytunnel and plastic mulch systems using a randomized complete block design with three replications. Significant difference among the hybrids were observed for most growth and yield parameters. Among the hybrids, HC3 produced the highest number of fruits (22.50 fruits plant⁻¹), the greatest individual fruit weight (52.33 g), and the highest fruit yield (1.08 kg plant⁻¹). BARI Hybrid Tomato-8 showed comparable performance for fruit weight and certain growth attributes, whereas HC2 and HC4 produced comparatively lower yields (0.80 kg plant⁻¹). Protective systems exerted limited influence on overall yield. However, plastic mulch promoted early flowering and improved fruit quality traits, while polytunnel cultivation enhanced total soluble solids. The highest fruit yield (1.17 kg plant⁻¹) was obtained from HC3 grown under polytunnel conditions. The result revealed considerable genetic variability among the tested Hybrids and identified HC3 as the most promising heat tolerant hybrid for achieving higher yield and improved fruit quality under summer growing condition in Bangladesh.

Keywords: Summer tomato, heat-tolerant hybrid, polytunnel and plastic mulch, yield

Evaluating the potential of salicylic acid, glutathione, and seaweed extract to enhance growth and yield of red beet (*Beta vulgaris* L.) under drought stress

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Abstract

The changing climate-induced warmth and unpredictable rainfall have imposed drought stress as a primary constraint for crop production in the climate-vulnerable regions of Bangladesh. In Bangladesh, the performance of red beet (*Beta vulgaris* L.), one of the most important root crops, under low moisture conditions was not fully explored. A pot experiment was carried out under controlled conditions at Sylhet Agricultural University during the Rabi season of 2025-2026 in a completely randomized design (CRD) with three replications. Starting 35 days after transplanting, the red beet (hybrid variety 'Heartbeat') plants were grown for 14 days under three moisture levels: well-watered control (100% of field capacity [FC]), moderate drought (60% FC) and severe drought (30% FC). Foliar applications were performed every 2 days from 28 days after transplanting with salicylic acid (SA) at 0.5 mM, glutathione (GSH) at 1 mM, and seaweed extract (SWE) at 2 mL L⁻¹ v/v. Severe drought stress enhanced oxidative stress markers hydrogen peroxide (H₂O₂) and malondialdehyde (MDA) and significantly lowered the root biomass, leaf number and total leaf length. Conversely, bio-stimulant treatments with seaweed extract were able to activate pathways that lead to a reduction of stress. At 30% drought stress, seaweed extract was the best treatment with the maximum osmotic regulation, antioxidant defence and reduced oxidative markers. It had the proline content (9.83 µmol g⁻¹ FW), total phenolics (15.31 mg GAE g⁻¹ DW), total flavonoids (7.26 mg QE g⁻¹ DW) and the highest free radical scavenging effect. The DPPH scavenging was 74.44%. The levels of malondialdehyde and hydrogen peroxide were the lowest. SWE @ 2mL L⁻¹ had the highest economic yield. The root fresh matter was 355.64 g. Under mild drought, salicylic acid application stimulated sugar metabolism, resulting in the highest Brix value (16.50%). Foliar seaweed extracts were successful in maintaining root biomass retention and yield under severe drought, present a very promising and environment-friendly approach to improve crop performance and enhance crop resilience in drought-prone agro-ecological zones.

Keywords: Drought, red beet, bio-stimulants, foliar application, seaweed, yield

Effect of plant growth regulator (PGR) on the growth, yield and photosynthetic activities of tomato (*Solanum lycopersicum*) under drought stress

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Abstract

Drought stress severely constrains tomato (*Solanum lycopersicum* L.) productivity. Seaweed biostimulants are widely advocated for stress mitigation, their agronomic efficacy is highly formulation and context-dependent. This study investigated the comparative effects of a commercial liquid (Sagarika) and a powder (Hidel) seaweed formulation on the growth, biomass allocation, yield and photosynthetic traits of tomato cv. BINA 12 under drought stress. A 4 × 3 factorial pot experiment was conducted using a completely randomized design, compromising four soil-water regimes (100, 75, 50, and 25% field capacity [FC]) and three biostimulant conditions (untreated control, Sagarika at 3 mL L⁻¹ and Hidel at 3 g L⁻¹). Progressive water limitation was the dominant constraint on crop performance, reducing fruit fresh-weight yield by approximately 51% from 100% FC (70.26 g plant⁻¹) to 25% FC (34.13 g plant⁻¹; $P = 0.00149$, partial $\eta^2 = 0.468$). Neither the overall biostimulant effect nor the Water × formulation interaction resulted in a statistically significant yield recovery. Instead, formulation responses were strongly trait and drought intensity specific. Shoot fresh biomass was significantly higher with Hidel than in the control ($P = 0.0348$), while fruit diameter exhibited a significant water formulation interaction ($P = 0.0328$). Root dry weight displayed the most robust formulation-dependent response, with a significant Water × formulation interaction on both raw ($P = 0.000788$) and log-transformed ($P = 0.01085$) scales. Under mild drought (75% FC), Hidel-treated plants produced

3.59 g of root dry matter compared with 1.38 g in untreated plants and 1.26 g in Sagarika-treated plants. Furthermore, descriptive PhotosynQ measurements revealed treatment-dependent shifts in PSII energy partitioning (Φ PSII, Φ NPQ and Φ NO). Because the subsampled plants could not be tracked back to independent pot replicates, these physiological results were interpreted qualitatively rather than used for inferential analysis. Overall, while seaweed formulations modified specific morphological and physiological components of drought response—particularly root dry-matter allocation under mild stress—they did not confer a generalized recovery of overall fruit yield. These findings underscore the critical need to distinguish physiological adjustment from actual yield preservation when evaluating biostimulant efficacy under severe water deficit.

Keywords: *Solanum lycopersicum*, seaweed extract, water deficit, root biomass allocation, biostimulant formulation, crop yield

Use of biofertilizer and potassium as an eco-friendly strategy to improve growth and yield of wheat under water stress condition

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Abstract

To evaluate the protective effect of additional biofertilizer and foliar application of potassium on yield attributes and final yield of wheat under water deficit stress (WDS) at the research field and laboratory of Crop Physiology and Ecology Department, Hajee Mohammad Danesh Science and Technology University, Dinajpur during November, 2025 to March, 2026. The experiment was designed in a split plot design and replicated thrice. Four growing conditions (control, biofertilizer, foliar application of potassium 2.23% K₂SO₄, biofertilizer + foliar potassium) were placed in a main plot treatments and two water regimes namely well water (ww) and water deficit stress (wds) were placed in sub plot treatments. Analysis of variance denotes that, the interaction effect of growing conditions and wheat varieties significantly influenced the different pheno-physiological traits, yield and yield attributes of wheat except seedling and canopy temperature. Between two water regimes (ww and wds), the contribution of water deficit stress conditions treatments are significantly lower than the well water condition. In well water condition water having capacity of wheat leaf in different extends, whereas biofertilizer, foliar potassium and combined application of (biofertilizer + foliar potassium) enhanced the water content of wheat by different magnitudes. Non-irrigated water deficit stress caused significant reduction different physiological traits, yield components and final yield of wheat. However, combined application of wheat significantly contributed to the yield percentage changed over control in well water and water deficit stress condition followed by 6.33% and 8.24% for plant height, 8.74% and 10.17% for spikes m⁻², 34.78% and 47.36% for spikes plant⁻¹, 16% and 20% for spike length, 25% and 22.66% for spikelets spike⁻¹, 18.63% and 20.15% for grains spike⁻¹, 25.92% and 36.11% for grains weight plant⁻¹, 17.06% and 20.19% for grains weight, 20.88% and 19.71% for above ground biological yield, 37.80% and 43.33% for grain yield, 13.37% and 19.75% for harvest index, respectively. Water deficit stress significantly affected the pheno-physiological traits and yield attributes of wheat leading to reduced grain yield, where the application of biofertilizer and foliar application of potassium mitigate the reduction of physiological traits and grain yield. From the overall results it may be concluded that the most highly valuable combined application (biofertilizer + foliar application of potassium) having the capacity to enhance drought resilience in wheat and to sustain wheat productivity under drought environment and also contributed to grain yield in well water conditions.

Keywords: Biofertilizer, potassium, water stress, growth, yield, wheat

Selection of rice genotypes for brown plant hopper resistance (*Nilaparvata lugens* Stål) under different levels of salt stress

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Abstract

In coastal Bangladesh, rice farmers frequently encounter simultaneous salinity and brown planthopper (BPH) stresses which limit rice productivity. Nevertheless, most rice improvement programs assess both these stresses in isolation and therefore information on genotype performance and molecular basis of resistance under stress-prone environments is limited. The present study aimed to perform integrated morpho-physiological and molecular screening of resistance-associated loci to identify rice genotypes with improved tolerance against salinity and BPH. A three-factor factorial completely randomized design with three replications was used to evaluate six rice genotypes,

including coastal landraces Kuchmuch and Kaliboro, Bangladeshi varieties (BRRI dhan87, BRRI dhan103, and BR3), and the reference genotype IR64 under a range of salinity levels (0, 5 and 10 dS m⁻¹) and BPH infestation. We measured growth parameters, biomass characteristics, SPAD value, electrolyte leakage and honeydew excretion. Further, PCR-based screening was performed using SSR markers linked to major BPH resistance genes, and the amplified DNA fragments were analyzed by gel electrophoresis to determine the molecular profiles of the rice genotypes. Growth, biomass accumulation, chlorophyll retention and membrane stability were severely limited by salinity and BPH infestation across all genotypes. Among all the varieties under both stresses, Kuchmuch and IR64 generally showed significantly higher biomass, vegetative growth, SPAD values and lower electrolyte leakage than other varieties, while BR3 was found to be most susceptible. Among the seven SSR markers evaluated, only MS10, linked to the Bph17 resistance locus, detected polymorphism by producing the expected resistant allele (~259 bp) in Kuchmuch and IR64. The results reveal Kuchmuch as a potential local donor genotype with combines some level of both BPH resistance and salinity tolerance traits. These findings open the potential of using these genetic resources for development of climate-resilient rice varieties through marker-assisted breeding approaches.

Keywords: Rice, salinity stress, brown planthopper, SSR markers and resistance

Mitigation of post-anthesis heat stress in wheat through introducing short-duration transplanted aman rice and early-sown wheat into the cropping system

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Abstract

Wheat grain yield in Bangladesh remains lower than the global average. Delayed sowing following the harvest of long-duration rice varieties often exposes wheat to terminal heat stress during grain filling. To address this issue, two field experiments were conducted during 2024–2025 at the Field Laboratory and the Physiology Laboratory, Department of Crop Botany, Bangladesh Agricultural University (BAU), Mymensingh. The study aimed to evaluate short-duration rice cultivars and their effects on subsequent wheat yield and grain-filling dynamics as a strategy to enhance wheat productivity. In the first experiment, two short-duration *T. aman* rice cultivars (BRRI dhan71 and BRRI dhan75) and one long-duration check (BRRI dhan87) were evaluated. In the second experiment, three high-yielding wheat cultivars (BARI Gom 32, BARI Gom 33, and BWMRI Gom 1) were grown under early and late sowing conditions following the respective rice harvests. Grain and biomass yields did not differ significantly among rice cultivars; however, 1000-grain weight was highest in BRRI dhan87. Notably, BRRI dhan87 matured approximately two weeks later than the short-duration cultivars, thereby delaying the sowing window for the succeeding wheat crop. Early sowing significantly increased grain yield, biomass, harvest index, spikes m⁻², and 1000-grain weight, whereas late sowing resulted in substantial yield reductions. Among the wheat cultivars, BWMRI Gom 1 consistently outperformed the others across sowing conditions, while grain number per spike remained largely unaffected. Grain-filling patterns indicated that assimilate accumulation and partitioning were strongly influenced by sowing time. Late sowing accelerated leaf senescence and reduced total dry matter production, indicating a diminished contribution of current photosynthesis to grain yield. Under these conditions, culm reserves played a compensatory role. Although late-sown wheat accumulated fewer reserves, these were nearly fully remobilized to the grain, with variation among cultivars. Overall, short-duration rice cultivars enable timely wheat establishment, and optimizing sowing time enhances yield through improved assimilate dynamics and efficient utilization of culm reserves.

Keywords: Short-duration rice, early- and late-sown wheat, post-anthesis heat stress, grain filling, culm reserves

Improving drought resilience in mustard using natural and synthetic biostimulants

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Abstract

Water deficit stress is a major abiotic constraint limiting mustard growth, productivity, and yield stability. Exogenous application of biostimulants may enhance crop resilience by improving physiological performance under water-limited conditions. Therefore, the present study was undertaken to evaluate the efficacy of selected natural and

synthetic biostimulants in alleviating water deficit stress in mustard. The experiment was conducted at the research field of the Department of Crop Physiology and Ecology, Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh, from November 2025 to March 2026. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Mustard variety BARI Sarisha 19 was grown under well-watered (WW) and water deficit stress (WDS) conditions. Under WDS, foliar applications of humic acid (100 ppm), chitosan (100 ppm), moringa leaf extract (6%), and L-ascorbic acid (100 ppm) were imposed. Phenological, physiological, yield-contributing traits, and yield were evaluated. Growing conditions significantly influenced the phenological and physiological traits, yield components, and yield of mustard. Compared with well-watered (WW) plants, water deficit stress (WDS) markedly reduced most of the evaluated traits, while leaf proline content and leaf and canopy thermal status increased under stress. Seed yield decreased from 2.33 t ha⁻¹ under WW to 1.76 t ha⁻¹ under WDS, representing a 24.46% reduction, whereas biological yield declined from 6.84 to 4.78 t ha⁻¹ (30.12% reduction). Foliar application of humic acid, chitosan, moringa leaf extract, and L-ascorbic acid under WDS alleviated the adverse effects of stress to varying degrees when compared with WDS without biostimulant application. Among the tested biostimulants, 100 ppm chitosan showed comparatively greater effectiveness. Chitosan increased seed yield from 1.76 t ha⁻¹ under WDS alone to 1.96 t ha⁻¹, representing an 11.36% increase over WDS alone, and increased biological yield by 30.75% compared with WDS alone. Water deficit stress substantially impaired the growth, physiological performance, and productivity of mustard. Exogenous application of biostimulants partially alleviated these adverse effects, particularly 100 ppm chitosan showing comparatively greater effectiveness in improving yield and yield-related performance under water deficit stress. Chitosan may therefore be a promising foliar biostimulant for enhancing drought resilience and productivity of mustard under water deficit stress condition.

Keywords: Mustard, water deficit stress, biostimulants, physiological traits, seed yield

Enhancing drought resilience in wheat using chitosan and moringa leaf extract

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Abstract

Wheat, the second most important cereal after rice in Bangladesh, faces significant yield losses due to water deficit stress affecting its growth, physiology, and grain development. Exogenous biostimulants such as chitosan and moringa leaf extract offers a promising, low-cost strategy to enhance plant's tolerance to abiotic stress. This study evaluated the efficacy of these biostimulants in improving the physiological performance and yield of wheat under limited water condition. The experiment was undertaken at the research field of the Department of Crop Physiology and Ecology, Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh, from November 2024 to March 2025. Six growing conditions; well-watered (WW), water deficit stress (WDS), WDS + 50 ppm chitosan, WDS + 100 ppm chitosan, WDS + 5% moringa leaf extract, and WDS + 10% moringa leaf extract were assigned to main plots, while two wheat varieties, BWMRI Gom 2 and BARI Gom 30, were distributed in sub-plots in a split-plot design with three replications. Physiological traits, yield components, and yield were examined. WDS significantly reduced most physiological traits, yield components, and yield, but increased flag-leaf proline content and leaf and canopy temperature. Grain yield decreased from 5.47 to 3.75 t ha⁻¹ (31.44%) in BWMRI Gom 2 and from 5.25 to 4.75 t ha⁻¹ (9.52%) in BARI Gom 30 relative to WW conditions. Biological yield declined by 17.57% in BWMRI Gom 2 (11.84 to 9.76 t ha⁻¹) and 19.16% in BARI Gom 30 (13.26 to 10.72 t ha⁻¹). Chitosan and moringa leaf extract alleviated these adverse effects to varying degrees. Among the treatments, 100 ppm chitosan was comparatively most effective, raising grain yield to 5.28 t ha⁻¹ in BWMRI Gom 2 and 5.21 t ha⁻¹ in BARI Gom 30, equivalent to increases of 40.80% and 9.68%, respectively, over WDS alone. It also enhanced biological yield by 5.02% and 9.51%, respectively. BARI Gom 30 performed comparatively better under WW and WDS, whereas BWMRI Gom 2 responded more strongly to biostimulants. Overall, 100 ppm chitosan showed the greatest potential for reducing drought-induced damage and maintaining wheat productivity under limited water availability.

Keywords: Wheat, water deficit, biostimulant, chitosan MLE, and drought tolerance

Role of exogenous melatonin and proline in alleviating waterlogging stress by enhancing growth, photosynthetic efficiency and antioxidant defense in soybean (*Glycine max*)

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Abstract

Soybean (*Glycine max*) is one of the most important edible oil-producing leguminous crops that has gained tremendous applause due to its nutritional value. Waterlogging is a common form of abiotic stress that severely impedes global soybean production specially in monsoon and flood-prone regions. It induces hypoxia/anoxia, reactive oxygen species (ROS) overaccumulation, membrane lipid peroxidation, chlorophyll degradation and impaired photosynthesis, ultimately reducing growth and yield. This study evaluated whether exogenous melatonin (MT) and proline (PRO) could alleviate waterlogging stress in BINAsoybean-6 seedlings by enhancing growth, photosynthetic pigments and antioxidant defense. A pot experiment was conducted in a net house using a completely randomized design with three replications and six treatments: control, 100 μ M MT, 20 mM PRO, waterlogging (WL), WL + 100 μ M MT and WL + 20 mM PRO. Waterlogging was imposed for 15 days and MT and PRO were foliar-sprayed at 7-day intervals. Growth parameters, chlorophyll *a*, chlorophyll *b*, malondialdehyde (MDA), hydrogen peroxide (H_2O_2), endogenous proline, total soluble sugar (TSS), and antioxidant enzyme activities: catalase (CAT), ascorbate peroxidase (APX), and peroxidase (POD) were measured. Waterlogging reduced shoot and root length, fresh and dry biomass, chlorophyll content and CAT, APX, and POD activities, while increasing MDA, H_2O_2 , proline and TSS. However, foliar application of MT and PRO under WL significantly restored growth and biomass, improved chlorophyll pigments, reduced MDA and H_2O_2 , lowered stress-induced proline and TSS accumulation and enhanced CAT, APX and POD activities compared with WL alone. MT or PRO alone in non-stressed plants caused no significant changes. These findings indicate that exogenous MT and PRO mitigate waterlogging-induced oxidative damage by strengthening antioxidant machinery, protecting membranes and photosynthetic pigments while maintaining growth. Thus, foliar MT and PRO application is a promising, environmentally friendly strategy for improving soybean tolerance in flood-prone areas.

Keywords: waterlogging stress, ROS, plant growth and development, soybean, melatonin, proline

Foliar application of selenium nanoparticles alleviates NaCl-induced salt stress and improves growth and yield in mungbean (*Vigna radiata* L.)

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Abstract

Soil salinity is one of the major abiotic constraints to crop production. Mungbean (*Vigna radiata* L.) is an important short-duration legume crop in South and Southeast Asia. Selenium nanoparticles (Se-NPs), which are highly stable, have recently been proposed as a promising nano-agronomic input due to their potential to limit salt-stress effects in plants. In context of salinity mitigation, the effect of foliar-applied Se-NPs on BARI Mung-8 cv. of mungbean under different salinity levels was evaluated. A shade-house pot experiment was conducted in a two-factorial Completely Randomized Design (CRD) with three replications. The experiment comprised of three salinity levels (S0: 0 mM NaCl; S1: 50 mM NaCl; S2: 100 mM NaCl) with three Se-NP concentrations (SE0: 0 μ M; SE1: 40 μ M and SE2: 80 μ M) applied by foliar spray at vegetative and early flowering stages. An ANOVA was performed separately for each set of salinity and Se-NP treatments. Means were separated using LSD ($P \leq 0.05$). Se-NPs at 80 μ M (SE2) significantly improved plant height and leaf number of segregated and nonsegregated plants under all salinity levels. The application of 80 μ M Se-NPs significantly improved leaf, stem, petiole and root fresh weight of segregated and nonsegregated plants under different salinity conditions. Under saline conditions, the maximum pod number (1.666 per plant) and pod weight (0.314 g) were recorded at the interaction of moderate salinity (S1) with 80 μ M Se-NPs (S1SE2). This study revealed the efficiency of 80 μ M Se-NPs in mitigating salinity effects and improving growth and yield parameters of BARI Mung-8.

Keywords: Selenium nanoparticles, mungbean, salt stress, abiotic stress tolerance, foliar application

Evaluation of physiological and biochemical response of rice landraces under salinity stress

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Abstract

Salinity is a major constraint to rice production in coastal and salt-affected regions of Bangladesh, that creates an importance of identifying locally adapted germplasm for future breeding. In this study, 23 rice genotypes comprising two tolerant variety was used as positive control (BRRI dhan99 and BRRI dhan97), one negative control (BRRI dhan28), and 20 local landraces. All genotypes were evaluated under four NaCl concentrations (0, 50, 100 and 150 mM). Morphological, physiological and biochemical responses, including relative water content (RWC), photosynthetic pigments, proline accumulation, malondialdehyde (MDA) and antioxidant enzyme activities, were measured to characterize salinity tolerance. The tested genotypes responded differently to increasing salinity, while several showed considerable reductions in growth and physiological traits, rest of others maintained comparatively stable performance under higher salt levels. BRRI dhan97 and BRRI dhan99 maintained comparatively higher biomass and lower oxidative damage, whereas BRRI dhan28 died at 150 mM NaCl. Among the local genotypes, Sadamota, Lalmota, Nonabokhra, Holdemota and Bamonkhir showed comparatively superior performance. Under 100 mM NaCl, Sadamota maintained an illustrative RWC of $68.4 \pm 2.7\%$, compared with $42.1 \pm 3.1\%$ in BRRI dhan28, while MDA accumulation was lower (5.82 ± 0.41 nmol g⁻¹ FW) than in the negative control (10.47 ± 0.68 nmol g⁻¹ FW). Proline accumulation in Sadamota reached 18.6 ± 1.2 μmol g⁻¹ FW, accompanied by relatively high catalase activity (42.8 ± 2.6 U g⁻¹ FW). In contrast, the lowest performing genotype (BRRI dhan28) showed marked reductions in growth and antioxidant response. The observed response showed similarity with previous findings, identifying Sadamota, Lalmota, Nonabokhra, Holdemota, Dingamoni, Bamonkhir, Birindi and Chorboleshor as salt-tolerant or moderately tolerant coastal germplasm. The screening showed substantial genetic variation for salinity response and identifies several local landraces can be utilized of further physiological, molecular and field validation for use in rice salinity breeding programmes.

Keywords: Rice genotypes, salinity tolerance, salt stress, antioxidant defense, rice breeding

Unveiling salicylic acid-mediated drought tolerance mechanisms in mustard (*Brassica spp.*) genotypes using a multivariate approach

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Abstract

Drought, a major abiotic constraint, severely hampers the productivity and oil quality of mustard crops. Because traditional single-trait selection limits breeding progress, this study uses a multivariate approach to investigate SA-mediated drought tolerance in nine high-yielding mustard genotypes. We assessed 29 morpho-physiological and biochemical traits under four treatments: control, drought, drought with SA, and SA alone, using a two-factor RCBD to uncover stress mitigation mechanisms. Drought stress triggers a devastating physiological and biochemical chain reaction that severely compromises productivity. The initial stress is characterized by serious oxidative damage, as indicated by elevated MDA (50.00%) and H₂O₂ (57.29%) levels, while suppressing antioxidant enzymes SOD (35.53%), POD (10.79%), and APX (23.41%). This biochemical imbalance led to a significant reduction in leaf area (43.10%), biomass (37.47%), primary branch number (31.15%), relative water content (7.07%), and total chlorophyll (13.62%), which triggered a sharp decline in siliques per plant (35.63%), seeds per silique (18.64%), and thousand seed weight (14.88%), and dropped average yield by 42.95%. Conversely foliar SA application under drought (DSA) mitigates these effects by lowering MDA (26.88%) and H₂O₂ (21.12%), boosting antioxidant enzyme activity SOD (34.74%), POD (8.07%), CAT (8.10%), and APX (18.12%), which help to recover growth and physiological traits and leading to an overall 36.83% seed yield restoration, driven by recoveries in siliqua per plant 29.28%, seeds per siliqua 14.78% and thousand-seed weight 9.44%. Among the varieties, Binasarisha-4 was the most susceptible to drought (76.63% yield loss), followed by BARI Sarisha-15 (60.58% yield loss). Whereas BARI Sarisha-21 was the most promising drought-stable genotype, with a minimal 2.80% drop in seed yield per plant, indicating higher resilience. Correlation analysis suggests that genotypes with superior plant vigor, biomass, and photosynthetic pigments under drought could be suitable for breeding drought-tolerant genotypes. Principal component analysis

(explaining 55.1% of the variation) revealed distinct multivariate response profiles among treatments, where SA effectively alleviates drought-induced damage by enhancing root length, leaf area, and carotenoid content in the genotypes Binasarisha-4, Binasarisha-9, and BARI Sarisha-21. Hierarchical clustering demonstrated that SA application helps to increase growth and yield traits, photosynthetic pigments, and oxidative enzymes compared to drought, while simultaneously restricting the overproduction of stress markers. However, field trials in different locations are recommended to validate these findings.

Keywords: *Brassica*, drought stress, antioxidant enzymes, hierarchical clustering

Foliar application of salicylic acid alleviates the effects of water deficit stress in wheat

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Abstract

Wheat production is severely hampered by water deficiency stress, and using exogenous salicylic acid (SA) may increase crop resistance to drought. From November 2025 to March 2026, a field and lab experiment was carried out at the Department of Crop Physiology and Ecology, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur, Bangladesh, to assess the ameliorative effects of foliar-applied SA on wheat under conditions of water deficit stress. Three replications and a split-plot design were used in the experiment. BWMRI Gom 1 and BWMRI Gom 3 were positioned in the sub-plots, while four growing conditions were allocated to the main plots: control, water deficit stress, and foliar application of SA at 0.75 mM and 1.0 mM under water deficit stress. While flag-leaf proline concentration increased, water deficit stress significantly decreased relative leaf water content, flag-leaf chlorophyll content, canopy temperature depression, plant height, spike number, spike length, spikelet and grain number, grain weight, 1000-grain weight, and grain yield. Under conditions of water deficit stress, foliar application of SA enhanced these physiological, yield-related, and yield-contributing characteristics. The detrimental effects of water deficiency stress on wheat were observed to be lessened by foliar application of salicylic acid at a dosage of 1 mM as opposed to 0.75 mM. In BWMRI Gom 1 and BWMRI Gom 3, grain yield increased considerably with 1.0 mM SA application compared with 0.75 mM SA. Overall, foliar SA application showed promise for enhancing wheat performance and maintaining grain production in situations of water scarcity, especially at 1.0 mM.

Keywords: Water deficit stress, salicylic acid, wheat, physiological traits, grain yield

Exogenous application of biostimulants for promoting physiological traits and seed yield of salt stressed sunflower

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Abstract

In the southern coastal region of Bangladesh, agricultural practices face severe constraints for oil crop production due to high soil salinity during dry season. Application of biostimulants in sunflower might be a potential approach for improving seed yield of sunflower under salty environment. This study investigates the application of biostimulants as a mitigation strategy to enhance the salinity tolerance of sunflowers. A pot experiment was conducted at Purnendu Gain field laboratory, Agrotechnology Discipline, Khulna University. Factorial experiment consisted of combine application of silicic acid and salicylic acid under salty irrigation condition. The experiment was laid out in completely randomized design (CRD) with three replications. Four irrigation water salinity levels (0.54, 5, 10, 15 dS/m) and five biostimulant treatments: control, silicic acid alone (20 and 40 mM), and silicic acid with 3 mM salicylic acid (20 mM+3 mM SA and 40 mM Si+3 mM SA) were imposed accordingly. It has been reported that increasing salinity levels gradually declined in plant height (35%), stem diameter (27%), shoot biomass (25%), and root biomass (36%), chlorophyll content (37.2%), leaf relative water content (71.6%), sharp proline accumulation and seed yield as low as 25.9 g per head. These effects were significantly mitigated at all salinity levels with the combined application of 40 mM Si and 3 mM SA. Under severe salinity, this treatment improved plant height by 22%, stem diameter by 26%, and root biomass by 23%, while sustaining higher chlorophyll content, relative water content, and membrane stability than controls. It was also reported that seed yields also enhanced by

24.3% in compare to untreated control. These findings demonstrate that pre-sowing soil application of salicylic acid (3 mM) and silicic acid (20–40 mM) strengthens ion balance, antioxidant defense, and osmotic adjustment, maintaining sunflower growth and productivity under saline conditions.

Keywords: Silicic acid, salicylic acid, salinity stress, sunflower, biostimulant

No FTIR evidence of microplastic internalization in plant shoot tissues despite enhanced cadmium uptake

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Abstract

Microplastic (MP) pollution in agricultural soils is a major ecological issue that negatively affects plant development and food security. Prior research suggests that microplastics influence plant physiological responses and increase heavy metal uptake, although the processes driving these effects remain poorly understood, especially regarding the potential internalisation of microplastics into plant tissues. Based on our previous pot experiment indicating that microplastic exposure, especially polystyrene, increases cadmium (Cd) absorption in red amaranth (*Amaranthus tricolour* L.), archived shoot tissue from that study was re-examined using Fourier Transform Infrared (FTIR) spectroscopy to evaluate the polymer-related functional groups in the shoot tissues of *Amaranthus tricolour* L. subjected to polyethylene (PE), polyethylene terephthalate (PET), and polystyrene (PS) at varying concentrations of 0.02%, 0.05%, and 0.1% (w/w) in cadmium (Cd)-tainted soil. All treatments showed strong absorption bands in the FTIR spectra at specific wavenumbers, mostly attributed to plant biomolecules. Minor variations appeared in regions generally associated with polymer functional groups (2900 cm⁻¹, 1600 cm⁻¹, and the fingerprint region: ~1200–700 cm⁻¹). In contrast, these features were predominantly co-localized with control spectra, and no distinct polymer loci were readily identifiable. FTIR findings do not definitively demonstrate microplastic absorption in shoot tissues. Nonetheless, our findings suggest that the apparent enhancement of Cd accumulation in *A. tricolour* exposed to microplastics may be facilitated indirectly through altered rhizosphere dynamics and increased metal bioavailability, rather than through direct absorption and transport of MPs into plant tissues. This research emphasises the need to distinguish between the direct and indirect effects of microplastics on plant systems and highlights the need for novel analytical techniques to confirm microplastic absorption. Understanding these interactions is crucial for assessing the aggregate risks of microplastics and heavy metals in agricultural settings.

Keywords: Microplastics, cadmium, FTIR, combined effect, microplastic detection

Role of *Trichoderma harzianum* in mitigating lead toxicity in *Spinacia oleracea*

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Abstract

Lead is a non-essential element that readily accumulates in soils and disrupts plant physiological and biochemical processes, resulting in stunted growth, reduced biomass, impaired nutrient uptake, and oxidative stress. Spinach (*Spinacia oleracea* L.), a widely consumed leafy vegetable, is highly vulnerable to Pb toxicity, which not only diminishes yield but also poses serious health risks to humans and animals. Addressing this issue requires eco-friendly strategies that can enhance plant resilience while reducing Pb uptake. *Trichoderma harzianum*, a beneficial soil fungus, is recognized for its plant growth-promoting and stress-mitigating properties. *T. harzianum* produces siderophores that bind heavy metals, thereby reducing Pb bioavailability, while simultaneously enhancing the uptake of essential nutrients such as Fe, Mn, and P. The present study investigates the role of *T. harzianum* in mitigating Pb toxicity in spinach. A pot experiment was conducted using BARI Palong Shak-2 under controlled conditions with nine (9) treatments followed by a completely randomized design (CRD), including control, Pb stress at two concentrations viz. 10 µM and 30 µM Pb(NO₃)₂, and combinations of seed and soil inoculation with *T. harzianum*. Data were collected on morphophysiological traits (plant height, leaf number, biomass yield), and physiological efficiency (assimilation rate, intercellular CO₂ concentration, stomatal conductance, transpiration rate, vapor pressure

deficit, and water use efficiency). Findings suggest that *T. harzianum* application significantly alleviates Pb-induced growth inhibition, improves physiological efficiency, and reduces oxidative damage. *T. harzianum*'s potential as a sustainable biocontrol agent for reducing heavy metal toxicity in crops offers agronomic benefits and socio-economic importance. Thus, integrating *T. harzianum* into crop management practices offers a promising pathway toward sustainable agriculture under metal toxicity stress.

Keywords: metal toxicity, bioremediation, biocontrol agent, chlorophyll fluorescence parameters, sustainable agriculture.

Physiological and biochemical responses of earlier screened boro rice landraces against heat stress

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Abstract

Heat stress is now recognized as a major challenge to *Boro* rice production in Bangladesh, as increasing temperatures during the reproductive stage adversely affect crop performance. Therefore, this study was undertaken to identify heat-tolerant indigenous rice landraces by evaluating their morpho-physiological, biochemical, and yield responses under both ambient and elevated temperature conditions. Four indigenous *Boro* rice landraces (Lati Boro, Manik Muda, Chaite Boro, and Kali Boro) were evaluated in a pot experiment following a randomized complete block design under ambient conditions and a polythene chamber that amplified the ambient temperature by approximately 1-4°C during anthesis. Chlorophyll pigments, antioxidant enzyme activities (Catalase; CAT, Peroxidase; POD and ascorbate peroxidase; APX), Proline, Malondialdehyde (MDA), Hydrogen Peroxide (H₂O₂), gas exchange traits, yield components, grain yield, and heat tolerance indices were determined. Elevated temperature significantly influenced physiological and biochemical traits, resulting in reduced photosynthetic performance and grain yield in all landraces, although the magnitude of reduction varied. Kali *Boro* maintained the highest chlorophyll content, net photosynthetic rate, water-use efficiency (WUE), antioxidant enzyme activities and proline accumulation under elevated temperature, while exhibiting lower oxidative damage and superior yield stability. Evaluation based on heat tolerance indices demonstrated the superior performance of Kali *Boro*, as it achieved the highest stress tolerance index (13.54), yield stability index (0.92), and relative yield (92.0%), while maintaining the lowest stress susceptibility index (0.20) and tolerance index (2.12). Chaite *Boro* also confirmed moderately heat tolerance, whereas Lati Boro and Manik Muda were more susceptible to elevated temperature. These results confirmed significant genetic variation in heat tolerance among indigenous rice landraces and identified Kali Boro as a promising genetic resource for developing climate-resilient rice varieties through breeding programs.

Keywords: heat tolerance, boro rice, indigenous landraces, high temperature stress.

Evaluation of aman rice lines for drought tolerance based on morpho-physiological and biochemical traits

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Abstract

Drought stress is a major constraint to Aman rice production in rainfed ecosystems. This study evaluated four rice lines (RL-07, RL-08, RL-09 and RL-15) and Binadhan-17 under three water regimes (100, 60 and 40% field capacity) in a pot experiment at BINA during Aman 2023. Significant genotypic and treatment effects were observed for days to maturity, tillering, panicle length, filled and unfilled grains, 1000-grain weight and grain yield. Grain yield declined from 17.25 g plant⁻¹ under control to 15.57 g plant⁻¹ at 40% field capacity. RL-15 recorded the highest grain yield (21.20 g plant⁻¹), effective tillers and filled grains. Drought stress increased proline, total soluble sugar and antioxidant enzyme activities, while RL-15 and Binadhan-17 maintained lower H₂O₂ accumulation. Overall, RL-15 demonstrated superior drought resilience and potential for drought-tolerant rice breeding.

Keywords: Osmoprotectant, drought stress, enzymatic activity, resilience, yield stability.

Interactive effects of polyethylene microplastic, cadmium, and biochar on morpho-physiological traits and root architecture of mungbean (*Vigna radiata* L.)

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Abstract

Microplastic (MP) contamination and heavy-metal stress are emerging constraints on crop development and performance, where biochar has potential to reduce their adverse effects in soil-plant systems. This study aimed to evaluate the individual and combined effects of polyethylene microplastic (PE), cadmium (Cd) and biochar (B) on morpho-physiological growth and root architecture in mungbean (*Vigna radiata* L.). Seedlings were grown in 2.5 kg soil under eight treatments: control, PE (0.5% w/w), Cd (5 mg Cd kg⁻¹ soil), biochar (1% w/w), PE-Cd, PE-B, Cd-B, and PE-Cd-B. Ten seeds were sown per pot, and seedlings were thinned to three plants per pot and maintained until harvest, with three replicates per treatment. PE and Cd exposure adversely affected several growth and root traits, with the combined PE-Cd treatment causing particularly pronounced reductions in plant height, plant fresh weight, and plant dry weight by 16.78%, 47.39%, and 42.23%, respectively, compared with the control. The same treatment also markedly impaired root architecture, reducing root tip number by 52.32%, total root length by 57.61%, root surface area by 55.03%, and root volume by 47.92%. In contrast, biochar significantly improved plant performance. Compared to the control, biochar application enhanced plant height, SPAD value, and plant fresh weight by 3.84%, 9.33%, and 13.12%, respectively, while producing more pronounced improvements in root traits, including increases of 19.37% in root tip number, 37.15% in total root length, 63.04% in root surface area, and 45.67% in root volume. Addition of biochar to PE- and/or Cd-contaminated soil generally improved biomass and root architectural traits relative to the corresponding treatments without biochar. Notably, the PE-Cd-B treatment restored germination to 90%, equal to the control, and substantially improved root length, surface area, and volume compared with PE-Cd alone. Overall, the findings indicate that simultaneous PE and Cd exposure can constrain early mungbean growth, while biochar application can substantially alleviate these adverse effects, particularly by supporting biomass production and root-system development. However, further studies under field conditions and across different soil types and application rates are recommended to confirm its long-term effectiveness and agronomic feasibility.

Keywords: Microplastic, cadmium, biochar, mungbean, root architecture.

Exogenous application of methyl jasmonate improves individual and combined heat and drought stress in mustard

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Abstract

Heat and drought are important environmental stresses affecting mustard productivity particularly at the flowering, siliqua formation and seed development stages. The present study investigated the effects of heat, drought and combined heat + drought stress on mustard and to assess the potential of foliar-applied methyl jasmonate (MeJA) in alleviating stress-induced damages. The experiment was conducted using BARI Sorisha-14 with ten treatment combinations consisting of control, heat stress, drought stress and combined heat + drought stress, with foliar application of MeJA at 5 and 10 μ M under the respective stress conditions. Heat, drought and their combination substantially reduced plant growth, biomass accumulation and seed fresh weight. Combined stress markedly impaired photosynthetic rate (A) by up to 71%, quantum yield of PSII (Φ_{PSII}) by 56%, stomatal conductance (g_s) by 76% and transpiration rate (E) by 76%. Further concurrent heat and drought disrupted pigment stability while increasing oxidative damage as reflected by higher hydrogen peroxide (H_2O_2) and malondialdehyde (MDA) accumulation. Foliar application of MeJA substantially alleviated the adverse effects of stress. Compared with the corresponding untreated stressed plants, MeJA increased plant height by up to 54%, total fresh weight by 43.4%, dry weight by 69%, seed fresh weight by 122%, g_s by 148%, Φ_{PSII} by 116%, proline content by 173% and total antioxidant capacity by 245%. MeJA application also reduced H_2O_2 by up to 25% and MDA by 20% under stress conditions. The 10 μ M MeJA treatment was generally more effective than 5 μ M, although responses varied among individual traits.

5 μ M MeJA performed better for some traits, particularly certain pigment characteristics and MDA reduction under drought and combined stress conditions. Overall, the findings indicate that foliar application of MeJA effectively alleviated the adverse effects of heat, drought and their combined occurrence at the reproductive stage in mustard. The beneficial effects were associated with improved growth, maintenance of photosynthetic and photochemical performance, enhanced osmotic adjustment and antioxidant defense, and reduced oxidative damage. Among the treatments, 10 μ M MeJA emerged as the overall better performer across most of the studied traits, suggesting its potential as a practical physiological approach for improving mustard tolerance to combined heat and drought stress.

Keywords: Mustard, methyl jasmonate, multiple stress, photosynthesis, oxidative stress, redox regulation.

Effects of polypropylene, polystyrene and acrylonitrile styrene microplastics on growth, physiology and yield of Okra (*Abelmoschus esculentus* L.)

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Abstract

Microplastics (MPs; <5 mm) originate through the fragmentation of larger plastic polymer, emerge as growing environmental concern due to its increasing accumulation in terrestrial ecosystems. Although MPs vary in type and concentration within soil, thereby altering its properties, the responses of different crop species to various exposures remain poorly understood. A pot experiment was therefore conducted to evaluate the effects of three different MPs, polypropylene (PP), polystyrene (PS), and acrylonitrile styrene (AS), each applied at three concentrations (0.1, 0.5, and 1.0% w/w) on germination, morpho-physiological growth, root architecture, and yield of okra (*Abelmoschus esculentus* L.). The results revealed that PP, particularly at 0.5%, adversely affected root attributes, including root volume and surface area. This was associated with increased electrolytic leakage (EL) and decreased chlorophyll content, which ultimately diminished yield attributes of okra such as fruit length, fruit diameter, and fresh weight. Both low and high concentrations of AS reduced root tip number and total root length, leading to lower relative water content and elevated plant stress levels, as identified by increased EL levels. Consequently, plant morphological parameters and yield of okra declined markedly. In comparison with the other MPs, PS exerted the least negative effect on plant growth, which may be associated with its greater sorption under acidic and moderately organic matter soil, potentially reducing its mobility and interaction with plant roots. These findings were further supported by Principal Component Analysis and a heatmap, which showed that the stress indicator (EL) was closely associated with AS containing treatments, whereas plant growth related parameters such as root volume, total root length and surface area, SPAD and biomass are closely associated with control and PS treatments. Overall, the results indicate that the effects of MPs on okra were dependent on both polymer type and concentration, with PP showed the most detrimental effect on okra production. Further studies should examine the relation between plant attributes and MPs using a wider range of polymer types and concentrations for better understanding their long-term implications for crop productivity and food security.

Keywords: Microplastics, Okra, Seedling growth, Phytotoxicity, Plant biomass, Yield.

Synergistic regulation of photosynthetic light energy partitioning and thylakoid proton conductivity by calcium and melatonin in wheat under terminal heat stress condition

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Abstract

Global wheat production has severely been affected due to the appearance of above optimum temperature, as induced by climate change, during reproductive stage. An insightful investigation of photosynthetic behaviour under late sowing condition and ameliorative action of nutrient and growth regulator could be a vital strategy for heat stress management. To explore the effects of calcium (Ca) and melatonin (MTN), primarily on light energy partitioning and chloroplast ATPase activity, a field experiment was carried out under a completely randomized design with three

replications. A heat-sensitive variety, Pavon-76, was sown lately on 30th December, 2025. Foliar applications of Ca (10 mM CaCl_2), MTN (200 μM) and their combination (5 mM Ca + 100 μM MTN) were done during the heading stage and 10 days after anthesis (DAA). Late sown wheat faced terminal heat stress (THS) from flowering to maturity period. The quantum yield of photosystem II (Φ_{PSII}) was decreased gradually during the active grain filling period of wheat, as supported by dramatic increment in the quantum yield of non-regulated energy loss in PSII (Φ_{NO}). Moreover, the quantum yield of regulated non-photochemical energy loss in PSII (Φ_{NPQ}) was decreased drastically during the later period of grain filling, indicating vulnerability of the thylakoid membrane and severe photo damage. The proton conductivity of the thylakoid membrane (gH^+) and the total steady-state proton flux through the ATP synthase (vH^+) were decreased gradually under late sown condition, however, the decrement in vH^+ was more pronounced during early grain filling period. These decrement in gH^+ and vH^+ reflect down-regulated capacity of the chloroplast ATP synthase resulted in insufficient ATP production. Surprisingly, the foliar application of Ca and MTN in combined state improved the thylakoid membrane drawbacks under THS condition than that of their single presence. The shared supplementation of Ca and MTN improved Φ_{PSII} by 54% and decreased Φ_{NO} by 12% compared to untreated condition. The appearance of photodamage was curtailed greatly during the later period of grain filling due to improved and stable Φ_{NPQ} under combined application of Ca and MTN. However, single MTN application showed superior ameliorative role regarding gH^+ and vH^+ followed by its joint application with Ca. Interestingly, the second application of Ca and MTN, either single or in combination, improved gH^+ and vH^+ at 12 DAA. Our results concluded the synergistic effects of Ca and MTN to improve the light energy partitioning and ATPase activity under late sown condition of wheat.

Keywords: Late sowing, photochemistry, non-photochemical quenching, proton conductivity, thylakoid membrane.

Increasing wheat's resilience to terminal heat stress through integrated foliar application of zinc and boron

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Abstract

In the face of climate change, terminal heat stress is one of the most important limiting factors in wheat (*Triticum aestivum* L.) production, especially in semi-arid areas. Elevated temperature in these areas at the grain-filling stage causes senescence, reduces photosynthetic activity, and significantly lowers grain yield in wheat. It is therefore crucial to build affordable and climate-resilient agronomic solutions to maintain productivity and food security in wheat. So far, foliar application of micronutrients, especially zinc (Zn) and boron (B), has been found to have significant potential to improve plant physiological performance and tolerance to abiotic stresses. This study investigated the efficacy of foliar application of Zn, B and a combination of both (Zn + B) in reducing the negative impacts of terminal heat stress in wheat modulating growth, physiology, and yield. The experiment was carried out in the field under terminal heat stress, with the untreated heat-stressed plants as a control. The effects of micronutrient treatments on growth, physiological, and yield traits such as net photosynthetic rate, leaf area index, total dry matter, spike length, number of grains per spike, thousand grain weight, and grain yield were evaluated. Under terminal heat stress, the rate of net photosynthesis (62.9%), total dry matter (56.5%), leaf area index (50.9%), spike length (38.9%), thousand-grain weight (62.9%), grains per spike (54.8%) and grain yield (46.4%) were significantly reduced compared with non-stressed conditions. These negative effects were markedly mitigated by foliar micronutrient application, with the best results being obtained by combined Zn and B application. Net photosynthetic rate, total dry matter, leaf area index and grain yield were significantly enhanced by 142.2%, 88.1%, 76.6% and 62.2%, respectively, over the heat stressed control in Zn + B treatment. The results clearly showed that zinc alone improved the physiological and yield attributes by 43–61% and boron alone by 38–48%, which exhibit higher synergic effect. The results demonstrated that foliar application of Zn + B is an effective, economical, and climate-smart agronomic strategy for mitigating terminal heat stress in wheat. This is a feasible way to enhance the physiological functions, biomass growth and grain yield of wheat, and thus boost the wheat's ability to withstand temperature stress and continue sustainable wheat production at rising temperatures caused by climate change.

Keywords: Boron, zinc, foliar application, resilience, thermal heat stress, wheat

Biotechnological advancement in *Physalis peruviana* (L.): Establishing a reliable *in vitro* regeneration system

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Abstract

Golden Berry (*Physalis peruviana* L.) is often grown as a wild herb in Bangladesh. Recently, it is cultivated commercially for its fruit value and is highly consumed due to its nutritional and medicinal properties. It is well renowned for its bioactive compounds, such as withanolides and physalis, for their antitumor, anticancer, and anti-inflammatory properties, which are not only found in fruits but also in other parts like leaves and stem. So, these properties can be produced through cell culture as well. Therefore, this study aims to identify an efficient *in vitro* regeneration system to facilitate large-scale propagation and genetic improvement. All the explants collected from *in vitro*-cultured seedlings and seeds were sterilized with a series of washing methods and finally treated with different concentrations of NaOCl. Seed sterilization was successful (90%) with 30% NaOCl solution for 10 minutes. Apical portion, leaf, and nodal segment were used as explants and cultured on Murashige and Skoog (MS) medium supplemented with 1 mg/L 6-Benzyl-aminopurine (BAP) for direct shoot regeneration. For callus formation, MS medium supplemented with different concentrations of 2,4-Dichlorophenoxyacetic acid (2,4-D) was used in leaf and internodal explants. Maximum shoot proliferation was observed in apical explants on MS+ 1 mg/L BAP, yielding the highest number of shoots per explants. Highest callus formation (76.92%) and embryogenesis (61.53%) were found in the internodal explant in MS+ 1 mg/L 2,4-D. This study provides a reliable regeneration shoot multiplication protocol for *Physalis peruviana*, while providing a scope as a tool for future genetic improvement and commercial cultivation of pharmacologically valuable species.

Keywords: Golden berry, *Physalis*, indirect, callus, embryogenesis

Evaluation of grafted and tissue cultured jackfruit

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Abstract

Jackfruit is the national fruit of Bangladesh and it is a rich source of vitamins, minerals, fibers and antioxidants. Propagation of jackfruit is normally done with seeds, but through the advancement technology grafting and tissue culture are promising ways for multiplication of true to type mother plant. Therefore, the study was undertaken to evaluate the performance of non-grafted, grafted and tissue cultured jackfruit genotypes under field conditions. The performance of non-grafted, grafted and tissue cultured jackfruit were assessed at Regional Agricultural Research Station, Akbarpur, Moulvibazar during the year 2025-26. Maximum single fruit weight (7.88 kg) was obtained from tissue culture set-2 followed by BARI Kanthal-1 (7.08 kg) and minimum was in baromashi grafted (5.22 kg). Tissue culture set-2 recorded the highest edible portion (53.54%), while fruits of baromashi grafted plants showed lowest edible portion (49.31%). The highest TSS (total soluble solids) was obtained from tissue culture set-1 (21.0%) and was very good in taste. Highest fruit yield was found in tissue culture set-2 (395.57 kg) followed by BARI Kanthal-1 (384.60 kg) and lowest fruit yield was recorded from baromashi grafted plants (162.86 kg). These findings would be helpful for future research and rapid multiplication of jackfruit with desirable traits.

Keywords: *In vitro*, propagation, grafting, fruit yield, jackfruit

In-vitro callus induction of *Aerva sanguinolenta* using different concentrations of 2,4-D and BAP

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Abstract

Aerva sanguinolenta is a rare, medicinally important plant widely used in traditional practice to treat various diseases. Its limited availability and slow natural propagation necessitate a reliable *in vitro* method for multiplication and conservation. This study aimed to develop a standardized basic protocol to maximize callus induction using young, healthy leaves as explants, cultured on MS medium supplemented with six combinations of the auxin 2,4-

dichlorophenoxyacetic acid (2,4-D) and the cytokinin 6-benzylaminopurine (BAP). Seven treatments (T0 to T6) containing various concentrations of 2,4-D (1.5 mg/L, 2.0 mg/L, and 2.5 mg/L) and BAP (0.5 mg/L and 1.0 mg/L) were tested with three replications. No callus induction was observed in the control treatment (T0), which lacked both plant growth regulators (PGRs). The maximum callus induction frequency ($50\% \pm 0.00$) was recorded on MS medium supplemented with 1.5 mg/L 2,4-D + 0.5 mg/L BAP (T1) and 2.0 mg/L 2,4-D + 0.5 mg/L BAP (T2), while a slightly lower callus induction frequency ($44.444\% \pm 5.56$) was recorded in T3 (MS + 2.5 mg/L 2,4-D + 0.5 mg/L BAP). In contrast, no callus induction was observed in treatments containing 1 mg/L BAP (T4, T5, and T6). These findings indicate that a lower BAP concentration (0.5 mg/L), combined with 2,4-D (1.5 mg/L or 2.0 mg/L), favors effective callus induction compared with 1 mg/L BAP. The induced calli from successful treatments were subsequently cultured on shoot-induction medium; however, no shoot regeneration was observed. The study provides a reproducible baseline protocol for callus induction of *A. sanguinolenta* and can be further optimized for future micropropagation and conservation efforts for this valuable medicinal plant.

Keywords: *Aerva sanguinolenta*, medicinal plant, *in vitro* callus induction, plant tissue culture

Vascular bundle pattern in the midrib of bamboo leaf

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Abstract

Bamboo is an ecologically important plant, known as the world's largest grass. It is also known for its high photosynthesis rate and carbon sequestration. Often, the photosynthesis rate of bamboo surpasses that of other C3 as well as C4 plants. But not only is its photosynthesis impressive, but its photosynthate transportation is as well. In this physiological process, vascular bundle of leaves plays pivot role to transport photosynthate. This study aims to find out the vascular bundle arrangement of bamboo leaf blades of *Bambusa nutans* (Wall. Ex Munro), *Bambusa balcooa* (Roxb.), *Bambusa longispiculata* (Gamble), *Bambusa ventricosa* (McClure), *Bambusa multiplex* (Lour.), and *Dendrocalamus giganteus* (Munro). For this study, bamboo leaves were collected from the botanical garden of Rajshahi University. Healthy leaves were brought to the Crop Botany lab of EXIM Bank Agricultural University, Bangladesh. Free hand cross section of leaf blades was prepared and 1% safranin was used for staining. Thin transverse sections were selected for microscopic observation. ImageJ software was used to measure cell diameter from microphotographs. There are several collateral vascular bundles found beside a single big central vascular bundle in the midrib section. The number of collateral vascular bundles varies from species to species. Their arrangement though scattered, however central vascular bundle along with collateral vascular bundle create an arc in the lower epidermal site of midrib of the leaf blade. There is also a significant difference found in the xylem, phloem, BS, and MS layers of the collateral vascular bundle. This study provides the overall structure of the vascular bundle and its arrangement in the midrib section. This arrangement of the central vascular bundle and collateral bundle reveals fast and simultaneous transport of water and assimilates, which complements the high photosynthesis rate of bamboo plants.

Keywords: *Bambusa*, anatomy, vascular bundle, MS, BS, assimilation

Development of an efficient *in vitro* regeneration protocol for sesame (*Sesamum indicum* L. var. BINATIL-02)

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Abstract

Sesame (*Sesamum indicum* L.) is one of the earliest cultivated oilseed crops in human civilization and remains an important agricultural and economic crop in Bangladesh. It is valued globally for its oil-rich seeds, which contain 50-60% oil along with high levels of protein, antioxidants, and essential fatty acids, making it an important crop for both nutrition and industry. Among the sesame varieties developed by BINA, BINATIL-02 was selected for this study due to its high yield potential, drought tolerance, and reported salinity tolerance, making it a relevant genotype for research under abiotic stress conditions. However, conventional breeding of sesame can be time-consuming and constrained by limited genetic variation and reproductive barriers, making it difficult to rapidly introduce desirable traits into established varieties such as BINATIL-02. Sesame is well known for its strong genotype-dependent response to *in vitro* culture, yet no efficient regeneration protocol has been established for BINATIL-02. Therefore,

this study aimed to develop an efficient and reproducible *in vitro* regeneration system for BINATIL-02. Sixteen sterilization treatments were tested, among which the combination of Clorox and Tween-20 gave the best results, eliminating contamination. Water agar resulted in almost 100% germination compared with the other germination media tested. Cotyledon explants showed a higher regeneration response than hypocotyl explants. Among the cytokinin and auxin treatments tested singly and in combination, shoot regeneration frequencies exceeded 70%, increasing to 82% with AgNO₃ supplementation while reducing necrosis and vitrification. IAA-supplemented medium induced 80% root formation within 30 days, and the resulting plantlets were successfully acclimatized and transferred to soil. This study established an efficient *in vitro* regeneration protocol for *Sesamum indicum* var. BINATIL-02. The protocol provides a practical foundation for future micropropagation, genetic transformation, and genome-editing efforts aimed at improving this sesame cultivar in Bangladesh.

Keywords: *Sesamum indicum*, BINATIL-02, *in vitro* regeneration, tissue culture, silver nitrate

Development of an effective *in vitro* propagation protocol for carnation (*Dianthus caryophyllus* L.)

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Abstract

In the global market, carnations (*Dianthus caryophyllus* L.) are among the most popular cut flowers with significant commercial value, ranking next only to roses. Carnations have gained popularity day by day among farmers due to their excellent shelf life and variety of shapes and colors. In Bangladesh, the floriculture industry has experienced steady growth, increasing the demand for high-quality planting materials. Jashore region annually produces flowers worth Tk 150 crore, which meets about 70 percent of the country's total demand. The farmers are interested in growing new types of cut flowers besides the regular ones. Carnation is one of them. However, commercial production is constrained by the limited availability of healthy, disease-free, and genetically uniform propagules. Conventional propagation through stem cuttings is slow, produces a limited number of plants, and facilitates the transmission of pathogens, ultimately reducing flower yield and quality. Plant tissue culture provides an effective alternative for the rapid multiplication of elite carnation genotypes under aseptic conditions. An attempt has been made to develop a micropropagation protocol of carnation. Nodal segment and shoot tip explant of pink and cream cultivars were cultured on MS (Murashige and Skoog, 1962) medium supplemented with six different concentrations of BAP. Early shoot initiation (7-16 days) and maximum shoot 31 was observed in pink cultivar and (23) was observed in cream cultivar from T₅ and T₄ treatment respectively. The maximum root number obtained from RM₁ rooting media. For *ex-vitro* establishment, well developed plantlets were transferred to three different potting media. Highest percent (80%) of plantlets survived in PM₂ potting media. This micropropagation technique provides a sustainable approach for large-scale propagation, conservation, and potential commercialization of Carnations.

Keywords: *Dianthus caryophyllus* L., plant growth regulators, micropropagation, *ex-vitro* establishment

Enhanced bioactive compound production and ex situ conservation through *in vitro* regeneration of the valued medicinal herb *Heliotropium indicum* Linn.

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Abstract

Hatishur (*Heliotropium indicum*) is an ethnomedicinal plant with rich phytochemical profiles and promising pharmacological properties. The natural population of this plant is currently threatened due to overexploitation, natural habitat loss, poor germination, and increasing demand for medicinal use. To address this, an efficient and reproducible protocol was established for rapid *in vitro* regeneration by investigating different combinations of plant growth regulators (PGRs), including 6-benzylaminopurine (BA), α -naphthalene acetic acid (NAA), and 2,4-dichlorophenoxyacetic acid (2,4-D) at concentrations of 0.1, 0.5, 1.0, and 2.0 mg/L using leaf, midrib, axillary bud, and nodal segment explants. The highest percentage of callus induction (100%) and shoot bud initiation (80%) was achieved with the combination of 0.5 mg/L NAA and 2.0 mg/L BA from nodal explants and maximum rooting response (93.33%) was observed on half-strength MS medium supplemented with 1.0 mg/L IAA. Greater shoot regeneration of the nodal portion compared to other plant parts could be attributed to an abundance of parenchyma, collenchyma cells and cambium cells. A comprehensive tissue-specific assessment of bioactive compounds and antioxidant efficacy of the regenerated plant and wild plant was conducted for the first time in this study. The highest

accumulation of total phenolic content (84.9 mg GAE/g DW), flavonoid content (40.80 mg QE/g DW), tannin (62.55 mg GAE/g DW) and superior antioxidant performance in DPPH radical scavenging activity (80.2%) was recorded in the inflorescence of the *in vitro*-raised plant. Pearson correlation revealed a significant positive correlation between phenolic compounds and the DPPH assay, suggesting that enhanced antioxidant activity is directly attributed to the upregulation of phenolic compounds. The findings of this study suggest that controlled *in vitro* culture and PGR application significantly enhance bioactive compounds in *H. indicum*. Furthermore, the established regeneration protocol facilitates a sustainable alternative to wild harvesting, assuring an effective ex situ conservation strategy and securing a reliable supply for pharmacological application.

Keywords: *In vitro*, plant growth regulators, *H. indicum*, ex situ conservation

Changing patterns of LULC and its impact on carbon sequestration in the hilly region of Sylhet division from 1990 to 2024

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Abstract

Forests play a crucial role in reducing global warming and maintaining a sustainable environment. Forests are degraded at a geometric rate due to biotic and abiotic causes in the hilly regions of Bangladesh. Determining forest degradation is essential to increase the availability of forest products and to meet national demand. The findings of the present study indicated that, on average, water areas and vegetation areas decreased by 0.35% and 0.45% per year, respectively. Moreover, barren land areas, crop lands, and built-up areas increased by 0.18%, 0.33%, and 0.30% per year from 1990 to 2024. Overall, the findings indicated that the tourism industry increased more in Moulvibazar and Sylhet districts than in Habigonj and Sunamgonj districts. The findings revealed that the total carbon storage was 298.19×10^6 , 287.38×10^6 , 275.70×10^6 , and 266.08×10^6 Mg in 1990, 2000, 2010, and 2024, respectively. The total carbon storage declined by about 10.81×10^6 Mg from 1990 to 2000. Finally, the total amount of carbon decreased by 32.11×10^6 Mg from 1990 to 2024, and on average, carbon decreased by about 0.94×10^6 Mg per year in the whole research area. The findings indicated that carbon storage declined due to deforestation, which led to increased greenhouse gas emissions and loss of biodiversity. The findings can act as a useful indicator for understanding the impacts of forest cover changes on carbon storage in other parts of Bangladesh and contribute to mitigating global warming and developing adaptation strategies.

Keywords: Forest degradation, carbon storage, land use and land cover change (LULC), deforestation, global warming mitigation

Restoration in soil properties by the application of legume plants in flood damaged cropland in Koshi basin, Nepal

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Abstract

Flood-induced deposition and removal of fertile topsoil can cause profound and persistent degradation of soil quality in croplands. This study assessed the restoration in soil properties including soil organic carbon (SOC), total nitrogen (TN), and soil microbial biomass carbon (MB-C) using legume plants in flood-damaged cropland of the Koshi basin, eastern Nepal. In 2022, Six experimental sites were designed: Site 1 represented severely flood-damaged cropland with sandy soil, Sites 2–5 were rehabilitation sites planted with legume species: *Tephrosia candida*, *Gliricidia sepium*, *Flemingia macrophylla*, and *Pithecellobium dulce*, respectively, while Site 6 located nearby was flood-unaffected cultivated cropland used as control site for the comparison of recovery. After two years of plantation, soil samples were collected from 0–5, 5–10, and 10–15 cm depths and analyzed for soil properties. Restoration status was evaluated in terms of the present content of each variable relative to the agricultural control site. The results demonstrated the enduring impacts of flood-induced soil degradation resulted in substantial depletion of key soil fertility indicators after the flood event. Across the three soil depths, 0-5cm depth soil of damaged site retained only 3.8% of SOC, 5.3% of total N, and 10% of MB-C, indicating severe depletion (90-96%) of both soil organic matter and biological activity. Plantation of legume species substantially improved soil properties. *G. sepium* showed the greatest recovery, of SOC, TN, and MB-C reaching 14%, 11%, and 29%, respectively at 0-5 cm corresponding to

agricultural control site. Recovery of MB-C was faster than the recovery of SOC and TN. *T. candida* also showed substantial improvement, particularly in SOC and MB-C, whereas *F. macrophylla* exhibited comparatively lower recovery. The depth-wise pattern indicated greater retention of restored SOC, TN, and MB-C in the upper soil layer, with declining in lower depth. Nevertheless, a considerable proportion of the recovery was seen with each legume species. These findings demonstrate that leguminous species can initiate measurable recovery of carbon, nitrogen, and microbial functioning in severely flood-degraded cropland within a relatively short restoration period. However, the substantial remaining deficit indicates that soil restoration is a progressive process requiring longer-term vegetation establishment and continued management. Among the tested species, *G. sepium* showed the strongest potential for accelerating recovery of investigated soil properties.

Keywords: Flood-damaged cropland, koshi floodplain, legume-based restoration, microbial biomass carbon, soil organic carbon.

Effect of flood on the loss of soil organic matter in agro ecosystems of Koshi river basin, Nepal

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Abstract

Flood is one of the major physical agents of disturbances in Nepal. In the year 2008, it damaged the croplands in a large area (700 hectares) in Koshi basin, eastern Nepal. Koshi river, the largest river system in eastern Nepal is among the highest silt yielding river in the world which deposited huge amount of silt on the croplands, consequently the fertile croplands converted into degraded lands. Before the event of flood, the cultivated land was productive rice growing area. Effect of flood on the loss of soil organic matter (SOM) was studied in five different sites: (1) severely damaged site, (2) damaged site without cultivation, (3) damaged site: with green gram cultivation, (4) with wheat cultivation and (5) with maize cultivation. To compare the loss in SOM in different agroecosystems, an undisturbed cultivated land was selected and treated as a control site. Soil properties were estimated in different soil depths as 0-5cm, 5-10cm, and 10-15 cm. Soil texture, moisture, water holding capacity, pH, soil organic carbon, and total soil nitrogen were estimated by standard methods. At 0-5 cm depth in severely damaged site, there was a loss of SOM by 87.5 % in comparison to the control site which contained 4.0% of SOM. After cropping, SOM was recovered by 21.07%, 44.82% and 54.74% in maize, wheat, and green gram cultivation respectively in 0-5 cm depth. SOM concentration decreased depth-wise in each experimental site. After 18 years of recovery period, the recovery of SOM was higher (54.74%) in green gram cultivation due to leguminous crop and lower (18.96%) in damaged site without cultivation. Among the cereals cropping, wheat cultivation showed relatively faster recovery than maize cultivation in soil organic matter. It is concluded that cultivation practice improves the soil quality in comparison to uncultivated damaged site. However, the recovery process is slow because the agroecosystems were severely damaged by flood.

Keywords: Flood disturbance, recovery, severely damaged site, soil organic matter, undisturbed cropland

Enhancing soil health and carbon stocks in Tista char lands of Bangladesh through forest tree-based agroforestry

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Abstract

The riverine char lands of Bangladesh are characterized by fragile soils, frequent flooding, and high livelihood vulnerability. Therefore, this study evaluated the potential of forest tree-based agroforestry systems to stabilize soils, enhance carbon stocks, and improve soil health under climate induced vulnerable ecosystem. We compared agroforestry systems integrating three forest tree species, namely mahogany (*Swietenia macrophylla*), lombu (*Khaya sp.*), and gamari (*Gmelina arborea*) as upper layer crops intercropped with cauliflower (*Brassica oleracea* var. botrytis) and taro (*Colocasia esculenta*) as ground layer crops against sole tree stands and monoculture cropping. Our study conducted between 2018 and 2021 using a randomized complete block design (RCBD) with three replications in the Tista River Basin of Bangladesh. Results showed that agroforestry system enhanced tree growth and biomass production. Lombu-based agroforestry performed best with as the highest total biomass (9.01 kg tree⁻¹) and carbon sequestration rate of 9.77 t ha⁻¹. Carbon storage in lombu systems (2662.9 kg ha⁻¹) was significantly

greater than in gamari-based systems (455.23 kg ha⁻¹), highlighting species specific effects on agroforestry systems. Our study also found an increased pattern of soil organic carbon from 0.61% to 1.05% within three years along with notable increase in available phosphorus and potassium. The findings suggested that forest tree-based agroforestry is a climate-smart land-use strategy that enhances soil fertility, increases carbon storage, and supports sustainable agricultural productivity in climate-vulnerable char land ecosystems in Bangladesh.

Keywords: Agroforestry, char lands, carbon sequestration, soil health, soil organic matter

Evaluation of contact and fumigant toxicity and repellency of botanical extracts against the rice weevil, *Sitophilus oryzae* (L.), under laboratory conditions

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Abstract

Rice weevil, *Sitophilus oryzae* (L.), is an important stored-grain pest that causes damage to stored rice. The use of synthetic insecticides and fumigants can create environmental and health concerns. Therefore, this study was conducted to evaluate the insecticidal, fumigant, and repellent effects of four botanical oils, namely neem, eucalyptus, peppermint, and castor oils, against adult *S. oryzae* under laboratory conditions at different concentrations and exposure periods. Contact, fumigation, and repellency bioassays were used to evaluate the effects of the oils. Contact toxicity was evaluated at 0–320 ppm, while fumigation toxicity was assessed at 0–1600 ppm over 24, 48, and 72 h of exposure. Repellency was evaluated at 80 ppm after 1 h of exposure. All botanical oils exhibited concentration- and exposure-dependent insecticidal activity under contact application. Neem oil showed the greatest contact toxicity, producing $98.0 \pm 4.47\%$ mortality at 320 ppm after 72 h, with LC₅₀, LC₉₀, and LC₉₉ values of 7.12, 128.75, and 1363.65 ppm, respectively. Neem oil showed the highest repellency ($84.0 \pm 8.94\%$) at 80 ppm, followed by eucalyptus oil ($68.0 \pm 11.00\%$). For fumigant toxicity, eucalyptus oil demonstrated superior fumigant activity, causing complete mortality (100%) at 800, 1200, and 1600 ppm after 72 h. At 72 h, its LC₅₀, LC₉₀, and LC₉₉ values were 169.83, 354.69, and 646.55 ppm, respectively. Overall, neem oil was most effective as a contact toxicant and repellent, while eucalyptus oil showed the highest fumigant activity. These findings highlight the potential of botanical oils, particularly neem and eucalyptus, as promising alternatives for developing eco-friendly management strategies against *S. oryzae* in stored rice.

Keywords: Rice weevil, botanical extracts, contact and fumigant toxicity, repellency

Growth, yield, and economic performance of Napier grass under different agroforestry systems and nitrogen management in Bangladesh

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Abstract

Bangladesh faces severe fodder shortages due to land scarcity and climate variability, necessitating sustainable intensification through agroforestry. This study evaluated the growth, biomass yield, and economic returns of Napier grass (*Pennisetum purpureum*) under different agroforestry production systems; Mango + Napier (S₁), Litchi + Napier (S₂), Moringa + Napier (S₃), and Sole Napier (S₄) across four nitrogen levels (0, 50, 100, and 150 kg N ha⁻¹). The experiment followed a two-factor Randomized Complete Block Design in Agro-Ecological Zone 1 of Bangladesh. Results indicated that both nitrogen fertilization and production systems significantly influenced productivity. Results indicated that fresh biomass yield increased from 7.91 t ha⁻¹ at 0 kg N ha⁻¹ to 13.68 t ha⁻¹ at 150 kg N ha⁻¹. The Moringa–Napier system with 150 kg N ha⁻¹ achieved the highest biomass yield (15.40 t ha⁻¹), surpassing sole cropping at the same nitrogen rate (15.27 t ha⁻¹). Conversely, the Litchi–Napier system without nitrogen yielded the lowest results (6.46 t ha⁻¹) due to heavy shading. Economically, the Moringa–Napier system at 150 kg N ha⁻¹ proved most viable, yielding the highest net return (USD 1,746 ha⁻¹) and benefit–cost ratio (3.73). The study suggested that integrating Napier grass with *Moringa oleifera* under high nitrogen fertilization (150 kg N ha⁻¹) offers a superior, climate-resilient strategy for enhancing fodder supply and farm profitability in Bangladesh.

Keywords: Agroforestry, Napier grass, nitrogen fertilization, *Moringa oleifera*, biomass yield

Effects of soil amendments on root architecture of leafy vegetables and its relation to assimilate production

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Abstract

Poor root growth is a major limiting factor in acidic soil and may be the most crucial one affecting overall leafy vegetable production, the acclimation of which can reverse the scenario. An experiment was conducted to improve the acidic soil conditions of some selected plots in Sylhet with Biochar and a biochar-based product (ComBio), and improvement in soil pH and electrical conductivity (EC) was estimated after four winter seasons (from 2021 to 2024). The whole roots of the two leafy vegetables (e.g., spinach and red amaranth) grown in the plots were uprooted at the harvesting stage (35 days), washed, and scanned using a flatbed scanner at high resolution (1200 dpi). The background correction and image segmentation were done in Fiji (ImageJ) and Photoshop software and analysed using RhizoVision Explorer software. The dry biomass of the plant parts, viz. root, stem and leaves, was estimated by drying at 65°C. The data related to soil properties were compared by a pair-comparison test between initial and current years, while root attributes were subjected to one-way ANOVA analysis. The biomass-related attributes were subjected to Pearson's correlation with the root attributes. The results show that the plot applied with Biochar and ComBio four seasons ago significantly ($p \leq 0.05$) improved pH (5.35 to 5.79; and 5.28 to 5.54) and EC (27 to 277.6; and 27.2 to 188). Significant improvements in 18 root-related parameters were observed in red amaranth, whereas 10 attributes were significantly improved in spinach. Attributes like root depth (cm), number of root tips as well as root length (mm), surface area (mm²) and volume (mm³) of both total and fine roots (diameter ≤ 2 mm) significantly influenced the dry matter deposition in the plant parts. The root depth was found to be most influential in both crops in increasing shoot dry weight ($r = 0.99^*$ and 0.79^*). While root dry weight was mostly influenced by root depth ($r = 0.84^*$) in spinach, it was the number of root tips that was most influential for red amaranth ($r = 0.88^*$). The reclamation of the acidic soil with a biochar-based product can serve in the long term to support root architecture of the leafy vegetables and can influentially contribute to the dry mass deposition.

Keywords: Soil reclamation, phenotyping, below-ground growth, biomass

Performance of French bean genotypes under late sowing condition in Sylhet

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Abstract

The present investigation was carried out from November 2022 to March 2023 at the experimental field of the Department of Horticulture, Sylhet Agricultural University with a view to evaluating French bean genotypes for growth and pod yield under late sowing conditions in Sylhet. During the experimental period, four French bean genotypes viz., BARI jharsheem-1, BARI jharsheem-2, BARI jharsheem-3 and Local-1(SG) were sown on 25 November, while six genotypes viz. BARI jharsheem-1, BARI jharsheem-2, BARI jharsheem-3, Local-1(SG), Local-2(GG) and Local-3(GT) were sown on 25 December. These two experiments were laid out by Randomized Complete Block Design with three replications. In the first experiment, the maximum plant height was recorded from BARI jharsheem-3 (44.93 cm) after 45 days of sowing. BARI jharsheem-3 had the lowest days to first flower (34.66 days). The genotype BARI jharsheem-1 (198.43 g) produced the maximum pod yield per plant which resulted in higher per unit pod yield (97.01 kg/decimal) followed by BARI jharsheem-2 (67.64 kg/decimal). These two genotypes can be taken into consideration for sowing on November 25 in Sylhet based on performance to boost availability during February when its production gradually decreases in this area. In the second experiment, the maximum plant height (48.33 cm) at 45 days after sowing was recorded from BARI jharsheem-3. The highest number of leaves per plant (10.44) at 45 days after sowing was counted from BARI jharsheem-3. Early flowering was recorded from all the Local genotypes and BARI jharsheem-3. The genotype BARI jharsheem-1 produced the maximum number of pods per plant (34.87), yielded maximum pod yield per plant (215.09 g), which resulted in higher per unit pod yield (105.11 kg/decimal) followed by Local-3 (95.80 kg/decimal). However, the final harvest was completed on March 10th, suggesting that fresh pods might be marketed beginning in March or later, when production in this area started to progressively decline. So, these two genotypes can therefore be recommended for late sowing (25 December) to increase the availability of French bean in the Sylhet area during March or later. Among the genotypes, significant performance in terms of yield was observed by BARI jharsheem-1 equally during sowing in late November and late December.

Keywords: French bean, late sowing, pod yield, Sylhet region

Influence of vermicompost, biochar and poultry manure on BJRI tossa pat-8 (rabi-1) for fibre production

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Abstract

The present study aimed to determine the appropriate nutrient management option for BJRI Tossa pat 8 (Rabi-1) for its optimum growth and yield with proper management of soil. The result indicates that significant effect on yield and yield-contributing characters over the control with different levels of organic (N,P,K and S) with inorganic fertilizers (biochar, vermicompost & poultry manure). At Rangpur, Manikganj and Jashore station the highest fiber and stick yield was found in T₆ treatment at 3.25 t/ha & 6.23 t/ha, 3.37 t/ha & 6.67 t/ha, 3.23 t/ha & 6.39 t/ha, respectively. The plant height, base diameter, green weight with leaves, and green weight without leaves were also at their peak at the same treatment combination T₆ in these three research stations. Therefore, it may be concluded that this treatment combination seemed to be optimum for proper growth and potential yield of BJRI Tossa Pat 8 (Rabi-1) for fiber production in Bangladesh.

Keywords: BJRI tossa pat 8 (rabi-1), organic fertilizer, nutrient management, fiber yield, stick yield

Integrated liquid and solid organic manures with mineral fertilizer improve soil properties and potato productivity under intensive cultivation

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Abstract

The excessive application of chemical fertilizers leads to problems of low yield and poor quality of potatoes in char areas. Therefore, the present study aimed to improve potato productivity in a char land region by the partial substitution of organic manures for chemical fertilizers. During 2024-25 and 2025-26, a two-year study was conducted to determine changes in soil properties, potato yield response, and pest infestation to treatments with application of solid organic manure (LOM) at basal and split application of liquid organic manure (LOM) at 30 and 45 days after planting (DAP) with chemical fertilizers. The treatments consisted of different doses of manures and fertilizers (T₁: Control, T₂: 100% RDF, T₃: 85% RDF + 15% SOM, T₄: 70% RDF + 30% SOM, T₅: 85% RDF + 10% SOM + 5% LOF, T₆: 70% RDF + 15% SOM + 15% LOM). The yield (35.3 tha⁻¹) and yield-contributing characteristics of Potato were significantly higher in T₆ than in the others, which received 70% RDF with 15% LOM and 15% SOM. Most of soil chemical properties such as soil pH (5.67), soil organic carbon 0.89%, total N 0.11%, available K, Ca and Mg 0.32, 14.1 and 2.11 meq/100g, available P, S, B, Cu, Fe, Mn and Zn were 32.3, 40.5, 0.97, 1.6, 75, 33 and 2.2 ppm respectively, which were higher in the T₆ treatment than others. Regarding soil biological properties, total bacteria such as Rhizobia, phosphorus-solubilizing bacteria (PSB), Azotobacter, fungi, and Actinomycetes were higher in T₆ than in other treatments. Moreover, treatment T₆ was associated with lower disease incidence than others. Overall, these results suggested that the 70% RDF with 15% LOM and 15% SOM treatment could be used to sustain Potato productivity. The combined application of organic and inorganic nutrients accelerated mineralization processes, enhanced soil biochemical properties, nutrient availability, suppressed plant diseases, and improved overall potato performance in the Char land conditions of Jamalpur, Bangladesh.

Keywords: Charland soil, integrated nutrient management, liquid organic manure, solid organic manure, potato productivity.

Vermicast-mediated chicken eggshell utilization for evaluating soil reaction, phosphorus fertility and phosphorus nutrition of a vegetable crop in acid soil over time

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Abstract

Soil acidity and bio-wastes are regarded as problem across the globe. This study evaluated the effects of calcitic lime and eggshell (bio-waste) with or without vermicast on soil acidity, available soil P and P nutrition of stem amaranth. An outdoor pot experiment was conducted using acidic sandy clay loam in a CRD with six treatments and three

replications. The treatments were T₁: calcitic lime, T₂: calcitic lime + vermicast, T₃: boiled chicken eggshell powder + vermicast, T₄: Un-boiled chicken eggshell powder + vermicast, T₅: Boiled + un-boiled eggshell powder (1:1) + vermicast, T₆: Boiled + un-boiled eggshell powder (1:1). The treated pots were incubated for one month (upto 30 days after treatment, DAT) prior to sowing of seeds of the test crop stem amaranth. Soil pH and available P were monitored during both soil conditioning (phase I) and soil-crop interaction (phase II) phases while stem P concentration, Plant Growth Index (PGI) and stem biomass were recorded during Phase II. Necessary statistical analyses were performed by python. All pots sharply raised soil pH from 4.92 to near-neutral values (6.95-7.00) during phase I (0-30 DAT). During phase II (30-90 DAT), soil pH declined gradually to reach 6.60 and 6.49 in the pots (T₁ and T₆ treated) with no vermicast. But pots with vermicast (T₂, T₃, T₄, T₅) showed a pH stability during 30-45 DAT. Afterwards, at 45 DAT these treatments also started to decline in pH values continued to decline till 90 DAT to reach 6.93; 6.91; 6.89; 6.85 respectively. Available P increased from the initial value of 12.20 to 17.05 $\mu\text{g g}^{-1}$ during 30 DAT. Vermicast-containing treatments maintained higher available P (average 15.02 $\mu\text{g g}^{-1}$) in both phases. T₂ and T₅ treated pots recorded the highest P values figuring 16.15 and 15.90 $\mu\text{g g}^{-1}$ at 60 days after sowing DAS, respectively while T₆ recorded the lowest value (11.95 $\mu\text{g g}^{-1}$). At 60 DAS, T₂ recorded the highest stem P uptake (631.20 mg P pot⁻¹) followed by T₅ (593.00 mg P pot⁻¹) while T₁ and T₆ showed lowest values (446.00 and 433.13 mg P pot⁻¹, respectively). Eventually, similar results were obtained in case of PGI, and stem biomass. Vermicast with lime and eggshell particularly T₂ and T₅ resulted in improved soil pH, available P, and stem P uptake throughout the study. Overall, combined use of eggshell or calcitic lime with vermicast improved soil fertility and P nutrition under the pot experimental conditions.

Keywords: liming material, phosphorus uptake, crop growth, and biomass yield

Optimization of lentil seed germination through pre-sowing treatments and soil moisture management

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Abstract

Lentil (*Lens culinaris* M.) is a pulse that belongs to the Fabaceae family and predominantly grows in the Rabi season in Bangladesh due to its high protein content and nutritional value. Cultivation of the crop often suffers from low-yielding lines that show poor seed vigor and uneven germination under field conditions. The present study aims to investigate the effects of various seed priming treatments on the germination and early growth of lentil (*Lens culinaris* M.), focused to evaluate the enhancement in productivity under both laboratory and field conditions. The experiment was divided into two separate phases: Phase I (laboratory conditions) and Phase II (field conditions). Both optimal and suboptimal moisture conditions were used. There were eight priming treatments, including control (T₀), hydropriming (T₁), dry heat treatment (T₂), hydrogen peroxide (T₃), ascorbic acid (T₄), sodium chloride (T₅), eucalyptus leaf extract (T₆), and moringa leaf extract (T₇) in Phase I. In Phase II, four treatments (T₁, T₄, T₆, and T₇) and two moisture levels (optimal and suboptimal) were used. In the second phase, the four most promising treatments from Phase-I- T₁ (hydropriming), T₄ (ascorbic acid), T₆ (eucalyptus leaf extract), and T₇ (moringa leaf extract) were re-evaluated and relabeled for clarity as T₁, T₂, T₃, and T₄, respectively, under two different moisture conditions (M₁: 60-65% and low moisture (M₂: 30-35%). Hydropriming (T₁) significantly outperformed all other treatments, achieving the highest germination percentage (GP: 89%), germination speed index (GSI: 45.33), and seedling vigor (SVI: 1.987). Biopriming with Eucalyptus (T₆: GP 74.67%, GSI 40.26, SVI 1.69) and Moringa (T₇: GP 74.53%, GSI 36.33, SVI 1.69) extracts significantly improved all metrics, achieving comparable performance to the control. Ascorbic acid (T₄) provided a moderate benefit, whereas dry heat (T₂), H₂O₂ (T₃), and NaCl (T₅) provided limited improvement compared to the control. Hydropriming (T₁) consistently outperformed all other treatments in terms of germination percentage, germination speed index (GSI), seedling vigor index (SVI), and root and shoot elongation, particularly under optimal moisture (M₁). Eucalyptus (T₆) and Moringa (T₇) extracts also showed significant potential, enhancing seedling vigor and root growth. Moisture availability played a crucial role, and suboptimal moisture (M₂) reduced performance across all treatments. Overall, hydropriming (T₁) emerged as the most effective method for improving lentil germination and growth, while plant-based treatments provided promising, eco-friendly alternatives. These findings highlight the potential of seed priming strategies to improve lentil cultivation, particularly in resource-limited or drought-prone regions.

Keywords: seedling vigor, priming, hydropriming, germination percentage, pulse crop

Combined waterlogging and soil compaction stress in grass pea: Linking soil degradation, root function, crop growth and yield

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Abstract

Grass pea (*Lathyrus sativus* L.) is an important climate-resilient grain legume widely cultivated in rice-based cropping systems. It is often exposed to waterlogging and soil compaction stresses simultaneously. However, their combined effects on grass pea remain poorly understood. This study investigated how concurrent waterlogging and soil compaction influence soil physical conditions, root development, crop growth, physiological performance, and yield of grass pea genotypes. A greenhouse pot experiment was conducted at ILVO, Melle, Belgium, using a split-split-plot design with three replications. Treatments consisted of two water regimes (non-waterlogged and waterlogged), two soil compaction levels (1.4 and 1.6 g cm⁻³), and three grass pea genotypes (BK-2021, BARI Khesari-3, and BD-5635). Waterlogging was imposed for eight days during the vegetative stage. Measurements included soil bulk density, hydraulic conductivity and penetration resistance, root architectural and biomass traits, plant growth, photosynthetic characteristics, shoot biomass, yield, and yield components. Waterlogging and soil compaction modified the root-zone environment and adversely affected several aspects of plant performance. Increased soil compaction restricted root development, while waterlogging imposed additional limitations associated with reduced soil aeration. Under combined stress, reductions in root growth and physiological activity were accompanied by lower shoot growth, biomass accumulation, and yield-related traits. Genotypic variation was observed across several responses, indicating differences in grass pea genotypes' capacity to maintain root function and above-ground performance under adverse soil conditions. The study demonstrates that soil compaction should be considered not only as a physical soil constraint but also as a factor that may intensify plant stress when combined with waterlogging. Integrating soil physical condition → root response → physiological performance → crop growth → yield provides a useful framework for understanding grass pea adaptation to degraded and poorly drained soils. These findings can support the identification of stress-resilient genotypes for rice-based cropping systems.

Keywords: *Lathyrus sativus*, waterlogging, soil compaction, root architecture, physiological stress, yield

Dose- and species-dependent effects of polyethylene terephthalate, polyamide, and polypropylene microplastics on germination and early seedling growth of mustard (*Brassica juncea*) and marigold (*Tagetes erecta*)

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Abstract

Microplastic (MP) contamination poses a significant issue in agricultural environments, but its impact on early plant growth remains poorly understood. This research examined the phytotoxic effects of prevalent microplastics by an initial dose-response assessment succeeded by a comparative main experiment. In our initial experiment, we utilised five varying concentrations of polypropylene (PP) microplastics (MPs) at 0, 250, 500, 1000, and 2000 mg/L to assess their impact on mustard germination. Our observations indicated that 250 mg/L exerted no influence on mustard germination and initial growth, but 2000 mg/L had detrimental consequences. In light of these results, we chose two MP concentrations, 500 and 1000 mg/L, utilising three polymer types: polypropylene (PP), polyethylene terephthalate (PET), and polyamide (PA), to evaluate the germination and initial growth response of mustard (*Brassica juncea*) and marigold (*Tagetes erecta*). Findings showed that germination rate, vigour, and speed were largely unaffected by MP exposure in both species. Nonetheless, the vigour index, shoot length, root length, fresh weight, and moisture content declined at elevated concentrations, suggesting that seedling growth was more sensitive

to MP exposure. Elevated concentrations led to greater phytotoxicity and enlarged cell growth, while simultaneously reducing stress tolerance, suggesting a dose-dependent exacerbation of stress with increased MP exposure. The antioxidant response differed across treatments and plant species. In comparison, mustard showed greater sensitivity than marigold, especially at elevated concentrations of PA and PP. The findings suggest that MPs may not significantly affect germination, but they can hinder early growth depending on type, dose, and species. These findings may provide a theoretical foundation and empirical evidence for further research into the toxicological impact of MPs on mustard and marigold, while also improving understanding of the specificity of microplastics' harmful effects on other plant species.

Keywords: Microplastics, mustard, marigold, germination, seedling growth, phytotoxicity

Accelerated generation advancement in wheat through overlapping speed breeding and field cycles at BWMRI

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Abstract

Wheat breeding in Bangladesh is constrained by a single annual field season, which prolongs generation advancement and delays the development of improved varieties. A combined speed breeding and field scheme was implemented at BWMRI to accelerate advancement while retaining selection under the target environment. The approach integrated chamber-based F₁ and F₃ advancement with field-based F₂ selection and scheduled successive breeding cohorts through overlapping chamber and field cycles. Under a 22-hour photoperiod and approximately 24/18°C Day/night temperatures, 222 F₁ populations from the 2024–25 crossing cohort were grown in the chamber beginning in May 2025. Subsequently, 217 F₂ populations were evaluated in the field during the 2025–26 wheat season, where single-plant selection followed by visual grain selection identified 62 populations for F₃ chamber advancement in August 2026. Meanwhile, F₁ materials from the 2025–26 crossing cohort occupied an intervening chamber slot beginning in April 2026, enabling successive use of the facility across cohorts. This subsequent F₁ cohort reached heading and maturity in averages of 46.0 and 97.2 days, respectively, and produced 277.4 seeds per entry. Among 199 entries with seed-production records, 197 (99.0%) produced at least 50 seeds, sufficient to establish the subsequent F₂ field plot, and 194 (97.5%) produced at least 100 seeds. F₃ advancement used five plants per pot and four pots per entry to support seed production from individual plants. The earlier cohort progressed from F₁ sowing to F₃ establishment within approximately 15 months, bringing forward F₃ advancement by one field season compared with conventional annual cycling. Prolonged grain filling and density-related reductions in seed production per plant identified priorities for further optimization. Integrating overlapping chamber cycles with field selection provides a practical pathway to shorten wheat breeding cycles in Bangladesh while preserving opportunities to select for local adaptation.

Keywords: Speed breeding, wheat, generation advancement, plant density, field selection, Bangladesh

Effects of IBA and GA₃ seed priming on the germination performance of papaya (*Carica papaya* L.) cv. Nassik green

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Abstract

Uniform and rapid seed germination is essential for successful papaya seedling production, but papaya seeds often exhibit poor and irregular germination. This study evaluated the effects of seed priming with indole-3-butyric acid (IBA) and gibberellic acid (GA₃) on the germination performance of papaya (*Carica papaya* L.) cv. Nassik Green. Seeds were subjected to three treatments: IBA at 100 ppm, GA₃ at 200 ppm, and an untreated control, with three replications. Priming consisted of soaking seeds in growth regulator solutions for 12 hours followed by 36 hours of water soaking. Germination percentage, germination index (GI), and mean germination time (MGT) were recorded. The highest germination percentage was observed in IBA-treated seeds (89.33%), followed by GA₃ (74.67%) and the control (61.33%). GA₃ treatment resulted in the highest germination index (7.23) and the shortest mean germination time (7.31 days), whereas IBA yielded a GI of 7.10 and MGT of 7.80 days, compared to a GI of 5.20 and MGT of 7.52 days for the control. One-way analysis of variance (ANOVA) showed a significant effect of treatment on germination percentage ($F = 8.57$, $p = 0.000255$). Tukey's HSD test ($\alpha = 0.05$) revealed that IBA significantly enhanced germination relative to the control ($p = 0.0167$), while differences between IBA

and GA₃ and between GA₃ and the control were not statistically significant. Overall, seed priming with 100 ppm IBA showed strong potential for improving final germination percentage, whereas 200 ppm GA₃ resulted in a higher germination index and shorter mean germination time. These findings suggest that growth regulator-based seed priming may be useful for improving papaya seed germination.

Keywords: Papaya, seed priming, IBA, GA₃, germination percentage, germination index, mean germination time

Determination of seed quality of rice (*Oryza sativa*) used by farmers in Chapainawabganj district

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Abstract

This research work focused on various aspects related to determination of seed quality of rice used by farmers in Chapainawabganj district. The research work accomplished at the Agronomy Laboratory, Department of Agronomy, EXIM Bank Agricultural University Bangladesh. The study assessed the seed quality used by the farmers and the possible causes of seed quality deterioration. A total of 9 different varieties of 250 g seeds were collected randomly from 9 farmers in different regions of Chapainawabganj district. Under the seed quality treatment those are five parameters, such as test weight, purity analysis, germination test, moisture test and vigor test conducted with three to six replications. Descriptive statistics such as standard deviation, standard error, LSD and level of significance were used to describe the variables. This study expressed that, maximum test weight of the variety 34-40 g, statistically purity was good, maximum germination percentage was above 80%, moisture content 6-10%, normal seedling 63.5% were found. Most of the seed quality has deteriorated with time, which is generally associated with inappropriate storage conditions like temperature, storage, seed health, humidity & moisture. The humidity and storage temperature are the main reasons for seed deterioration in home or conventional methods. To ensure timely supply of adequate quantities of quality seeds to the farmers to enable them to minimize the lack of proper management to maintain seed quality and minimize the yield gaps.

Keywords: Seed quality, seed deterioration, organoleptic properties, test weight, purity, germination, moisture, vigor

Identifying toxic microplastic polymers through their effects on seed germination and early growth responses: A comparative study of mustard (*Brassica juncea* L.), maize (*Zea mays* L.), and carrot (*Daucus carota* L.)

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Abstract

Microplastic (MP) contamination has emerged as a potential environmental threat due to its potential effects on seed germination and early seedling growth. Our study examined the effects of eight microplastic types, namely polystyrene (PS), polyethylene (PE), polyethylene terephthalate (PET), polypropylene (PP), polyvinyl chloride (PVC), polylactic acid (PLA), polyethersulfone (PES), and polytetrafluoroethylene (PTFE), on seed germination and early seedling establishment of mustard, maize, and carrot to identify the most phytotoxic polymer for each species. Seeds were germinated in petri dishes and exposed to each MP polymer at 1,000 mg L⁻¹, alongside an untreated control. The dishes were incubated in a growth chamber at 25 ± 1 °C under a 12 h light/12 h dark photoperiod. We found that MP had significant negative effects on the vigour index, fresh and dry weight, moisture content, shoot and root length, phytotoxicity, stress tolerance, and germination index (GI) of mustard, maize, and carrot, compared with the control. However, significant negative effects on germination rate and germination speed were observed only in maize. Vigour index was reduced by 53.0% in mustard, 82.2% in maize and 54.3% in carrot compared with the control when exposed to PES, PVC and PE, respectively. The highest phytotoxicity was observed in mustard, maize, and carrot when exposed to PES, PVC, and PP, respectively, with phytotoxicity increasing by 51.5%, 74.6%, and 50.1% relative to the control. PES, PVC, and PP produced the lowest GI in mustard, maize, and carrot, respectively, reducing it by 44.5%, 12.9%, and 52.4% relative to the control. Based on the vigour index, we can conclude that PES was the most harmful polymer for mustard, PVC for maize and PE for carrot. Overall, MP toxicity varied across polymer types and crop species, with distinct differences in their effects on germination and early growth.

Keywords: Microplastic, germination, early growth, vigour index, mustard, maize, carrot

Interactive effects of polystyrene microplastic and salinity on seed germination and early seedling establishment of Okra (*Abelmoschus esculentus* L.)

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Abstract

Microplastic (MP) pollution and salinity stress often increasingly coexist in agricultural soils, yet their combined effects on early seedling establishment remain largely unexplored. Our study examined the individual and combined effects of polystyrene microplastic (PS) and NaCl-induced salinity on seed germination and early seedling growth of okra (*Abelmoschus esculentus* L.). Four PS concentrations (0, 250, 500, and 1000 mg L⁻¹) were combined with three NaCl concentrations (0, 50, and 100 mM), and seeds were exposed to the treatment in Petri dishes under controlled growth chamber. Compared with the control, all NaCl- and/or PS-containing treatments significantly reduced germination parameters, such as germination rate, germination speed, germination vigour, and vigour index, as well as early growth parameters, including root length, root–shoot ratio, fresh weight, dry weight, and dry matter content, and increased phytotoxicity. However, NaCl-induced salinity generally exerted stronger inhibitory effects than PS. The PS₅₀₀-NaCl₁₀₀ treatment showed the greatest overall inhibition, reducing germination rate (by 75.9%), germination speed (by 100%), shoot length (by 59.0%), root length (by 74.9%), vigour index (by 91.1%), stress tolerance (by 63.7%) relative to the control. Cell length and width also decreased in all treatments, with the highest reductions of 68.4% and 71.9%, respectively, was observed under PS₅₀₀-NaCl₁₀₀, compared to control. Overall, the combined PS and NaCl stress inhibited germination indices, early seedlings growth and stress tolerance and increased phytotoxicity in okra, highlighting the potential vulnerability of early plant growth and development to co-occurring microplastic contamination and salinity. Further pot and field studies deserve to evaluate these interactions under more realistic soil conditions.

Keywords: Polystyrene, salinity, okra, phytotoxicity, germination

Cis-regulatory variants in the *MdCKX6* promoter is associated with allele-specific expression and apple fruit size

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Abstract

Fruit size is an important agronomic trait in apples. Fruit size is predominantly influenced by cell expansion and is regulated by phytohormones such as cytokinin. Cytokinin oxidase/dehydrogenase (CKX) enzymes are key regulators of cell expansion that irreversibly degrade cytokinin (CKs). The contribution of natural variation in CKX genes to fruit size remains poorly understood. In this study, we elucidated *MdCKX6* as a candidate regulator of fruit growth in apple. Our study determined that the pronounced allelic-specific expression (ASE) of *MdCKX6* during the early stages of fruit development in the ‘Royal Gala’ (RG) cultivar. Sequence analysis identified a promoter SNP associated with differential promoter activity and allele-specific expression. Genotyping of diverse apple cultivars and wild *Malus* accessions revealed a significant association between *MdCKX6* promoter genotype and fruit size. The *MdCKX6* genotype was correlated with apple fruit size across diverse cultivars, demonstrating a consistent negative regulatory role, in which high-expression alleles led to smaller fruits and low-expression alleles to larger fruits. This negative regulatory role was further validated by overexpression in tomatoes, which resulted in a small fruit phenotype. Transcriptome analysis of transgenic fruits revealed widespread changes in genes associated with cell-cycle regulation, cell wall modification, hormone-related processes, and transcriptional regulation. Together, these results identify *MdCKX6* as a potential negative regulator of apple fruit growth and reveal an association between cis-regulatory variants, gene expression, and fruit size. These findings provide fundamental insights into hormone-related gene regulation during fruit development and highlight regulatory variation in *MdCKX6* as a potential target for trait-specific breeding of apples.

Keywords: Apple, ASE, Cis-regulatory element, *MdCKX6*, fruit size

Rapeseed-mustard breeding for two decades at Bangladesh Agricultural University

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Abstract

Bangladesh faces acute shortage in oilseed production and therefore rely heavily on import. Rapeseed and mustard are the indigenous oilseed crops in Bangladesh that covers around 70% of total oilseed growing areas. In Bangladesh, three oilseed species *Brassica campestris*, *B. napus* and *B. juncea* are cultivated. Total rapeseed-mustard production can only meet <20% of total domestic demand of edible oils. Our research for nearly two decade focused on higher yield, short duration, *Alternaria* blight resistance and salinity stress tolerance and fatty acid contents. Over 300 genotypes were screened at both laboratory and field conditions for five years to select for *Alternaria* blight resistant genotypes. At the field condition, *Alternaria* blight infection starts at the lower leaves of 45 days old plants. Five high-yielding, >90% blight resistant *B. juncea*, genotypes bearing monogenic NBS-LRR genes were selected. Embryo rescue followed by inter-specific hybridization targeting short duration was conducted. The cotyledonary stage of the developing embryos in half-MS media resulted in the highest regeneration percentage when developing embryos were isolated 15 days after crossing. A 5×5 diallel mating gave rise to two short duration genotypes of *B. napus* at the F₇ generation that matures at around 80 days of age but yields >20% compared to existing elite check varieties. A new rapeseed variety with short growth duration and comparatively higher oleic acid content and oil content has been released as BAU Sarisha-9. Screening parental, hybrid and segregating generations in the laboratory condition identified that length and density of root hairs were the key for increasing the estimated root surface area under the salinity stress. *B. napus* recorded 6% higher oleic acid than that in *B. juncea* but the contents of polyunsaturated fatty acids were higher in *B. juncea*. The research efforts for a decade helped developing six new rapeseed-mustard varieties those are increasingly being accepted by the mustard growers in the different regions of Bangladesh.

Keywords: Rapeseed, mustard, salinity stress, short duration, yield, fatty acids

Tissue culture-independent transformation of farmer-popular Bangladeshi tomato varieties with the helicase gene PDH45 for salinity tolerance

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Abstract

Tomato (*Solanum lycopersicum* L.) is among the most nutritionally and economically important vegetables in Bangladesh. However, this glycophytic plant's cultivation faces challenges due to soil salinity, which prevails in about 30% of Bangladesh's arable land. For improvement, conventional breeding offers limited scope, as tomato is strictly self-pollinating. Earlier work established transformation of the vacuolar Na⁺/H⁺ antiporter genes *AtNHX1* and *OsNHX1* into five Bangladeshi tomato varieties. The putative transformants remained green at 100 mM NaCl in leaf disc bioassay. Unfortunately, the seeds produced from these plants were infertile. To explore other genes' effects on enhancing salt tolerance in tomatoes, *PDH45*, a helicase gene from pea, was selected for transformation. This study establishes an *in planta* protocol for introducing *PDH45* into BARI Tomato-8, 11 and 21. Baseline salinity and antibiotic sensitivity were assessed, and pricked seeds were infected with *Agrobacterium tumefaciens* LBA4404 harboring pCambia1305.1-PDH45 across varying bacterial densities, infection durations and co-cultivation periods, with response assessed by germination efficiency and histochemical GUS assay under hygromycin selection. All three varieties showed high salt sensitivity, where germination fell to as low as 15% at 50 mM NaCl. Before performing transformation, antibiotic sensitivity was also assessed. Hygromycin at ≥10 mg/L suppressed healthy seedling establishment, indicating the preferred selection pressure for transformant selection. After transformation, transient GUS expression reached 20% in BARI Tomato-11 (OD₆₀₀ 0.4, 30 min, 48 h co-cultivation) and 26.67% in BARI Tomato-21 (OD₆₀₀ 0.6, 30 min, 72 h), with germination of 53.74-95.43% and 69.69-95.78%, respectively. No

GUS expression was detected in BARI Tomato-8 under any combination tested, confirming that the parameters are not compatible for all genotypes. Together with growth on selection medium and presence of the reporter gene, this evidences T-DNA delivery in BARI Tomato-11 and -21. PCR further confirmed the gene integration. In future, these plantlets will be transferred to soil and grown to observe their phenotype.

Keywords: Salinity tolerance, In planta transformation, PDH45, *Solanum lycopersicum*

Optimizing pH for ethanol production from sugarcane bagasse and rice husk by SSF process and its characterization

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Abstract

The global energy demand has increased with population growth, changes in life style and rapid industrial revolution. The effective and efficient utilization of agricultural residues for bioethanol can help to address the waste management, energy security, environment conservation and energy sustainability challenges. The aims of this work were to investigate the effect and systematic precise optimization of pH in order to achieve maximum bioethanol yield from lignocellulosic agricultural residues (sugarcane bagasse, rice husk and mixture of bagasse & rice husk) using commercial cellulase enzyme and fermenting yeast strain, *Saccharomyces cerevisiae* by simultaneous saccharification and fermentation (SSF) method in a laboratory. Although, the process efficiency is significantly limited by the divergent pH, the SSF method is the cost effective as well as efficient operational pathway for the high-yield bioethanol. Fermentation of the hydrolysate was performed using fermenting yeast *Saccharomyces cerevisiae* across controlled pH in between 3.0–5.5 (sugarcane bagasse, rice husk and their mixture of 1:1) under anaerobic conditions. The fermented broth was filtered using membrane filter and extracted bioethanol by distillation process. The FTIR test has confirmed the presence of bioethanol by (-C-H) stretching vibration, hydroxyl group (-OH) and blending methyl (CH₃-) protons, methylene (-CH₂-) protons in the obtained product. The GC-FID test revealed that under anaerobic condition at 37°C, the static control at optimum pH is 4.80, where successfully achieved a maximum bioethanol yield of 43.13 g/L within 72 hours, corresponding to a fermentation efficiency of 85.50% of the theoretical yield. This qualitative and quantitative test also revealed GCV (28.60 MJ/ Kg), pour point (below -114°C) and flash point (13.20°C) as the characterization of obtained bioethanol. These findings of the experiment successfully demonstrated that optimum pH determination is a viable mechanism and provides an efficient, scalable and eco-friendly framework for converting agricultural residues into high-yield bioethanol contributing in highly sustainable energy solution.

Keywords: Bioethanol, lignocellulosic biomass, SSF, GC-FID, FTIR.

Agrobacterium-mediated transformation of *Lathyrus sativus*

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Abstract

Grass pea (*Lathyrus sativus*), often referred to as the “poor man’s meat” in Bangladesh, is a vital source of affordable protein for millions of low-income households. It is uniquely adapted to drought-prone and marginal environments and is widely cultivated across Bangladesh. However, its potential remains constrained by low productivity and the presence of the neurotoxin β-ODAP, which can cause lathyrism in humans and animals. Though, grass pea is a climate-resilient legume with agronomic and nutritional importance, yet progress in genetic improvement has been hampered by the absence of reproducible transformation systems. A safe, nutritious, and high-yielding crop that can sustainably support vulnerable communities under a changing climate is needed. A major technical bottleneck in grass pea research has been its recalcitrance to genetic transformation. Here we report a robust

Agrobacterium-mediated half-seed transformation method coupled with RUBY-cassette-based visible selection and in vitro grafting to regenerate fertile T₀ plants. This protocol reliably yields PCR- and phenotype-confirmed transformants and provides a tractable platform for gene functional studies and genome engineering in grass pea. By enabling genome editing in grass pea, this research seeks to bridge cutting-edge plant biotechnology with real-world food security challenges faced by developing countries.

Keywords: Gene editing, plant transformation, *Lathyrus sativus*, climate smart agriculture

Optimization of hygromycin doses for *Corchorus capsularis* seedlings (CVL-1 and Komola genotype)

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Abstract

The success of Agrobacterium-mediated genetic transformation in deshi jute plants (*Corchorus capsularis* L.) depends on the selection of transformants. In the present research, the hygromycin sensitivity test was performed on wild-type seeds to obtain the most effective hygromycin concentration for selection of transgenic. Based on root growth, the most effective concentration of hygromycin was determined 25 mg/l. In this concentration of hygromycin, non-transgenic plants indicated no root elongation, as compared to transgenic plants. A clear decrease of root growth was optimized for the selection of transformants. Thus, for effective optimization and selection of transformants, we can make easy the laborious screening tasks in planta transformation for further verification through polymerase chain reaction (PCR).

Keywords: Hygromycin, selective marker, *Agrobacterium tumefaciens*, deshi jute

Molecular docking of resistance phytochemicals isolated from bio-stimulated chili genotypes against chili leaf curl virus

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Abstract

Chili (*Capsicum annum* L.) is an essential daily-used vegetable and condiment worldwide whose yield and quality are severely threatened by Chili Leaf Curl Virus (ChiLCV), a widespread begomovirus. To minimize this damage, the current study focused on the field evaluation of eco-friendly microbial biostimulants as chemical alternatives to enhance chili's innate defensive phytochemicals against ChiLCV, alongside identifying potential antiviral candidates through molecular docking analysis. Five varieties of chili were subjected to a field experiment with ten microbial treatments comprising single and combined applications of Arbuscular Mycorrhizal Fungi (AMF), *Trichoderma harzianum*, *Trichoderma viride*, and *Pseudomonas* spp., following a randomized complete block design (RCBD) with three replications. As per ANOVA, the combined microbial consortium of AMF + *T. harzianum* + *T. viride* + *Pseudomonas* spp. exhibited significantly the most consistent improvement in growth, disease suppression ($3.22 \pm SE$), yield, and biochemical traits, while *Pseudomonas* spp. showed strong genotype-specific effectiveness. By contrast, Binamorich-1 and BARI Morich-5 performed significantly better, while Local-Bona responded comparatively weakly under disease pressure. Combined microbial treatments increased the accumulation of defense-associated bioactive phytochemicals (BAPC) such as apigenin, capsanthin, myricetin, and beta-carotene, offering enhanced disease resistance potential in the studied chili varieties. Of the seven (7) identified BAPCs, capsanthin and myricetin were highlighted as potential candidates based on molecular docking analysis, owing to their stringent predicted interactions with begomovirus-related proteins. Overall, this study provides an integrated field-to-molecule framework linking microbial biostimulation, enhanced phytochemical defense, improved crop performance, and the identification of potential phytochemicals for sustainable chili production.

Keywords: Chili leaf curl virus, biostimulants, phytochemicals, molecular docking, viral protein

Disrupting host-seeking behavior in the Asian citrus psyllid (*Diaphorina citri*): an in silico molecular docking approach targeting odorant-binding Protein 1 with *Persicaria hydropiper* phytochemicals

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Abstract

The Asian citrus psyllid (ACP), *Diaphorina citri*, is the major vector of Huanglongbing (HLB) a devastating disease of citrus. Current control strategies depend on non-selective neurotoxic insecticides and this calls for the need to develop new environmentally friendly alternatives. Increasingly, use of DcitOBP1 as a target in the insect olfactory system is being developed into non-lethal behavior disrupting strategies which inhibit host-seeking and feeding that can consequently transmit HLB. This study described herein is the first investigation of nine phytochemicals from *Persicaria hydropiper* for their antagonistic effects on modeled DcitOBP1 and Chemosensory Protein 1 (DcitCSP1) using an in silico molecular docking and dynamics approach. SWISS-MODEL was used for homology modeling (template, 3NOG). XP Docking (Pyrx) - Binding affinities were robust. Drimenol, showed the greatest binding energy (-7.8 kcal/mol) to DcitOBP1 compared with known antifeedant polygodial (-6.9 kcal/mol) revealing that an aldehyde group is not arguably required to inhibit OBP1. Flavonoid persicarin exhibited the highest binding affinity (-8.6 kcal/mol) against DcitCSP1. Stability of such complexation was affirmed through molecular dynamics simulations for these top leads. Importantly, in silico ecotoxicological profiling identified persicarin as an exceptionally safe candidate with no registered bee, crustacean, or mammalian toxicity and readily biodegradable contrasting the moderate ecotoxicity of drimane counterparts. Finally, phytochemicals from *P. hydropiper*, especially drimenol and persicarin, are identified as potential environmentally friendly behavioral disruptors of ACP. Occlusion of DcitOBP1 and DcitCSP1, targeted by these compounds, provides a sustainable specific method to block the host-seeking behavior of the citrus greening vector and HLB-induced transmission and is worthy of further validation in vivo in the development of this chemophore as part of an integrated pest management program.

Keywords: Odorant-binding protein, molecular docking, huanglongbing, olfactory disruption, phytochemicals, molecular dynamics

Role of non-fused pyrimidine analogues as green and sustainable agrochemicals in modern agriculture through bioactivity and computational study

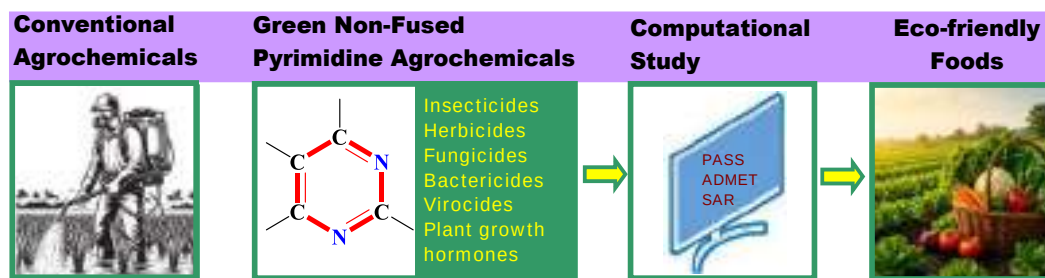
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Abstract

Non-fused pyrimidine derivatives have attracted much attention as possible green and sustainable alternatives to harmful agrochemicals used in conventional agriculture. In this study, several recently reported pyrimidine-based compounds with insecticidal, herbicidal, fungicidal, bactericidal, virucidal, and plant growth-regulating activities were selected for an in-silico computational study. Their possible biological activities, safety-related properties, and structure-activity relationships were evaluated using PASS prediction, ADMET profiling, and Structure-Activity Relationship (SAR) analysis. PASS prediction was used to assess possible biological activities, while ADMET profiling was used to examine absorption, distribution, metabolism, excretion, and toxicity-related properties. SAR analysis was performed to understand the relationship between molecular structure and biological activity. The results show that several of the studied compounds have promising biological activities and acceptable safety-related properties. These findings suggest that non-fused pyrimidine derivatives may have good potential as safer, eco-friendly, and sustainable agrochemicals for modern agriculture. Further laboratory and field studies are needed to confirm their biological effects and safety. In particular, these pyrimidine-based compounds may contribute to sustainable agricultural development and food security in agriculture-based countries such as Bangladesh.



Graphical Abstract

Keywords: Non-fused pyrimidines, green agrochemicals, sustainable agriculture, PASS prediction, ADMET profiling, computational study

Dynamics of the cytochrome B5 gene family in *Arabidopsis thaliana*: tissue specificity, phytohormonal responsiveness, and abiotic stress responses

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Abstract

Cytochrome b5 (CB5) proteins are heme-containing electron-transfer proteins involved in a range of oxidation–reduction reactions, including fatty acid desaturation, lipid metabolism, and cytochrome P450-dependent pathways. Their involvement in plant development and responses to environmental conditions has also been reported, but the expression behavior and regulatory characteristics of the CB5 family in *Arabidopsis thaliana* have not been examined together in detail. Here, we characterized the *AtCB5* family and investigated its expression patterns in different tissues and developmental stages, as well as its responses to phytohormones and abiotic stresses. Phylogenetic relationships, gene structures, conserved motifs, chromosomal positions, and physicochemical properties were analyzed to examine the structural and evolutionary features of the family. We identified the cis-acting elements associated with diverse environmental abiotic stresses. Protein interaction and functional enrichment analysis further suggested connections with metabolic and cellular processes related to activity. Expression analysis revealed distinct patterns among *AtCB5* genes across tissues and developmental stages suggesting that individual members may have specialized functions. Their transcription levels also changed in response to hormone treatments and different abiotic stress conditions, indicating that *AtCB5* genes may participate in hormone regulated and stress responsive process. Overall, the result Highlight the structural and expression diversity of the family and support its possible involvement in redox regulation, plant development, hormone signaling and environmental stress response the identified expression patterns and regulatory features provide useful basis for selecting candidate *AtCB5* genes for further functional characterization in *Arabidopsis*.

Keywords: Cytochrome b5, *Arabidopsis thaliana*, Gene family, Abiotic stress, Phytohormone response

Computational transcriptomic and comparative genomic analysis of the DEAD box RNA helicase gene AT2G45810 expressed in *Arabidopsis thaliana*

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Abstract

Arabidopsis thaliana has a short life cycle with a small genome, and the Brassicaceae family includes winter annual small flowering plants. It is frequently used as a model organism in genetics and plant biology research, providing insight into the molecular biology of various plant features, including light sensing and flower formation. It also plays a key role in the science of agronomy, plant transcriptomics, and genomics during the time of development of multicellular creatures, and transcriptional programs are crucial. *Arabidopsis* embryos possess a remarkable transcriptome compared to other plant tissues, comprising the circumstances that operate somatic embryo differentiation during plant embryogenesis. The study has shown the transcriptomic analysis of the genome DEAD-

box RNA helicase gene AT2G45810 of *Arabidopsis thaliana*, which revealed the specific gene expression and co-expression patterns of Arabidopsis tissue-specific information of developmental map, embryogenesis, homologs, phylogenetic, functional annotation, cellular interactions, pathway analysis, etc., by utilizing computational transcriptomics and comparative genomics approaches. In this study, we have employed several Arabidopsis plant comparative genomics dedicated portals, as well as significant statistical analysis, for the retrieval, identification, and validation of specific gene interest and its numerous expression patterns. These results indicate that the DEAD-box RNA helicase gene AT2G45810 makes a significant contribution to the developmental process and influences the physiological traits of *Arabidopsis thaliana*.

Keywords: Plant transcriptomics, comparative genomics, in silico analysis, developmental biology, plant genomics

Genome wide identification and characterization of the rad5/16 like group chromatin remodeling gene family in *Arabidopsis thaliana* with their developmental, hormonal, and stress-responsive expression

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Abstract

Chromatin remodeling proteins of the SNF2 superfamily play a fundamental role in regulating DNA accessibility for transcription, replication, and repair. Among these, the Rad5/16-like group is structurally diverse, combining a conserved SNF2 ATPase core with variable RING-finger, HIRAN, and PHD-type domains, yet a comprehensive genome-wide characterization of this group in *Arabidopsis thaliana* has been lacking. In this study, we identified 12 *AtCHR* genes belonging to the Rad5/16 like group- five Rad5/16, five Ris1 and two SHPRH members by integrated phylogenetic and domain analyses, which grouped the genes into three clades with matching their subfamily classification. The genes were unevenly distributed across the chromosome (1, 2, 3, and 5) with two segmental duplications found within the family and 38 syntenic gene pairs shared with four crop species, suggesting that some members are more evolutionary conserved than others. Promoter analysis identified 69 cis-acting elements linked to light, hormones, stress and growth responses, indicating to broad transcriptional control. Additionally, the protein interaction, homology-based protein models showed the highest confidence for *AtCHR37* and *AtCHR26*. These models were then used for molecular docking against ATP, AMP-PNP, ATPγS, ADP, GSH, GSSG, NAD⁺, and ABA, where *AtCHR30*, *AtCHR27*, *AtCHR28*, and *AtCHR37* formed the strongest predicted interactions. Gene Ontology and KEGG analysis linked the family mainly to DNA repair, chromatin organization, and ubiquitin-related regulation, while protein interaction analysis identified *AtCHR39* as a key network hub. Expression profiling across tissues, growth stages, seven hormones, and nine stress conditions revealed distinct, gene-specific patterns, with *AtCHR29*, *AtCHR41*, *AtCHR26*, and *AtCHR32* emerging as the most dynamic members. This study offers insights into the roles of Rad5/16 like group chromatin remodeling genes and their potential mechanisms in hormone-mediated responses, chromatin organization, stress adaptation, plant growth development and reproduction.

Keywords: *Arabidopsis thaliana*, chromatin remodeling, rad5/16-like group, expression pattern, stress response

High-throughput virtual screening and molecular dynamics-guided identification of potential virucidal compounds against papaya ringspot virus

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Abstract

The papaya ringspot virus (PRSV) causes significant agricultural losses in global papaya production, and no virucidal compounds are currently available for field management. Here, we tested for the possible identification of virucidal agents against two distinct functional proteins in PRSV; nuclear inclusion protein A protease domain (NIa-Pro) and

viral coat protein (CP) core. The targets were predicted to have high-confidence three-dimensional structures using ColabFold, and their major ligand-binding cavities characterized by SiteMap, which revealed the catalytic pocket of NIa-Pro (His45; Cys149) as the most important site and a highly druggable CP cavity. More than 99,000 ligand states based on a natural-product library derived from PubChem were generated in LigPrep followed by an integrated and high-throughput hierarchical computational workflow. This pipeline combined Glide high-throughput virtual screening (HTVS), RDKit-based cheminformatic prioritization, and standard-precision (SP) back-docking to target-selective binding fingerprints. The high-scoring compounds were optimized in the next step via Glide extra-precision (XP) docking, and additional in silico approaches: Molecular dynamics (MD) simulations, ADMET profiling data analysis, as well as toxicity assessments. The construction of multi-tiered screening provided a relatively prioritized 60 candidates from the initial library, and XP docking was responsible for creating 11 lead compounds markedly re-ranked compared to the original. P1L15 (XP DockingScore: -9.581 kcal/mol) and P1L24 were the top-ranking hits for the NIa-Pro target, binding stably with residues in the catalytic site pocket. The most preferred binding modes for P2L5 (XP DockingScore: -7.089 kcal/mol) and P2L8 were observed in the CP target. Further analysis of the interaction revealed that key hydrogen bonds and hydrophobic contacts remained intact. The stabilities of these top protein–ligand complexes were confirmed through MD simulations, in which essential contacts remain throughout the trajectories. Moreover, their developability was supported by drug-likeness and ADMET predictions, showing no major predictive toxicological or ecotoxicological liabilities. Together, the identified compounds, especially P1L15 and P2L5, are valid lead candidates for PRSV control. Such computationally generated scaffolds could serve as a basis for further drug optimization of PRSV and require validation via subsequent experimental in vitro testing to evaluate its antiviral effect.

Keywords: Structure-based screening, viral coat protein, natural products, antiviral lead discovery, plant virology

Establishment of an efficient callus induction and plant regeneration protocol for rata boro rice: A foundation for genome-based genetic improvement

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Abstract

Rata Boro is a traditional, photoperiod-insensitive, aromatic rice landrace valued for its distinctive grain aroma and relatively short growth duration. These characteristics make it well adapted to the flood-prone haor regions of Bangladesh, particularly in Sylhet, Sunamganj, Habiganj, Moulvibazar, Netrokona, and Kishoreganj. However, its tall plant stature, reaching approximately 150 cm, makes it prone to lodging and contributes to a relatively low grain yield of 2–3 t/ha. Reducing plant height through genome editing could therefore improve its agronomic performance while retaining its desirable local characteristics. An efficient in vitro culture and regeneration system is an essential first step toward this goal. This study aimed to establish an effective callus induction and plant regeneration protocol for Rata Boro as a basis for future genetic improvement. This research work was conducted at the Biotechnology Division of BIRRI following Complete randomized design with three replications. Dehusked mature seeds of Rata Boro were surface-sterilized, and 100 seeds were cultured for each treatment across four callus induction media: C1 (MS + 2 mg/L 2,4-D), C2 (MS + 2 mg/L 2,4-D + 0.5 mg/L kinetin), C3 (N6 + 2 mg/L 2,4-D), and C4 (N6 + 2 mg/L 2,4-D + 0.5 mg/L kinetin). Callus induction was evaluated based on the percentage of seeds producing callus and callus length. Fifty three-week-old calli were subsequently transferred to each of four MS-based regeneration media: R1 (MS+2 mg/L BAP + 1 mg/L kinetin + 1 mg/L NAA), R2 (4 mg/L BAP + 1.2 mg/L kinetin + 0.5 mg/L NAA), R3 (1 mg/L BAP + 1 mg/L kinetin + 1 mg/L NAA), and R4 (2 mg/L kinetin + 1 mg/L NAA + 300 mg/L casein hydrolysate). Cultures were maintained at $25 \pm 1^\circ\text{C}$; callus induction was performed in darkness, and regeneration was conducted under a 16 h light / 8 h dark photoperiod were also maintained at $25 \pm 1^\circ\text{C}$. Among the tested treatments, C1 produced the best callus induction response, with 16.77 % callus induction and a callus length of 0.233 mm. For plant regeneration, R2 performed best, producing 100% regeneration and an average of three green plants per callus. This may be the first report describing an effective callus induction and plant regeneration protocol for the local rice landrace Rata Boro. The established protocol provides a useful foundation for future genetic transformation and genome-editing studies aimed at reducing plant height while preserving the desirable characteristics of this locally adapted aromatic rice.

Keywords: Rata Boro, aromatic rice, callus induction, plant regeneration, genetic improvement

Integrated virtual screening and molecular dynamics simulations identify commercial fungicides as potential inhibitors against *Phytophthora infestans*

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Abstract

Late blight, caused by the oomycete *Phytophthora infestans*, is one of the most destructive diseases of potato, and the need for effective disease-management strategies has stimulated interest in identifying new molecular targets for fungicide repurposing. As a sterol-auxotrophic oomycete, *P. infestans* relies on host-derived sterols and employs diverse proteins and secreted effectors to facilitate host colonization and suppress plant defense responses. In this study, a structure-based computational approach was employed to investigate the potential interactions of 40 commercial fungicides with selected proteins and host-pathogen interaction structures associated with the infection biology of *P. infestans*. The selected structures represented functionally distinct components of pathogen virulence, including lytic polysaccharide monooxygenase (LPMO; 6Z5Y), associated with plant cell-wall degradation; the RxLR effector PexRD2 (3ZRG), involved in suppression of host immune signaling; the RxLR effector AVRvnt1 (7XP9), associated with manipulation of host defense responses; and the PexRD54-potato ATG8 complex (5L83), associated with pathogen-mediated manipulation of host autophagy. Molecular docking was performed to evaluate the predicted binding of the fungicides to these target structures using Schrödinger Glide standard precision docking. Among the screened compounds, Carbendazim demonstrated the most favorable predicted binding affinity toward LPMO (6Z5Y), with a docking score of -6.143 kcal/mol, while Bismethiazol, Cyproconazole, and Strobilurin showed the most favorable predicted affinities toward PexRD2 (3ZRG), the PexRD54-ATG8 complex (5L83), and AVRvnt1 (7XP9), with docking scores of -4.270, -5.797, and -4.921 kcal/mol, respectively. The ADMET assessment indicated the top compounds had acceptable pharmacokinetic properties, including no violation of Lipinski rules and favorable predicted bioavailability scores ranging from 0.55 to 0.85. Furthermore, Carbendazim-LPMO (6Z5Y) was selected for a 100-ns molecular dynamics simulation to investigate the stability and persistence of the predicted protein-ligand interactions. Overall, the integrated computational analysis provides a comparative framework for exploring the potential interactions of existing fungicides with diverse virulence-associated and host-pathogen interaction targets of *P. infestans*. The prioritized compounds may serve as candidates for further experimental validation and contribute to the exploration of alternative molecular strategies for late-blight management.

Keywords: *Phytophthora infestans*, fungicide repurposing, molecular docking, molecular dynamics simulation, virulence-associated proteins, ADMET profiling

Rice husk-derived silica nanoparticles: A sustainable approach for synthesis and application

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Abstract

More than 200 million tons of rice husk (RH), a silicon-rich (15-28% wt.) agricultural biowaste, are generated annually which are frequently discarded, landfilled, or burned, causing severe environmental pollution. Meanwhile, agricultural production is threatened with 51-82% crop losses by major abiotic conditions, while using excessive chemical fertilizer causing water scarcity, soil degradation and global food production needed to be increased by 70% by 2050. RH-derived silicon nanoparticles offer an eco-friendly alternative to chemical fertilizer, herbicides, pesticides thus stimulating plant growth, biomass accumulation due to their small size, large surface area and ease of cellular penetration. RH is often considered as a renewable source of biomass which is 20% of the total rice production. RH Ash market is projected to grow from USD 2.6 billion in 2023 to USD 3.2 billion by 2028 at a Compound Annual Growth Rate (CAGR) of 4.5% during the forecast period. This review is important because it bridges the gap between abundant rice husk, extreme climate conditions cause yield loss and fragmented single method evidence lacking production cost comparison and industrialization pathways. A comprehensive literature

review was carried out through relevant publications on rice husk derived silicon nanoparticles (RH-SiNP) synthesis routes, physico-chemical characteristics, potential applications, sustainability and research gaps were evaluated, retrieved and developed through an interdisciplinary approach. The Life Cycle Assessment (LCA) findings show that 1 kg of silica has a carbon footprint of 4.25 kg CO₂-equivalent. RH-SiNPs therefore represent a promising route to reduce environmental impact compared with conventional silica production method. Future work should focus on process optimization of chemical usage, reaction conditions and improving energy efficiency, integration of renewable energy sources (e.g., solar, biomass) for thermal and chemical processing.

Keywords: Rice husk, silica nanoparticles, sustainable agriculture, physicochemical properties, life cycle assessment

Functional characterization of sphinganine C4-hydroxylase MoSUR2 and its potential as a fungicide target in *Magnaporthe oryzae*

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Abstract

Magnaporthe oryzae causes rice blast disease and possesses significant threat to global rice production; yet sustainable molecular targets for its control remain limited. Sphingolipid metabolism is essential for fungal membrane organization, development and pathogenicity, but its potential as a target for rice blast control remains unexplored. We investigated a key sphinganine C4-hydroxylase in MoSur2 and evaluate it as a candidate antifungal target and to identify candidate inhibitors capable of suppressing rice blast disease. MoSur2 is localized in the endoplasmic reticulum and interacts with upstream proteins MoSpt2 and MoTsc10. Knockout of MoSur2 resulted has significant reduced plasma membrane tension and virulence on the host plant, also regulates cell wall intensity, osmotic stress pathway, and responses to the target of rapamycin complex 2 signaling. Lipidomics analysis of the deletion mutant further revealed significant alterations in membrane components. Building on this structural and functional characterization, we used predicted three-dimensional model of MoSur2 to perform structure-based screening virtual screening, molecular docking, and molecular dynamics simulation to identify candidate inhibitors. Our screening identified HY-101120 (CREBi) as a potential MoSur2 inhibitor that suppresses conidiation, germination, and appressorium formation, at 50-100 µM. Ultrastructural and microscopic fluorescence investigations revealed disrupted, impaired, and altered cellular structure, endoplasmic reticulum organization, and conidial integrity. Along with disruption of MoSur2-mediated membrane homeostasis, untargeted lipidomics showed extensive remodeling of sphingolipid and phospholipid metabolism, specifically accumulation of ceramide related components. Additionally, CREBi demonstrated antifungal efficacy against a variety of phytopathogenic fungi. Together, these results acknowledged MoSur2 as a susceptible target in pathogenicity and growth of *M. oryzae*. In addition to offering a basis for the development of lipid metabolism-targeted antifungal strategies developing against phytopathogenic fungi, our research identified CREBi as a promising lead compound for rice blast control.

Keywords: *Magnaporthe oryzae*, sphingolipid biosynthesis, lipid homeostasis, TORC2 regulation, pathogenicity, structure-based drug development, CREBi

Biochemical evaluations of Ethiopian sweet sorghum [*Sorghum bicolor* (L.) Moench] accessions for sugar production

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Abstract

Sweet sorghum [*Sorghum bicolor* (L.) Moench] is a promising sugar-producing crop characterized by high concentrations of soluble sugars in its stalks. This study evaluated Ethiopian sweet sorghum germplasm for its potential as an alternative feedstock for sugar and syrup production. Ninety-one sweet sorghum accessions were initially screened for total soluble sugar content, from which eight accessions with relatively high sugar levels were selected for further biochemical evaluation. Three high-quality sugarcane (*Saccharum officinarum*) genotypes

collected from the Kessem Sugar Industry were included as standard checks. The evaluated traits included total soluble solids ($^{\circ}$ Brix), polarization, sucrose content, juice purity, days to maturity, stem height, and stalk diameter. Significant differences were detected among the evaluated genotypes for polarization and juice purity ($p \leq 0.001$). Total soluble solids ranged from 16.88% in T-28 to 20.23% in T-11. Polarization values ranged from 41.57 in T-28 to 69.30 $^{\circ}$ Z in C-86/12, with the sugarcane checks generally exhibiting higher polarization than the sweet sorghum accessions. Among the sweet sorghum accessions, T-13 showed relatively high polarization. Sucrose content ranged from 11.98% in T-28 to 16.77% in the sugarcane genotype C-86/12, while juice purity ranged from 63.62% in T-11 to 90.77% in the sugarcane genotype SP-70. Correlation analysis revealed significant positive associations of $^{\circ}$ Brix with polarization ($r = 0.56$) and sucrose content ($r = 0.71$), while polarization was strongly and positively correlated with sucrose content ($r = 0.95$), juice purity ($r = 0.76$), and days to maturity ($r = 0.78$). In comparison with sugarcane, the evaluated sweet sorghum accessions generally exhibited lower polarization, sucrose content, and juice purity. Nevertheless, the study demonstrated considerable variation among Ethiopian sweet sorghum germplasm and identified promising accessions with potential for sugar and syrup production, supporting their further evaluation as climate-smart alternative sugar crops.

Keywords: Biochemical traits, soluble sugar, sweetener, sweet sorghum accessions

Improvement of growth, physio-biochemical properties and yield of beetroot using bio-stimulants

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Abstract

Beetroot is a nutritious root vegetable valued for its high antioxidant content, playing an important role in human health. Bio-stimulants, including amino acids and beneficial microbes, have been shown to enhance beetroot growth and yield by improving nutrient uptake and stress tolerance. The present study was conducted to observe the effect of foliar application of tryptophan, lysine, threonine and *Serratia* sp. HSTU-ABK35 on growth, yield and physio-biochemical properties of beetroot. The experiment was conducted at the research farm of Department of Crop Physiology and Ecology, Hajee Mohammad Danesh Science and Technology University in Dinajpur during the period from September 2024 to June 2025. This experiment was tested with eight sets of treatment; T_0 = Control, T_1 = Tryptophan + Lysine + Threonine (20g/l), T_2 = Tryptophan + Lysine + Threonine (30g/l), T_3 = Tryptophan + Lysine + Threonine (40 g/l), T_4 = T_1 + *Serratia* sp. HSTU-ABK35, T_5 = T_2 + *Serratia* sp. HSTU-ABK35, T_6 = T_3 + *Serratia* sp. HSTU-ABK35, T_7 = *Serratia* sp. HSTU-ABK35. Data were collected on Plant height, number of leaves, root diameter, fresh weight of leaves, dry weight of leaves, fresh weight of roots, dry weight of roots, leaf area, leaf thickness, total photosynthetic pigment at 30, 50 and 70 days after transplanting. Total phenolic content, total flavonoid content, total sugar content, vitamin C, betanin and anthocyanin were recorded at harvest. At 30 days after transplanting (DAT) most parameters showed little to no response to treatment, while the control (T_0) often performing comparatively better. At 50 days after transplanting (DAT), the results revealed a significant improvement with the treatments T_2 ; Tryptophan + Lysine +Threonine (30g/l), T_5 ; T_2 + *Serratia* sp. HSTU-ABK35 and occasionally T_7 ; *Serratia* sp. HSTU-ABK35. By 70 DAT and at harvest, however, T_5 ; T_2 +*Serratia* sp. HSTU-ABK35 emerged as the most effective treatment, consistently outperforming the others across key parameters. These findings suggest that the combined foliar application of amino acids (tryptophan, lysine, threonine-) at 30 g/L with *Serratia* sp. HSTU-ABK35 (T_5) significantly enhances the growth, yield, and physio-biochemical properties of beetroot. The improvement in antioxidant content, vitamin C, phenolic contents, flavonoid content, betanin, and anthocyanin, highlights the nutritional and functional value of beetroot. This integrated bio-stimulant approach offers a sustainable and effective strategy to boost the productivity and health-promoting qualities of this highly nutritious root crop.

Keywords: Beetroot, bio-stimulants, amino acids, *Serratia* sp., yield

Multimodal nuclear imaging of carbon and phosphorus transport in cucumber plants using ¹¹C and ³²P radiotracers

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Abstract

Understanding the dynamic transport and allocation of essential nutrients in plants is fundamental to elucidating source-sink relationships, photosynthetic carbon distribution, and nutrient utilization. Nuclear imaging provides a unique opportunity to visualize these physiological processes non-invasively and quantitatively in living plants. In this study, we propose a comparative multimodal imaging approach to investigate carbon and phosphorus transport in cucumber plants using carbon-11 (¹¹C) and phosphorus-32 (³²P) radiotracers. ¹¹C was administered as ¹¹CO₂ to investigate photosynthetic carbon fixation and subsequent translocation of ¹¹C-labelled photosynthates through source-sink pathways, while ³²P-labelled phosphate was used to investigate phosphorus uptake, vascular transport, redistribution, and accumulation in developing plant organs. Five complementary imaging modalities-PET-CT(Eminence), Dual-head Positron Emission Mammography (d-PEM), Positron-Emitting Tracer Imaging System (PETIS, Nikon Pink-5000), Typhoon FLA-9500 Phosphor Imaging (IP), and Gamma-camera Imaging (PICOLA)-were evaluated according to their spatial and temporal resolution, sensitivity, FOV and quantitative capability for different plant organs. Dynamic ¹¹C imaging was used to characterize tracer movement from source leaves toward stems, roots, flowers, and developing fruits, with time-activity curves and transport-kinetics used to quantify tracer distribution. ³²P imaging provided complementary information on phosphorus uptake and accumulation, particularly in roots, vascular tissues, leaves, and reproductive organs. The multimodal approach enables comparison between three-dimensional PET-based imaging, high-resolution dual-head detection, dynamic plant-specific PET imaging, and high-sensitivity phosphor imaging. This study demonstrated the potential of combining complementary nuclear imaging technologies to provide a more comprehensive understanding of carbon and phosphorus dynamics in living plants. The proposed framework may contribute to improved characterization of plant source-sink relationships, nutrient allocation, and physiological responses and may establish a basis for quantitative multimodal nuclear imaging in plant science.

Keywords: Plant physiology, ¹¹C and ³²P tracers, phosphorus uptake, multimodal molecular imaging

Optimization of selenium biofortification in oyster mushroom (*Pleurotus djamor*) using sodium selenate: effects on yield attributes, biological efficiency, and selenium enrichment

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Abstract

Oyster mushroom (*Pleurotus djamor*) is a commercially important edible fungus valued for its substantial nutritional benefits. It is high in protein, dietary fiber, vitamins, minerals, and bioactive compounds. Selenium is an essential trace mineral that mainly functions as a component of antioxidant enzymes (e.g., glutathione peroxidase), protecting cells from oxidative damage and supporting immunity and thyroid function. Selenium biofortification in oyster mushrooms is a novel strategy to improve their nutritional quality while ensuring satisfactory yield performance. The research aimed to enhance selenium percentage in oyster mushrooms through selenium fortification and assess its impact on growth, yield and yield attributes. The study used 500 g pack size substrate made of 50% sugarcane trash and 50% sawdust, employing three replications and six treatments with a completely randomized design (CRD): T₀ (control), T₁, T₂, T₃, T₄ and T₅ containing 0, 25, 50, 75, 100 and 500 ppm of sodium selenate, respectively. The findings indicated that the different concentrations of selenium markedly affected the colonization duration, primordial initiation, fruit body formation, morphological traits, biological yield and selenium accumulation efficiency. The T₀ treatment had the most superior yield performance, with an average fresh mushroom biomass of 257 g and a biological efficiency of 85%. The biomass and biological efficiency decreased with the increase of selenium concentration. Treatment T₁ yielded an average biomass of 133 g and a biological efficiency of 67%, followed by T₂, which produced 122 g biomass and 61% biological efficiency. Elevating selenium levels beyond 75 ppm adversely affected mushroom development and productivity, with 500 ppm sodium selenate yielding the least

biomass (32.33 g) and biological efficiency (17%). Selenium accumulation increased steadily with higher concentrations of sodium selenate. The selenium concentration rose from 0.12% in the T₁ treatments to 0.14%, 0.16%, 0.18%, 0.36%, and 0.29% in treatments T₁, T₂, T₃, T₄, and T₅, respectively. Nevertheless, increased selenium levels resulted in reduced cap diameter, stipe length, quantity of fruit bodies, and total productivity, suggesting potential selenium toxicity at higher concentrations. The research indicates that modest selenium supplementation, specifically 25-50 ppm sodium selenate, is appropriate for cultivating selenium-enriched oyster mushrooms with enhanced nutritional benefits while ensuring a satisfactory yield and could be an option for commercial biofortification.

Keywords: Selenium biofortification, *Pleurotus djamor*, sodium selenate, yield, biological efficiency, nutritional enhancement

Physiological and biochemical mechanisms of genotypic differences in cadmium tolerance in hulless barley

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Abstract

Cadmium (Cd) contamination in agricultural soils has become a growing global issue, reducing crop yields and posing serious risks to food safety. Tibetan hulless barley (*Hordeum vulgare* L. var. *nudum*) is a nutritionally and economically vital staple uniquely adapted to the harsh climatic conditions of the Qinghai–Tibet Plateau. Its extensive genetic diversity offers a valuable resource for identifying Cd-tolerant germplasm; however, efficient assessments of genotypic variation in Cd response remain limited. Understanding this variation is crucial for breeding resilient cultivars suitable for Cd-polluted environments, thereby safeguarding productivity and food quality in affected regions. Hydroponic experiments were conducted to evaluate 71 hulless barley genotypes for Cd tolerance. Barley seedlings were exposed to Cd stress, and multiple growth and physiological parameters were measured, including chlorophyll content (SPAD value), shoot height, root length, shoot and root fresh weight, and shoot and root dry weight. Principal component analysis (PCA) was employed to identify key traits contributing to Cd stress responses and to rank genotypes based on tolerance indices. Validation experiments were subsequently performed on the most tolerant (X178) and most sensitive (X38) genotypes under 20 µM Cd stress, with comprehensive assessments of photosynthetic performance, antioxidant enzyme activities (SOD, POD, CAT), Cd accumulation and translocation, and oxidative stress markers. Cd stress triggered significant reductions across all measured parameters: SPAD value (–11.74%), shoot height (–39.69%), root length (–48.09%), shoot fresh weight (–52.88%), root fresh weight (–58.39%), shoot dry weight (–40.59%), and root dry weight (–40.52%). PCA revealed that chlorophyll content, shoot and root length, and biomass traits were major contributors to stress responses, explaining 76.81% and 79.72% of the variance in preliminary and secondary selections. Based on integrated scores and PCA, genotypes X178, X192, X215, X140, and X162 exhibited high Cd tolerance, while X38 was the most sensitive. Validation confirmed X178 as the most tolerant, showing smaller growth reductions, higher chlorophyll content, enhanced net photosynthesis and PSII photochemical efficiency, and higher Cd translocation to shoots. Additionally, X178 showed noticeably elevated activities of SOD, POD, and CAT, coupled with reduced oxidative damage, indicating a strong antioxidant defense system. This study reveals significant genotypic variation in Cd tolerance among hulless barley, with X178 emerging as a promising tolerant genotype. These findings provide a physiological and biochemical basis for breeding Cd-resistant cultivars and highlight X178 as a promising candidate for sustainable cultivation in Cd-contaminated soils, contributing to food safety and agricultural resilience in vulnerable regions.

Keywords: Hulless barley, cadmium tolerance, integrated score, photosynthesis, oxidative stress, antioxidant enzyme

Application of *Spirulina platensis* extract and plant growth regulators to alleviate floral heterostyly and photoinhibition in brinjal (*Solanum melongena* L.)

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Abstract

Brinjal (*Solanum melongena* L.) productivity is constrained by floral heterostyly and field-induced photoinhibition, both of which adversely affect reproductive success and source–sink relationships. This study evaluated the

comparative efficacy of a microalgae biostimulant (*Spirulina platensis*) and synthetic plant growth regulators (gibberellic acid and Florigen) in alleviating these reproductive and physiological constraints. A field experiment was conducted using a randomized complete block design to evaluate two brinjal cultivars under ten foliar treatments: an untreated control, *Spirulina* extract (2-6%), gibberellic acid (50-150 ppm), and Florigen (50-150 ppm). The results showed that low-to-intermediate concentrations of *Spirulina* extract and gibberellic acid significantly increased fruit yield and fruit number by reducing the proportion of sterile short-styled flowers. In addition, *Spirulina* treatments enhanced photosynthetic capacity by maintaining higher maximum photochemical efficiency ($F_v/F_m = 0.82-0.83$) and Performance Index (PIabs) values compared with the untreated control, which exhibited severe photoinhibition ($F_v/F_m = 0.69$). Multivariate analysis revealed a strong negative correlation between the proportion of short-styled flowers and crop productivity, while also indicating that supra-optimal concentrations of growth regulators resulted in physiological tradeoffs that restricted overall yield. In conclusion, the findings demonstrate that foliar application of *Spirulina platensis* extract and selected plant growth regulators can effectively modify floral morphotype distribution and alleviate photoinhibition, thereby improving reproductive performance and yield in brinjal. These results highlight the potential of integrating microalgal biostimulants with plant growth regulators as a practical agronomic strategy for enhancing productivity in brinjal and other solanaceous crops.

Keywords: Brinjal, *Spirulina platensis*, floral heterostyly, plant growth regulators, photoinhibition, fruit yield

One carbon metabolism (OCM): the ‘administrative hub’ of life

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Abstract

One-carbon metabolism (OCM) is a tightly interconnected network of biochemical pathways that activates and transfers single-carbon units to support essential cellular processes, from nucleotide synthesis to epigenetic regulation and redox homeostasis. Because it integrates nutrient sensing with genome maintenance and antioxidant defense, OCM functions as a central metabolic hub governing growth, aging, and disease susceptibility across kingdoms. Functionally, OCM operates through three coordinated arms. First, an inventory arm captures single-carbon units from nutrients (serine, glycine, and folate-derived sources) onto the universal carrier tetrahydrofolate (THF); the resulting CH₂-THF pool then feeds purine and pyrimidine biosynthesis. Second, a regulatory arm supplies methyl groups for DNA and RNA methylation, controlling gene activation and silencing through epigenetic marks. Third, a defense arm redirects excess homocysteine into the transsulfuration pathway to produce glutathione, the cell's principal antioxidant, while OCM-linked NADPH regeneration recharges antioxidant systems that neutralize the reactive oxygen and nitrogen species (including peroxynitrite, ONOO⁻) generated during respiration and immune responses. Because these three arms are mechanistically interdependent, disruption of OCM has wide-ranging consequences: in animals, dysregulation is linked to cancer, cardiovascular disease, and diabetes, while in crop plants it compromises biotic and abiotic stress tolerance, immune signaling, and ultimately yield stability. This synthesis highlights OCM as a unifying framework connecting nutrient metabolism, genome regulation, and stress physiology, and underscores its potential as a target for improving both human health outcomes and crop stress resilience.

Keywords: One-carbon metabolism, tetrahydrofolate, epigenetic methylation, glutathione, oxidative stress, abiotic stress tolerance

Diverse transport properties and expression profiles of OsHKT1;1 variants in rice

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Abstract

OsHKT1;1, a member of the high-affinity K⁺ transporter (HKT) family, plays a key role in Na⁺ homeostasis and salinity tolerance in rice. In our previous study, multiple OsHKT1;1 splicing variants were identified, along with the full-length (FL) OsHKT1;1 transcript from salt-tolerant rice Pokkali. In this study, we analyzed the gene expression and ion transport properties of one such variant, OsHKT1;1-V2, in detail. The two-electrode voltage-clamp experiment using *Xenopus* oocytes strongly suggested that V2 mediates Cl⁻ transport, in contrast to the Na⁺ selectivity of FL. Oocytes expressing V2 accumulated significantly more Cl⁻ than those expressing FL. Subcellular localization analyses using oocytes and mesophyll cells from *Arabidopsis* indicated that both V2 and FL localize to

the plasma membrane. Functional assays using a yeast mutant further showed that V2 does not mediate Na⁺ uptake, unlike FL. V2 from a japonica rice cultivar, Nipponbare, exhibited Cl⁻ transport characteristics similar to those from Pokkali. However, the transcript levels of FL and V2, as well as their changes under salt stress, were significantly different between Pokkali and Nipponbare. This study offers new insight into HKT-mediated ion homeostasis in rice.

Keywords: HKT, heterologous expression systems, Na⁺ selectivity, Cl⁻ selectivity, rice

Morpho-physiological, biochemical and molecular responses and yield performance of rice plants under road dust stress

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Abstract

Road dust pollution is an emerging abiotic stressor that may adversely affect rice growth and productivity in roadside agricultural environments. However, the responses of rice plant growth to road dust stress remain poorly understood. This study evaluated the effects of road dust exposure on two Boro rice varieties, Binadhan-24 and BINA dhan25, under field conditions in Mymensingh, Bangladesh, during the 2025-2026 Boro season. The responses were assessed through morphological, physiological, biochemical, anatomical, elemental and molecular parameters. Road dust stress reduced chlorophyll content, photosynthetic rate and relative water content in both varieties, with reductions becoming more pronounced with increasing exposure duration. In contrast, stomatal conductance and transpiration increased under dust stress. Road dust exposure also markedly increased proline accumulation, H₂O₂ content, and ascorbate peroxidase (APX) activity, indicating enhanced oxidative stress and activation of antioxidant defense mechanisms. Anatomical observations revealed relatively minor changes in vascular tissues of Binadhan-24, whereas BINA dhan25 exhibited substantial reductions in xylem, phloem, and total vascular bundle areas under dust stress. Elemental analysis showed increased accumulation of potentially toxic elements, particularly As, Pb, Ni, and Cr, in leaves and dehusked grains, with generally greater accumulation in BINA dhan25. At the molecular level, *P5CS1* expression was induced by dust stress in both varieties, reaching maximum levels at 48 h, suggesting enhanced activation of proline biosynthesis. Therefore, the results demonstrate that road dust stress disrupts water status, photosynthetic function, redox homeostasis, vascular anatomy and elemental balance in rice. The comparatively stable physiological and anatomical characteristics of Binadhan-24 suggest greater adaptation to road dust exposure, while the observed responses identify potential physiological, biochemical, anatomical and molecular traits for further evaluation of dust-stress tolerance in rice.

Keywords: Road dust stress; rice; photosynthesis; relative water content; oxidative stress; proline; APX; vascular anatomy; heavy metal accumulation; *P5CS1* gene

Light use behavior of leafy winter vegetables grown under different light conditions

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Abstract

The cultivation of winter vegetables is usually light-limited, influencing the physiological processes leading to light adaptability, which might respond differently if provided with adequate light. An experiment was conducted to ascertain the light use behavior of winter vegetables (e.g., Spinach, Red Amaranth, and Radish) for quantum yield at different levels of photosynthetic photon flux density (PPFD), grown under natural and limited light conditions. The growing conditions and their effects on the plants were characterized by the incident light (PAR $\mu\text{mol m}^{-2}\text{s}^{-1}$) on the canopy, leaf angle, leaf thickness (mm), and Greenness (SPAD) of the leaves. A total of five plants from each growing condition (shade and ambient light) were subjected to investigation from 50 to 1800 $\mu\text{mol m}^{-2}\text{s}^{-1}$ PPFD using a handheld PAM fluorometer (MultispeQ V.2). The light intensity of the shaded plots was 83%, 71.8%, and 82.8% lower for the Spinach, Red amaranth, and radish, respectively, compared to ambient plots. The leaf angle of the red amaranth was about 40% lower in the shaded plants. Though SPAD did not reduce significantly, the leaf thickness

in the shaded plants reduced to about 70-78%. Under the low light conditions (50-200 PPFD), the PSII of the vegetable was efficient (Φ_2 about 0.58-0.65) with a F_v/F_m' of about 0.75-0.79, indicating that most of the light energy was used for photochemistry. However, under rising light, Φ_2 falls steadily, with a takeover by Φ_{NPQ} (regulated heat dissipation), increasing from 0.1-0.2 at low light to 0.46-0.66 at 1800 PPFD, with a decline to a fraction of the open PSII centers (q_L). The linear electron flow (LEF) rises with light intensity but then plateaus or declines based on the condition and crop. Though all three crops follow the same pattern of light utilization, the capacity of the crops at different intensities differs, and the difference was most prominent in the radish plant. While spinach from two growing conditions was largely insensitive to this, the shaded red amaranth was found to have weaker photoprotection. PSI might have been acceptor-side limited at high light, as PSII was found to be already throttled at high light by NPQ, with PSI electron carriers staying fairly reduced. Crops like red amaranth were affected mostly by limited light and might be less suitable to recover due to underdeveloped photosynthetic machinery.

Keywords: Quantum yield, photosynthesis, physiology, adaptation

Role of acid phosphatase in enhancing wheat tolerance to phosphorus deficiency in acidic soils of Bangladesh

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Abstract

The present research was conducted at the laboratory and research field of Crop Physiology and Ecology Department, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur during December 2025 to April 2026 to assess acid phosphatase activity and the ability of different wheat genotypes to tolerate phosphorus deficient acidic soil, focusing on their growth and yield traits. In the first experiment, ten wheat genotypes (BWMRI Gom 1, BWMRI Gom 2, BWMRI Gom 3, BWMRI Gom 4, BWMRI Gom 5, 23HTWYT 9, 23HTWYT 10, 23HTWYT 17, 23HTWYT 18, 23HTWYT 25) were examined at two phosphorus levels (without phosphorus and recommended phosphorus @ 2.72 g per 20 litre water) in hydroponic culture following two factor completely randomized design with three replications. It was observed that shoot length and shoot dry weight were decreased but root length, root dry weight and acid phosphatase activity were increased in wheat genotypes due to phosphorus deficiency at different degrees with some minor exceptions. The order of wheat genotypes based on percentage of increase in acid phosphatase activity under P free condition was 23HTWYT 17>23HTWYT 25>BWMRI Gom 5>23HTWYT 18>23HTWYT 9>BWMRI Gom 4>BWMRI Gom 1>BWMRI Gom 3>23HTWYT 10>BWMRI Gom 2. In second experiment, two wheat genotypes with high acid phosphatase activity (BWMRI Gom 5, 23HTWYT 17) and two wheat genotypes with low activity (BWMRI Gom 2, 23HTWYT 25) were tested in pots with three phosphorous levels- optimum P (40 kg ha⁻¹), moderately low P (20 kg ha⁻¹) and very low P (10 kg ha⁻¹) following two factors completely randomized design with four replications. The findings revealed significant decline in all measured growth, yield contributing and yield traits in phosphorus deficient acidic soil at different magnitude. Considering yield traits, BWMRI Gom 5 was recognized as the more tolerant genotype and BWMRI Gom 2 as the more sensitive one under phosphorus deficiency. The order of wheat genotypes based on reduction percentage in grain yield plant⁻¹ and above ground biological yield plant⁻¹ under acid soil was BWMRI Gom 5>23HTWYT 17>BWMRI Gom 2>23HTWYT 25 both under moderately low to very low P level.

Keywords: Wheat, acid phosphatase activity, phosphorous tolerance, acidic soils and yield

Morpho-physiological response of different crops grown under shade conditions

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Abstract

Light is an essential factor to drive photosynthesis and associated physiological processes of the plants. The experiment was conducted to ascertain the vegetative growth and physiological responses of six winter crops viz., Spinach, Red amaranth, Radish, French bean, Mustard and Pea grown under ambient field conditions and shaded conditions. The temperature, humidity, and light intensity (kLux) of the plots were measured at regular intervals through the growing period, and it was about, on average, 12.2%, 17.2%, and 69.6% lower in the shaded plots. The results show that the biomass of the leafy crops (fresh wt. g m⁻²) was significantly reduced in the shade. The plant morphological and physiological attributes like primary root length (cm), shoot length (cm), leaf number, root dry

weight (g plant⁻¹), root ash content (%), shoot fresh biomass (g plant⁻¹), shoot dry weight (g plant⁻¹), shoot ash content (%) were reduced in the shaded plants. However, attributes like root moisture content (%) and shoot moisture content (%) were higher in the shaded plants, might be associated with higher moisture content in growing conditions. The leaf area of these crops responded differently under shaded conditions. While the leaf area of crops like Red amaranth, Spinach and Pea did not vary, the leaf area of broad, leafy crops like French bean, Mustard and Radish was significantly reduced in the shaded condition. The leaf chlorophyll content (mg/g FW) also showed a differential response. Except for Red amaranth and Pea, the Chl-a, Chl-b, and total chlorophyll contents of the leaves were higher in the shaded plants, while French bean had higher Chl-b and total chlorophyll but a reduced Chl-a content. A lower chlorophyll content under sun might be associated with photochemistry, and higher in Red amaranth and Pea might be related to its photo demand. Shade conditions produce lower vegetative yield might be associated with lower supply of light rather than limitation in conversion by the internal machinery, as evident by better pigment contents of the plants.

Keywords: Photochemistry, biomass, vegetative, yield

Foliar zinc application: implications for biofortification of BRRI rice varieties

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Abstract

Zinc (Zn) deficiency is an important micronutrient deficiency associated with poor dietary quality and adverse effects on human health. Rice is the major staple food in Bangladesh; however, rice grains generally contain low levels of bioavailable Zn, making rice an important target crop for Zn biofortification. This study evaluated the effects of foliar Zn application on the growth, yield, and grain quality attributes of four BRRI rice varieties, viz. BRRI dhan67, BRRI dhan89, BRRI dhan92, and BRRI dhan102. The experiment followed a Randomized Complete Block Design (RCBD) with three replications. Four treatments were applied at panicle initiation and milk stages: control (T₀), 0.5% ZnSO₄·H₂O (T₁), 1.0% ZnSO₄·H₂O (T₂), and 1.5% ZnSO₄·H₂O (T₃). Growth and yield-related parameters, including plant height, effective tiller number, leaf greenness, panicle traits, filled grains, grain yield, and harvest index, were recorded. The results showed differential responses to Zn application among the tested varieties. BRRI dhan89 attained a plant height of 97.51 cm at 1.0% ZnSO₄·H₂O, compared with 92.55 cm in the control, and recorded 257.47 filled grains per panicle at 1.5% ZnSO₄·H₂O, compared with 219.67 in the control. BRRI dhan92 produced 247.33 filled grains per panicle at 0.5% ZnSO₄·H₂O, compared with 194.00 in the control, while BRRI dhan102 produced 17.40 effective tillers per hill at 1.5% ZnSO₄·H₂O compared with 13.13 in the control. The highest harvest index and grain yield were recorded in BRRI dhan92 at 1.0% ZnSO₄·H₂O, with 43.5% and 10.85 kg per 12 m², equivalent to 9.04 t ha⁻¹, respectively, compared with 38.4% and 9.80 kg per 12 m² (8.17 t ha⁻¹) in the control. The recorded yield was 10.7% higher than that of the control group. Overall, foliar Zn application produced variation in growth and yield characteristics among the tested BRRI rice varieties, depending on the variety and concentration used. Further, the quantitative analyses of Zn and Fe in rice grains will be conducted to evaluate the response of foliar Zn application to micronutrient biofortification.

Keywords: Zinc biofortification, BRRI rice varieties, grain yield, grain quality

Management of bipolaris leaf blight in wheat using silicon dioxide: disease dynamics, seed transmission, and economic optima

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Abstract

Bipolaris leaf blight (BLB), caused by *Bipolaris sorokiniana* (Sacc.) Shoemaker, remains a critical biotic constraint in wheat (*Triticum aestivum* L.) production across South Asian rice-wheat cropping systems, where seed-to-seed pathogen transmission perpetuates inoculum across seasons yet is rarely co-evaluated with foliar disease management. This factorial field study-conducted at the Bangladesh Wheat and Maize Research Institute (BWMRI) research field, Dinajpur, during the 2025–2026 growing season-is the first to integrate dose-response quantification of silicon dioxide (SiO₂), temporal disease dynamics Area Under the Disease Progress Curve (AUDPC), seed-borne pathogen burden, and grain quality in a single unified experiment using two contrasting Bangladeshi commercial varieties (BARI Gom-30 and BARI Gom-33). Six SiO₂ doses (0, 20, 40, 60, 80, and 100 kg ha⁻¹) were applied as

split soil amendments at four intervals (land preparation, 25, 50, and 75 DAS) in an RCBD with three replications (36 plots). Silicon at 80 kg ha⁻¹ was optimal: it reduced flag-leaf disease severity by 52–57% and flag-1-leaf severity by 22–25% relative to the untreated control, achieved the lowest seed-borne *B. sorokiniana* infection (7.41% in T5×BARI Gom-33), raised grain yield by 37% (3.85 vs. 2.68 t ha⁻¹), and increased thousand-grain weight by 18.5% (52.40 vs. 41.37 g). Critically, 100 kg ha⁻¹ (T6) did not outperform T5 for any disease or yield metric, confirming a definitive agronomic optimum with a benefit-cost ratio of 2.87:1. Regression analysis revealed that flag-1-leaf disease severity at 75–79 DAS was the strongest predictor of final grain yield ($R^2 = 0.52$), identifying a previously undescribed critical management window for this pathosystem.

Keywords: silicon dioxide, spot blotch, AUDPC, seed health, disease-yield regression

Morpho-physiological and molecular evaluation of Mungbean cultivars under moderate salinity stress

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Abstract

Mungbean (*Vigna radiata* L.) is an important pulse crop in Bangladesh and a valuable source of high-quality protein for human consumption. Salinity and water scarcity, particularly in coastal regions, pose major constraints to crop productivity. Owing to its short growth duration, biological nitrogen fixation capacity and potential contribution to soil fertility, Mungbean is considered a promising crop for cultivation in stress-prone environments. The present study was conducted at the BINA Sub-station Farm, Satkhira, during the Kharif-1 season of 2026 to identify promising Mungbean cultivars for cultivation and future breeding programs targeting saline-prone areas. Nineteen Mungbean cultivars were evaluated in a randomized complete block design (RCBD) with three replications, using a unit plot size of 2 m × 2 m. Morphological and physiological data were collected from five randomly selected plants per plot and analyzed using the statistical package R. Significant variation was observed among the cultivars for all evaluated morphological and physiological traits. At maturity, Local Binamoog-10 exhibited the earliest flowering, while Binamoog-10 produced the highest number of branches plant⁻¹. Local Harodda recorded the highest number of leaves plant⁻¹, whereas Binamoog-9 produced the longest pods. Local Tillmoog had the highest number of pods plant⁻¹, BARI Moog-3 recorded the highest number of seeds pod⁻¹ and Local Patuakhali produced the highest seed yield. At the vegetative stage, significant variation was also observed in all measured physiological traits. Local Patuakhali showed comparatively better performance for several physiological traits, including K⁺, NPQt, ΦPSII, ΦNO, ΦNPQ and relative water content (RWC). The highest Na⁺ concentration was observed in BU Moog-1. Principal component analysis (PCA) identified key agro-morphological traits contributing to cultivar variation, with the first two principal components explaining 43.7% of the total variation. Cluster analysis grouped the cultivars into four distinct clusters, with Cluster I containing the largest number of accessions (7). Molecular analyses are currently being conducted in the Crop Physiology Laboratory, BINA, Mymensingh. Integration of the molecular data with the morpho-physiological responses will facilitate the identification of promising Mungbean cultivars for saline-prone environments and provide useful materials for future breeding programs.

Keywords: Mungbean, salinity tolerance, morphological traits, physiological responses, molecular analysis, coastal areas

Screening aromatic medicinal for antioxidant potential: Implications for nutraceutical and therapeutic applications using *Camellia sinensis* as a benchmark

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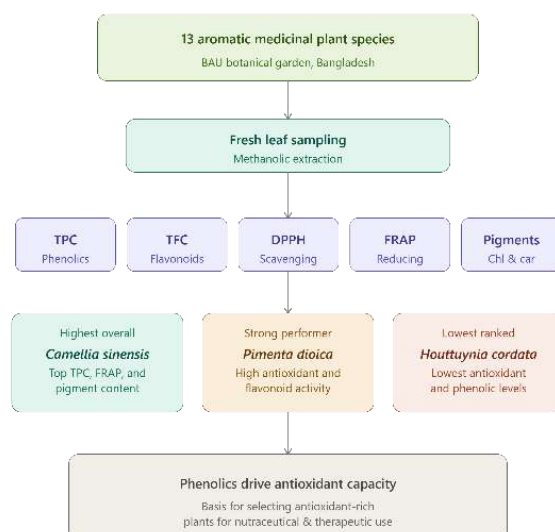
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Abstract

Medicinal plants, widely valued for their antioxidant potential, are largely attributed to their phenolic and flavonoid constituents. Plant-derived antioxidants protect against oxidative stress and disease. *Camellia sinensis* is widely used as an antioxidant benchmark due to its exceptionally high polyphenol content (20–30%). We profiled 13 volatile-rich aromatic medicinal plant species from the Bangladesh Agricultural University Botanical Garden. We use the fresh leaves as a sample, and methanolic extraction was performed to quantify morphological traits and total phenolics (TPC), flavonoids (TFC), free-radical scavenging assay (DPPH), ferric reducing antioxidant power (FRAP assay), and pigment content (chlorophylls and carotenoids). *C. sinensis* displayed the highest TPC, FRAP, and

pigment levels. In contrast, *Pimenta dioica* exhibited notably strong antioxidant and flavonoid activity, while *Houttuynia cordata* ranked lowest. Antioxidant capacity correlated closely with phenolic content, consistent with the fundamental role of phenolics in antioxidant defense. The results suggest that antioxidant efficiency is primarily driven by phenolic composition and redox-active metabolites. Variations among species may reflect differences in genetic background, metabolic specialization, and environmental adaptation. The findings align with published studies and provide a foundation for selecting antioxidant-rich medicinal plants for nutraceutical and therapeutic applications.



Keywords: Phytochemical analysis, phenolic, flavonoid, antioxidant activity, DPPH assay, FRAP assay

Effect of nitrogen fertilizer management on the growth and yield of modern fine boro rice under Hakaluki haor area in Sylhet

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Abstract

In the hoar wetland ecosystems of Bangladesh, low soil fertility and severe nitrogen (N) loss frequently limit crop productivity. This study evaluated the effects of optimized nitrogen fertilizer management on the growth and yield-contributing traits of Boro rice. The experiment was laid out in two factors Randomized Complete Block Design (RCBD), where factor A consist of BRRI dhan50 (V₁), BRRI dhan89 (V₁) and the factor B consist of four fertilizer doses involving F₁: Recommendation Fertilizer Dose (RFD): NPKSZn @138.2-22.4-63.5-13.5-1.3 kg ha⁻¹, F₂: RFD + 20 kg N, F₃: RFD - 20 kg N, F₄: Farmers' practice (FP: NPK @ 83-8.4-21 kg ha⁻¹). Each treatment was replicated three times. Data were collected on plant height, tillers number, effective tillers, grains panicle⁻¹, sterile spikelet's panicle⁻¹ (no.), panicle length (cm), 1000 grains weight (g), grain yield (t ha⁻¹), straw yield (t ha⁻¹). The results of the experiment showed that both rice variety and nitrogen fertilizer had a significant effect on plant height and tiller number, whereas BRRI dhan89 performed better than BRRI han50 and among the fertilizer doses, F₂ treatment contributed to achieve the highest growth. Grains number (124.3 panicle⁻¹), grain yield (5.64 t ha⁻¹), and straw yield (6.7 t ha⁻¹) were recorded as the highest at F₁ dose, where panicle length (23.5 cm), 1000 grains weight (20.5 g) were found the highest at F₂ treatment. Nutrients content of post-harvest soil varied with the application of N fertilizer compared to initial soil of the experimental field. The study revealed that selection of suitable rice variety and proper N fertilizer dose would significantly influence the growth and yield characteristics of Boro rice.

Keywords: BRRI dhan50, BRRI dhan89, recommendation fertilizer dose, haor

Performance of grafted and non-grafted sweet pepper (*Capsicum annuum* L.) Genotypes during summer season

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Abstract

Sweet pepper (*Capsicum annuum* L.) is a high-value vegetable crop whose production is constrained by various biotic and abiotic stresses, particularly during the summer season. Grafting technology offers a promising strategy for mitigating major production constraints, including bacterial wilt and heat stress, by combining desirable scion traits with stress-tolerant rootstock characteristics. Initially, wild brinjal, chili pepper, and Naga chili were evaluated as potential rootstocks for sweet pepper grafting. Based on grafting success and compatibility, Naga chili was selected as the most promising rootstock and was subsequently used in the present experiment. Therefore, this study evaluated six sweet pepper genotypes (V1–V6) under grafted (G) and non-grafted (NG) conditions in a two-factor RCBD with three replications at the Horticulture Research Field, Sylhet Agricultural University, from February to July 2025. The objectives were to evaluate the effects of grafting on the growth, yield, and biochemical responses of different capsicum genotypes. The tallest plants (97.67 cm) and highest branch number (8.33) were recorded in V5NG, while earliest flowering (20 days) occurred in V4G. Grafting markedly improved yield attributes, the highest fruit number (6.33), maximum individual fruit weight (147.61 g), and highest fruit weight per plant (722.35 g) were consistently observed in V5G. Pigment analysis showed maximum total chlorophyll (0.241 mg g⁻¹ FW) and carotenoids (0.0165 mg g⁻¹ FW) in V6G. The highest SPAD value was recorded in V6NG (62.67). The highest SOD (920.22 U g⁻¹ FW), POD (0.28 mM g⁻¹ FW), CAT were measured in V1G (0.69 mM g⁻¹ FW), while APX was maximum in V6G (26.71 mM g⁻¹ FW) and strong proline accumulation (29.47–32.37 µg g⁻¹ FW) was observed in V4G and V6G indicating superior ROS detoxification. Oxidative stress markers were lowest in grafted genotypes, with minimal H₂O₂ in V1G (2.45 µM g⁻¹ FW), lowest O₂⁻ in V3G (0.26 µM g⁻¹ FW), and least membrane damage (MDA) in V6G (19.82 nmol g⁻¹ FW). Among non-enzymatic antioxidants, DPPH was highest in V1G (63.53%), TFC in V6G (218.29 mg/100 g), while TPC peaked in V6G (99.87 mg/100 g). The findings suggested that the grafted genotypes V4, V5, and V6 exhibited superior overall performance, with enhanced growth, yield, and antioxidant defense capacity. These grafting combinations therefore showed strong potential for sustainable sweet pepper production under summer stress conditions.

Key words: Sweet pepper, Grafting, Summer season, biochemical response and yield

Profiling morpho-physiological characteristics, antioxidant capacity and nutritional traits of French bean varieties

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Abstract

French bean (*Phaseolus vulgaris* L.) is a globally vital legume valued for its high nutritional density and antioxidant potential, yet comprehensive varietal comparisons remain limited. This study evaluated three Bangladesh Agricultural Research Institute varieties - BARI Jharsheem-1, BARI Jharsheem-2, and BARI Jharsheem-3—under field conditions using a Randomized Complete Block Design (RCBD) with four replications to compare their morpho-physiological traits, nutritional composition, and antioxidant capacities. Significant varietal differences were observed across most parameters. BARI Jharsheem-3 demonstrated superior overall performance, exhibiting the highest plant height (55.48 cm), trifoliate leaf count (17.00 plant⁻¹), crude protein (15.57%), crude fat (2.75%), total ash (5.30%), total soluble sugars (106.40 mg g⁻¹), total phenolics (248.33 µg g⁻¹), anthocyanins (61.84 µg g⁻¹), and guaiacol peroxidase activity (0.1883 µmol min⁻¹ mg⁻¹ protein). Meanwhile, BARI Jharsheem-2 recorded the highest total flavonoids (78.39 µg g⁻¹) alongside peak catalase (17.53 µmol min⁻¹ mg⁻¹ protein) and ascorbate peroxidase (0.220 µmol min⁻¹ mg⁻¹ protein) activities. Both BARI Jharsheem-2 and BARI Jharsheem-3 showed strong DPPH radical scavenging activity (>94%), markedly outperforming BARI Jharsheem-1 (38.53%), which consistently exhibited lower nutritional and antioxidant performance. Overall, BARI Jharsheem-3 emerged as the most promising variety due to its balanced combination of robust morpho-physiological growth, high nutritional value, and strong antioxidant capacity, offering valuable potential for enhancing dietary nutrition and food security.

Keywords: French bean, BARI Jharsheem, antioxidant potential, nutritional quality

Effects of different soil amendments on the growth and yield of spring onion (*Allium fistulosum* L.) in acidic soil condition of Sylhet

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Abstract

The cultivation of spring onion (*Allium fistulosum* L.) is comparatively less popular in Bangladesh and its adaptability haven't been fully assessed all over the country. Thus, the present experiment was conducted to evaluate the effects of different soil amendments on the adaptive potential of spring onion under acidic soil condition of Sylhet. The experiment used four treatments, viz. T1 (Sawdust + Cowdung), T2 (Dolomite + Cowdung), T3 (Rice straw + Cowdung) and T4 (Control), each having four replications, following Randomized Complete Block Design. The findings revealed a significant effect of treatment on soil pH and organic carbon. At 120 DAT, T2 showed the highest rise in soil pH from 4.8 to 6.9 and organic carbon from 0.91% to 3.94%. Such improvement of growing media significantly impacted different growth and yield parameters. T2 had the maximum plant height (58.1 cm), number of leaves (16.5), pseudostem length (9.57 cm), diameter (9.13 mm), weight (5.8 g), and fresh yield (9.99 tha⁻¹) at 60 DAT. T4, however, had the lowest values: 41.8 cm, 6.25, 5.12 cm, 2.88 g, 5.19 mm, and 5.01 tha⁻¹. Every morphological parameter showed an increasing trend over time. Fresh yield was highest at 120 DAT (10.5 tha⁻¹) compared to 60 DAT (9.99 tha⁻¹) and 90 DAT (10 tha⁻¹). T1 and T3 had moderate growth and yield effects, generally statistically similar. T2 contributed to the highest Total Soluble Solid (8.68), Total Phenolic Content (3.98 µg GAE/mg DW), Total Flavonoid Content (3.57 µg GAE/mg DW), ascorbic acid (36.1 mg/100 g of FW), and sulphur content (0.558%) at 60 DAT, followed by T3, T1, and T4. The incorporation of organic and inorganic amendment in T2, significantly outperformed all other treatments. This research showed that combination of organic and chemical amendment like cowdung and dolomite, can improve growth and yield of spring onion in the acidic soil condition of Sylhet.

Keywords: Spring onion, soil amendments, acidic soil, soil pH, growth and yield, soil organic carbon

Effects of moringa leaf extract, indole-3-acetic acid and growing medium on growth and pigment content of red amaranth (*Amaranthus tricolor* L.) microgreens

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Abstract

Red amaranth (*Amaranthus tricolor* L.) microgreens are promising sources of photosynthetic and bioactive pigments. Moringa leaf extract (MLE) and indole-3-acetic acid (IAA) are widely proposed as low-cost biostimulants, yet their effects on microgreens, and how these effects depend on the growing medium, remain unclear. As microgreens are grown in simple, short-cycle systems, identifying which inputs actually matter is important for practical production. This study therefore evaluated the effects of 3% MLE and 25 µM IAA, applied alone and combined, on the growth and pigment content of red amaranth microgreens grown on coco peat and tissue paper (2 × 4 factorial, completely randomized design, three replicates). Shoot and root lengths were measured 9 days after sowing, and pigments were quantified spectrophotometrically from fresh shoots. MLE, IAA, and their combination had no significant effect on any measured variable in either medium (all $p > 0.4$), and no medium × treatment interaction was detected. In contrast, the growing medium had a marked effect. Coco peat produced longer shoots (5.97 vs 2.88 cm) and roots (4.03 vs 3.05 cm), whereas tissue paper gave higher concentrations of chlorophyll *b* (0.076 vs 0.048 mg g⁻¹) and higher betacyanin, betaxanthin, and total betalain indices, the last being 1.5-fold higher. Total chlorophyll and carotenoid-like pigments did not differ significantly between media. Overall, the growing medium influenced early growth and pigment concentration more strongly than MLE or IAA at the tested concentrations, indicating that substrate choice should take priority over these treatments. Dose–response studies with greater replication are needed to test whether they are effective under other application conditions.

Keywords: *Amaranthus tricolor*, microgreens, growing medium, moringa leaf extract, indole-3-acetic acid, betalains, chlorophyll

Multivariate assessment of oxidative stress and growth responses to combined salinity and waterlogging in wheat

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Abstract

The combined effect of salinity and waterlogging stress (NaCl + WL) poses major challenge to global food security. While plant responses to sole salinity (NaCl) and waterlogging (WL) stresses have been extensively studied, the combined impact of NaCl + WL stress in wheat (*Triticum aestivum* L.) remains underexplored. To address this gap, the current study explored the consequences of NaCl (200 mM), WL, and their dual stress on stress damage index, growth parameters, chlorophyll content, leaf greenness (SPAD value), lipid peroxidation (MDA), and hydrogen peroxide (H₂O₂) levels in five wheat genotypes (BWMRI Gom-2, BWMRI Gom-4, BARI Gom-25, BARI Gom-30, and BARI Gom-33). Treatments were applied at the three-leaf stage for four weeks, with non-saline, well-drained plants serving as control. Results showed that WL and combined NaCl + WL stresses were more detrimental than salinity alone. Combined stress markedly reduced plant height (10-29%), shoot (29-74%) and root biomass (91-96%), SPAD value (51-81%), total chlorophyll (67-90%) and carotenoid contents (59-79%), as well as relative water content (RWC, 16-41%) across all genotypes, while levels of MDA (18-202%), H₂O₂ (200-400%), and the stress damage index increased significantly. As shown in the PCA analysis, the combined NaCl + WL stress was located on the positive side of PC1 and was strongly associated with stress-related indicators, particularly H₂O₂, MDA, and SDI. Based on the hierarchical clustering, BWMRI Gom-4, BARI Gom-25 and BWMRI Gom-2 exhibited greater tolerance and showed lower stress indicators and maintained better growth and photosynthesis-related traits than other varieties under all stress conditions. The overall genotype performance ranked as BWMRI Gom-4 > BARI Gom-25 > BWMRI Gom-2 > BARI Gom-33 > BARI Gom-30. These findings underscore the importance of identifying and selecting stress-tolerant genotypes for combined NaCl + WL conditions.

Keywords: Combined stress, tolerance, wheat, salinity, waterlogging, stress

NAA and GA₃ regulated regrowth, biomass allocation and root anatomical plasticity in water spinach (*Ipomoea aquatica*)

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Abstract

Leafy vegetables are rapidly growing and commonly harvested several times, while yield performance may reduce with canopy recovery and regrowth after first cutting. However, this study evaluated the effects of exogenous application of plant growth regulators on growth, regrowth dynamics, biomass allocation, and root anatomical responses of water spinach (*Ipomoea aquatica*) under successive harvesting. An experiment was conducted at Habiganj Agricultural University from April to June 2025, using a randomized complete block design with three treatments (T₀: distilled water, T₁: (NAA) at 60 ppm, and T₂: gibberellic acid (GA₃) at 50 ppm, applied as foliar sprays from seven days after sowing at three-day intervals) and six replications. Plants were harvested at 5 cm above the soil surface, and leaf traits, growth, biomass accumulation, regrowth efficiency and root anatomy were assessed across initial, first regrowth and second regrowth harvests. NAA increased morphological traits, producing the highest plant height during initial growth, higher leaf number during regrowth and consistently greater leaf length, leaf width and leaf area index. GA₃ enhanced regrowth height, root biomass, root elongation, and total dry matter accumulation through successive harvests. The GA₃ also increased total dry matter by 58.1%, 36.2%, and 33.3% over the control at the initial, first regrowth, and second regrowth harvests, respectively. The root anatomical observations indicated treatment-specific plasticity, with NAA associated with enhanced phloem development and compact cortical structure, whereas GA₃ stimulated cortical aerenchyma formation and xylem expansion. Finally, NAA increased morphological parameters, while GA₃ increased root-supported biomass recovery in recurrently harvested water spinach. Therefore, exogenous application of plant growth regulators will improve leafy vegetables production in successive harvesting and sustainable crop production.

Keywords: Regrowth efficiency, anatomical plasticity, biomass allocation, gibberellic acid, naphthalene acetic acid, water spinach

Multivariate analysis-based selection of wheat varieties under individual and combined waterlogging and drought stress

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Abstract

With climate change, winter waterlogging for heavy rains and also summer drought for longer periods without precipitation will become more frequent. Although wheat responses to individual waterlogging (WL) and drought (D) stresses have been widely studied, responses to combined WL and D remain comparatively underexplored. Therefore, this study evaluated the responses of five wheat (*Triticum aestivum* L.) genotypes—BWMRI Gom1, BARI Gom25, BARI Gom30, BARI Gom32 and BARI Gom33 to control, WL, D and combined WL + D stresses in a pot experiment conducted during the Rabi season (December 2023–March 2024) at the net house of the Agronomy Field, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh. The experiment was laid out in a completely randomized design with three replications. Results revealed that WL, D and combined WL + D stress significantly influenced growth, root traits, water relation, photosynthetic pigments and oxidative stress indicators. Multivariate analyses revealed distinct physiological responses to the individual and combined stresses. Drought tolerance was primarily associated with the maintenance of biomass production, root growth; chlorophyll content and plant water status, whereas WL and combined WL + D were more strongly associated with oxidative stress and membrane injury, particularly increased MDA and H₂O₂. Membership-function analysis further demonstrated strong stress-specific differences among genotypes. BARI Gom32 showed the highest tolerance under D, whereas BARI Gom25 exhibited the highest tolerance under WL and combined WL + D. BARI Gom30 showed relatively greater tolerance to WL but lower tolerance under combined stress, while BARI Gom33 showed contrasting responses between D and WL. Overall, the results demonstrated that wheat tolerance to D, WL and their combination was stress-specific and could not be reliably predicted from responses to an individual stress. BARI Gom25, particularly for combined and WL stress, may therefore serve as a promising genetic resource for developing wheat cultivars adapted to variable water-stress environments.

Keywords: Combined stress, tolerance, wheat, drought, waterlogging, stress

Synergistic effects of vermicompost, biochar, and humic acid on growth, photosynthetic performance, physiology and yield of broccoli (*Brassica oleracea* var. *italica*)

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Abstract

Agroecology is a major concern for sustainable agriculture, while soil health is gradually declining due to intensive cultivation, excessive use of inorganic fertilizers, less or no use of organic fertilizers, climate change etc. Thus, the present study was conducted to investigate the sole and combined effects of inorganic and organic fertilizers on growth, physiology, and yield of broccoli at Sher-e-Bangla Agricultural University, Dhaka. Nine different compositions of soil organic amendments such as cowdung, vermicompost, biochar, and humic acid, along with inorganic fertilizers as treatments were used in this study. The treatments were T₁ = control (no organic amendment); T₂ = 1.0 kgm⁻² cowdung; T₃ = 1.0 kgm⁻² vermicompost; T₄ = 0.3 kgm⁻² biochar; and T₅ = 1.5 gm⁻² humic acid, T₆ = 1.0 kgm⁻² vermicompost + 0.3 kgm⁻² biochar; T₇ = 1.0 kgm⁻² vermicompost + 1.5 gm⁻² humic acid; T₈ = 0.3 kgm⁻² biochar + 1.5 gm⁻² humic acid; and T₉ = 1.0 kgm⁻² vermicompost + 0.3 kgm⁻² biochar + 1.5 gm⁻² humic acid. The treatments were applied using a randomized block design with three replications. The results showed significant variations on different parameters of growth, physiology and yield. The highest plant height (60 cm), stem diameter (34.69 mm) and leaf number (16.5 plant⁻¹) as growth characters were found in T₉ treatment followed T₇ and T₆ while minimum was in T₁ or only inorganic fertilizers. The maximum photosynthetic assimilation (A=24.47 μmol CO₂ m⁻² s⁻¹), stomatal conductance (g_s=489.67 mmol m⁻² s⁻¹), transpiration (E=8.13 mmol m⁻² s⁻¹) were found from T₉

treatment which were physiologically consistent with vapour pressure deficit (VPD=1.80 kPa), intercellular CO₂ concentration ($C_i=218.33 \mu\text{mol mol}^{-1}$). These leaf gas exchange parameters were also linked with other physiological data including chlorophyll content, water relation and mineral content of broccoli leaf. The highest curd yield (353.27 g plant⁻¹) and biological yield (1.43 kg plant⁻¹) were found from T₉ followed by T₇ and T₆ treatment while control treatment T₁ produced minimum yield (254.71 g plant⁻¹). Combined use of vermicompost, biochar and humic acid or vermicompost with either biochar or humic acid along with inorganic fertilizers significantly showed better performance on growth, physiology and yield of broccoli. Therefore, it can be concluded that combined application of vermicompost, biochar, and humic acid along with inorganic fertilizers could be a smart technique for the development of sustainable crop production.

Keywords: Vermicompost, biochar, humic acid, growth, photosynthesis, physiology, yield, broccoli

Induction of resin in *Aquilaria malaccensis* by inoculating native fungi associated with agarwood production

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Abstract

Agar (*Aquilaria malaccensis*) is a valuable non-timber forest product formed as a defense response to wounding and microbial infection. However, this study evaluated the resin- inducing potential of selective fungal isolates and investigated associated biochemical responses of *A. malaccensis*. For this study, healthy 10-year-old *A. malaccensis* trees were inoculated with selected native fungal isolates by drilling and injecting a fungal spore suspension. After 3 months, lesion development was assessed, and secondary metabolites such as hydrogen peroxide (H₂O₂), malondialdehyde (MDA), proline, peroxidase (POD), catalase (CAT), total phenolic content (TPC), and total flavonoid content (TFC) content were measured. The biochemical results showed that H₂O₂ levels increased by 14.72%, 6.83%, and 3.57% comparing with the non-inoculated control. MDA increased by 8.3%, 4.56% and 10.2%, respectively, indicating enhanced oxidative and membrane-lipid peroxidation responses. Proline content showed increases of 74.8%, 52.2%, and 49.5% in the three fungi. The synthetic TPC indicated increases of 73.6%, 44.6% and 81.4%, whereas TFC increased by 93.6%, 56.6% and 61.1% in different treatments. POD and CAT assays also demonstrated dependent variation in absorbance responses over the reaction period. Morphological observations showed discoloration and lesion development around inoculation sites. Overall, fungal inoculation was associated with changes in oxidative stress markers, antioxidant responses and secondary metabolite-associated parameters in *A. malaccensis*. Our findings suggested that native fungal inoculation can activate defense responses with agarwood formation and provide a basis for further investigation of biological agarwood induction techniques.

Keywords: Malondialdehyde, catalase, total flavonoid content, lipid peroxidation

Fruit growth and biochemical attributes of sweet pepper (*Capsicum annuum* L.) under aphid (*Myzus persicae*) infestation and its systemic suppression

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Abstract

Sweet pepper (*Capsicum annuum* L.) is an important vegetable crop whose growth, productivity, and biochemical status can be adversely affected by aphid infestation. The green peach aphid (*Myzus persicae*) causes feeding injury and may disturb physiological processes, biochemical constituents, and antioxidant defense mechanisms of plants. Therefore, the present study was undertaken to evaluate the physiological, biochemical, and antioxidant responses of sweet pepper under aphid infestation and to assess the effectiveness of imidacloprid in suppressing the stress-associated effects under these protected experimental growing conditions. A pot experiment with three treatments (control, aphid infested and aphid infested + imidacloprid) in a restricted growing condition (protected by insect net) two factors as 70 days after sowing (DAS) and 100 DAS was accomplished. Fruit growth features such as number of flowers, number of fruits, and weight of fruits were evaluated in this study. The biochemical parameters were chlorophyll, malondialdehyde (MDA), hydrogen peroxide (H₂O₂), vitamin C, titratable acidity (TA), reducing sugar (RS) and total sugar (TS). Antioxidant enzyme activities of ascorbate peroxidase (APX), peroxidase (POD) and catalase (CAT) were also determined using standard protocols. Data were analyzed using STAR version 2.0.1 through analysis of variance based on a completely randomized design, followed by Duncan's Multiple Range Test (DMRT). All the parameters were statistically significant ($P \leq 0.01$) except for H₂O₂ content and CAT activity which were also significant at $P \leq 0.05$. Due to aphid infestation, there were significant reduction in fruit number plant⁻¹, flower number

plant⁻¹, fruit weight plant⁻¹ (84.93 g), chlorophyll content (38.04 mg g⁻¹), vit-C content (128.64 mg/100 g), titratable acidity (0.0274%), reducing sugar content (3.12%), TS content (2.58%), which were further restored significantly by imidacloprid spraying. On the other hand, antioxidant enzyme such as CAT activity (0.202 mM/min/g), APX activity (2.25 mM/min/g) and POD activity (0.22 mM/min/g) and reactive oxidative species regulators such as MDA content (306.93 µmol/g) and H₂O₂ content (166.85 µmol/g) were increased significantly in aphid infestation since induction of successful biotic stress. As expected, imidacloprid applications reduced them significantly.

Keywords: Sweet pepper, *Myzus persicae*, imidacloprid, antioxidant enzymes, oxidative stress

Comparative analysis of nutrient composition and antioxidant activity in three dragon fruit cultivars

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Abstract

Dragon fruit has significant economic value in many countries due to has excellent nutritional content, health advantages, and adaptability to diverse climatic conditions. This study aimed to gather comprehensive nutritional data on three dragon fruit cultivars by analysing the levels of micronutrients, fibre, carbohydrates, antioxidants, vitamins, and minerals in their pulps. Uniform dragon fruit samples underwent thorough analysis for proximate composition, mineral content, pigments, antioxidants, and vitamin C. The proximate composition analysis revealed significant differences among the three dragon fruit cultivars. Among the proximate components, protein (0.40 ± 0.02 g/100 g), moisture ($91.33 \pm 0.88\%$), crude fibre (0.32 ± 0.07 g/100 g), and ash (1.27 ± 0.09 g/100 g) were more abundant in *Hylocereus costaricensis* than in *Hylocereus undatus* and *Hylocereus megalanthus*. On the other hand, *Hylocereus undatus* had higher carbohydrate (17.02 ± 0.63 g/100 g) and energy (69.74 ± 2.44 kcal/100 g) contents. In case of mineral nutrients, K (7.23 ± 0.35 mg/100 g), Ca (1.61 ± 0.13 mg/100 g), Fe (1.84 ± 0.05 mg/100 g), and Zn (0.37 ± 0.034 mg/100 g) are highly abundant in *H. costaricensis*. Additionally, *Hylocereus costaricensis* had the highest anthocyanin content (120.15 ± 3.29 mg/g FW) and total carotenoid content (72.51 ± 1.62 mg/g FW), along with the highest vitamin C content (8.92 ± 0.13 mg/g FW) and total soluble phenolic content (572.48 ± 20.77 mg/100 g). Its remarkable antioxidant activity was further highlighted by the lowest SC₅₀ value (13.50 ± 0.4 mg/mL) for its DPPH radical scavenging capacity. The total soluble sugar content was highest in *Hylocereus megalanthus* (8.72 ± 0.30 g/100 g FW). Hierarchical clustering analysis revealed distinct trait and genotype associations; among the studied cultivars, *Hylocereus costaricensis* demonstrated superior performance across multiple traits. Correlation analysis indicated significant positive correlations among several traits, while principal component analysis highlighted the contribution of each trait to overall variance, with PC1 explaining 73.95% of the total variance. This study highlights the nutritional variations among dragon fruit cultivars, with *Hylocereus costaricensis* showing superior performance, guiding dietary planning and functional food development.

Keywords: Antioxidant, dragon fruit, energy, minerals, Vitamin-C

Mepiquat chloride-mediated modulation of morpho-physiological traits and yield in cotton

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Abstract

Mepiquat chloride (MC) is widely used to control excessive vegetative growth and improve canopy architecture in cotton. However, its concentration-dependent effects on morpho-physiology and yield may vary. The study was undertaken to evaluate the response of cotton to different concentrations of MC and identify a suitable concentration for regulating plant growth while maintaining physiological performance and yield. A field experiment was carried out at Cotton Research, Training and Seed Multiplication Farm, Sadarpur, Dinajpur, Bangladesh during cotton growing season of 2025-2026. The experiment was laid out in a randomized complete block design and replicated

thrice. Eight treatments including a control and seven concentrations of MC (150, 180, 210, 240, 270, 300 and 330 ppm) were applied on CDB Tula M-1. Morphological, physiological and yield traits were observed to assess the concentration-dependent effects of MC on cotton. MC significantly influenced most of the studied traits. Plant height notably decreased with increasing MC concentration, from 157.80 cm in the control to 94.57 cm at 330 ppm. The leaf numbers, monopodial and sympodial branches, nodes plant⁻¹ and internodal distance also declined, resulting in a more compact canopy. In contrast, MC application improved selected physiological traits presenting the highest relative leaf water content (92.68%) at 210 ppm, and maximum SPAD value (50.73) at 300 ppm. Though, individual boll weight was not significantly affected but the control produced the highest number of bolls plant⁻¹ (25.91), closely followed by 270 ppm MC (25.87). Seed cotton yield was also maximum in the control (4.21 t ha⁻¹), whereas among the MC treatments, 270 ppm produced the highest yield (3.90 t ha⁻¹) and 330 ppm resulted in the lowest (3.68 t ha⁻¹). Mepiquat chloride effectively regulated vegetative growth and improved selected physiological traits of cotton. However, none of the tested concentrations increased seed cotton yield over the untreated control. Among the MC treatments, 270 ppm provided a comparatively balanced response in terms of vegetative growth, physiological performance and yield, indicating its potential for growth regulation under the conditions of the present study.

Keywords: Cotton, mepiquat chloride, growth regulation, physiology, seed cotton yield

Silicon and potassium mediated modulation of root physiological and biochemical responses in rice under Fe²⁺ toxicity

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Abstract

Ferrous iron (Fe²⁺) toxicity is a major nutrient disorder in rice (*Oryza sativa* L.), particularly in waterlogged soils, where excessive Fe accumulation disrupts root growth, membrane integrity, and cellular metabolism. Silicon (Si) and potassium (K) have been recognized for their roles in enhancing plant tolerance to various abiotic stresses; however, their combined effects on rice under Fe²⁺ toxicity remain insufficiently understood. Therefore, this study evaluated the individual and combined effects of Si and K on the physiological and biochemical responses of rice roots exposed to excess Fe²⁺. A factorial experiment was conducted using two Fe²⁺ concentrations (0 and 300 mg L⁻¹), two Si concentrations (0 and 56 mg L⁻¹), and two K concentrations (0 and 200 mg L⁻¹) in a completely randomized design. Excess Fe²⁺ markedly suppressed root growth and adversely affected membrane stability, protein accumulation, and antioxidant-related traits, while increasing lipid peroxidation and hydrogen peroxide accumulation. Supplementation with Si or K substantially alleviated these detrimental effects, with the combined application generally providing greater protection than either nutrient alone. Under Fe²⁺ stress, combined Si and K supplementation improved root length, volume, and dry matter while enhancing proline, phenolic compounds, and total antioxidant activity and reducing oxidative damage. The treatment also reduced root Fe accumulation while increasing Si and K concentrations. Silicon appeared to restrict Fe²⁺ uptake through enhanced Fe deposition in root vascular and epidermal tissues, whereas K primarily strengthened antioxidant defenses. Despite some antagonistic interaction between Si-induced root modification and K uptake, their combined application provided the greatest overall mitigation of Fe²⁺ toxicity. These findings highlight the potential of Si-K supplementation as a nutrient-management strategy for improving rice resilience in Fe²⁺-toxic environments.

Keywords: Iron toxicity, nutrient management, *Oryza sativa* L., potassium; silicon, stress alleviation

Effect of nanofertilizers and biofertilizers on photosynthetic performance, antioxidant metabolism and yield components of soybean (*Glycine max* L.)

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Abstract

Soybean is a vital global oilseed legume; however, sustainable yield optimization requires innovative nutrient management strategies that reduce synthetic input reliance. Although nanofertilizers and biofertilizers independently improve nutrient delivery and soil health, their combined effects on soybean physiology remain inadequately

explored. This study evaluated the performance of foliar nanofertilizer (nano urea at 3 mL L⁻¹ + nano DAP at 2 mL L⁻¹; T₁), *Rhizobium* biofertilizer (T₂), and their combined application (T₃) on photosynthetic efficiency and yield components of soybean relative to a Recommended Fertilizer Dose control (T₀) in a completely randomized design with three replications. PhotosynQ analysis revealed gross photosynthesis increased significantly from 85.3 $\mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$ in T₀ to 109.9 $\mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$ in T₂ ($p < 0.001$), while linear electron flow peaked at 128.7 $\mu\text{mol electron m}^{-2} \text{ s}^{-1}$ in T₃ vs. 100.3 $\mu\text{mol electron m}^{-2} \text{ s}^{-1}$ in T₀ ($p < 0.001$). Non-regulated energy dissipation (ΦNO) was significantly reduced in T₁ (0.251) and T₃ (0.259) vs. T₀ (0.290; $p = 0.002$), indicating optimized energy distribution supported by increased ΦII (0.476 in T₁ vs. 0.423 in T₀) and open PSI reaction centers (0.300 in T₁ vs. 0.188 in T₀; $p < 0.001$). Biochemical profiling showed T₁ and T₂ markedly increased total flavonoid content (TFC: 0.970 and 0.874 mg QE g⁻¹ FW vs. 0.475 in T₀) and total phenolic content (TPC: 1.35 and 1.32 mg GAE g⁻¹ FW vs. 1.06 in T₀) ($p < 0.001$), with highest DPPH scavenging in T₂ (0.481%). Combined treatment (T₃) exerted greatest oxidative stress mitigation, lowering H₂O₂ absorbance from 0.846 (T₀) to 0.499 ($p < 0.001$). Although morphological traits showed no significant differences ($p > 0.05$), T₂ and T₃ numerically increased leaf area (up to 1633.3 cm²) and pod number per plant (6.33 in T₃ vs. 3.67 in T₀). In conclusion, combined nano- and biofertilizer application (T₃) optimized photosynthetic electron transport and oxidative stress defense, while individual applications enhanced secondary metabolites, collectively improving physiological resilience despite no statistically significant yield gains under present conditions.

Keywords: BINA Soybean 7, nanofertilizers, biofertilizers, photosynthetic efficiency, antioxidant capacity

Application of sulphur fertilizer for increasing yield of quality seed of sesame

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Abstract

Sesame is a major oilseed crop with considerable potential for improving nutritional security and farm profitability; however, inadequate sulphur nutrition can limit its productivity and seed development. A field experiment was conducted at the Agronomy Field Laboratory, Department of Agronomy and Agricultural Extension, University of Rajshahi, Bangladesh, during March to July 2024 to assess the response of sesame varieties to different levels of sulphur fertilization and to identify an appropriate variety and sulphur fertilizer combination for maximizing seed yield of sesame. The experiment was conducted in a factorial Randomized Complete Block Design (RCBD) with three replications, comprising two locally cultivated sesame varieties, namely black coloured (V₁) and white coloured (V₂), and six sulphur levels: 0 (S₀), 30 (S₁), 35 (S₂), 40 (S₃), 45 (S₄), and 50 kg S ha⁻¹ (S₅). The results demonstrated a remarkable variation between sesame varieties and sulphur regimes for several growth and yield contributing characteristics of sesame. The white coloured variety showed superior performance, providing higher plant height (120.511cm), number of grains pod⁻¹ (54.555), plant population (47.888), 1000-grain weight (2.577t/ha) and grain yield (1.260t/ha) compared to black coloured variety. Sulphur fertilization substantially improved the yield performance of sesame compared with the unfertilized control treatment. With 40 kg S ha⁻¹ (S₃) produced the most positive response for grain yield (1.401t/ha) and the majority of the evaluated traits. The varietal response to sulphur further showed a significant advantage of the white-coloured variety under optimum sulphur nutrition. The highest grain yield (1.376t/ha) was obtained from the combination of the white-coloured variety (V₂) with 40 kg S ha⁻¹ sulphur (S₃), indicating an advantageous interaction between genotype and sulphur availability. Overall, the findings from the research suggest that integrated selection of a responsive sesame variety together with an appropriate sulphur fertilizer application rate can positively increase the seed productivity of sesame. Under the agro-ecological conditions of Rajshahi, Bangladesh, the white-coloured variety with 40 kg S ha⁻¹ combination (V₂S₃) appears to be a promising production strategy for improving seed yield of sesame and resource-use efficiency.

Keywords: Sesame, sulphur nutrition, varietal response, seed yield, resource use efficiency

In silico dual-target screening of phytochemicals from ethnomedicinal plants against epidermal growth factor receptor and KRAS G12C

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Abstract

Cancer remains one of the leading causes of mortality worldwide, driving an urgent need for novel, selective, and less toxic therapeutic agents. Ethnomedicinal plants offer a chemically diverse source of small molecules for early-stage anticancer discovery. Dual-targeting strategies aimed at key oncogenic drivers, such as Epidermal Growth Factor Receptor (EGFR) and KRAS G12C, represent a promising approach to overcome therapeutic resistance in kinase- and GTPase-dependent cancers. This study aimed to computationally screen 134 phytochemical compounds derived from 53 ethnomedicinal plants against cancer-associated proteins represented by PDB structures 1M17 (EGFR) and 6OIM (KRAS G12C). Molecular docking was performed using AutoDock Vina for 134 phytochemical ligands against both 1M17 and 6OIM structures. Drug-likeness was evaluated using Lipinski's Rule of Five, with an initial size-based filter applied for molecular weight (≤ 500 g/mol). Compounds exhibiting a binding affinity of ≤ -8.0 kcal/mol against both targets were classified as potential dual-target lead candidates. The absorption, distribution, metabolism, and excretion (ADME) properties of these phytochemicals were predicted using SwissADME, while their toxicity profiles were evaluated using ProTox 3.0. Docking against 1M17 yielded binding energies ranging from -3.8 to -10.2 kcal/mol (mean: -7.78 kcal/mol), while 6OIM scores ranged from -3.9 to -9.4 kcal/mol (mean: -7.49 kcal/mol). Thirty-eight compounds met the predefined docking-score threshold of ≤ -8.0 kcal/mol against both targets. Among the compounds identified, cucurbitacins from *Bacopa monnieri* showed predicted binding affinities of -9.7 and -9.4 kcal/mol against EGFR and KRAS G12C, respectively, while cardenolide from *Calotropis gigantea* showed scores of -10.2 and -8.6 kcal/mol. Other notable compounds included ginkgetin from *Ginkgo biloba* (-9.6/-8.9 kcal/mol), orientin from *Ocimum sanctum* (-9.9/-8.5 kcal/mol), quercetin from *Cuscuta reflexa* (-8.9/-9.1 kcal/mol), luteolin from *Hygrophila auriculata* (-8.8/-9.3 kcal/mol), and myricetin from *Cuscuta reflexa* (-8.8/-9.2 kcal/mol). Flavonoids, particularly quercetin, luteolin, myricetin, and kaempferol, were frequently represented among compounds showing favorable docking scores against both targets. Of the 134 compounds, 91.0% had a molecular weight ≤ 500 g/mol, indicating that most compounds satisfied this molecular-weight criterion for drug-likeness assessment. The computational screening identified 38 phytochemicals with favorable predicted binding to both EGFR and KRAS G12C, with cucurbitacins, cardenolides, ginkgetin, and orientin emerging as notable candidates for further investigation. These findings provide a computational basis for subsequent validation through comprehensive drug-likeness and ADMET profiling, molecular dynamics simulations, and in vitro experiments. Further experimental studies are required to determine whether the predicted interactions translate into biologically relevant anticancer activity.

Keywords: Phytochemicals, Molecular docking, EGFR, KRAS G12C, AutoDock Vina, Anticancer drug discovery

Physiological responses of Debdaru (*Polyalthia longifolia*) and Nagweshwar Chapa (*Mesua ferrea*) leaves to dust deposition at BAU campus

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Abstract

Dust is a major contributor to air pollution and can adversely affect vegetation when its concentration in the ambient atmosphere exceeds the tolerance limit of plants. The present study evaluated the effects of dust stress on gas-exchange and related physiological parameters in young and mature leaves of *Polyalthia longifolia* and *Mesua ferrea* at BAU campus. The study aimed to identify the physiological parameters most sensitive to dust stress and to compare the responses of different leaf-age classes to determine their relative tolerance. The physiological parameters assessed included photosynthetic rate (A), stomatal conductance (gsw), transpiration rate (E), intercellular CO₂ concentration (Ci), SPAD chlorophyll index, PSII quantum yield (PSII), and electron transport rate (ETR). In addition, intrinsic water-use efficiency (A/gsw) and instantaneous water-use efficiency (A/E) were calculated. Measurements were conducted on young and mature leaves, with 10 leaves used as replicates for each treatment, leaf-age class, and species under dust-affected and dust-free conditions. In *P. longifolia* (Debdaru), young leaves exposed to dust showed significant reductions in stomatal conductance (gsw) (27.92%), transpiration rate (E),

and SPAD chlorophyll index (14.57%) compared with leaves under dust-free conditions. In contrast, none of the measured parameters showed a significant change in mature leaves under dust stress. In *M. ferrea* (Nagweshwar chapa), no significant changes were observed in any of the measured parameters in young leaves. However, mature leaves exposed to dust exhibited significant reductions in SPAD chlorophyll index (23.95%) and transpiration rate (E) (38.09%). Overall, the results indicate that stomatal conductance, transpiration rate, and SPAD chlorophyll index were among the physiological parameters most responsive to dust stress. The response to dust varied with leaf age and species. In *P. longifolia*, young leaves were more sensitive to dust stress than mature leaves, whereas in *M. ferrea*, mature leaves exhibited greater sensitivity than young leaves. These findings demonstrate that both species and leaf developmental stage influence the physiological response of plants to atmospheric dust stress.

Keywords: Dust, Debdaru (*Polyalthia longifolia*), Nagweshwar Chapa (*Mesua ferrea*), Stomatal Conductance, Transpiration Rate, SPAD Chlorophyll Index

To be a male or a female flower, a question of ethylene in hemp

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Abstract

Hemp (*Cannabis sativa* L.) is one of agriculture's most multipurpose and economically important crops, with applications across industrial, medical, nutritional, and environmental sectors. Although arguably the most significant economic potential of the cannabis plant lies in the diverse array of cannabinoids and terpenoids produced and accumulated by the trichomes of the female inflorescence bracts and perigonal bracts. Male flowers, despite producing trichomes on their anthers, accumulate minimal quantities of cannabinoids. The species follows an XX/XY sex determination system, with females carrying XX chromosomes and males carrying XY chromosomes. Nevertheless, phenotypic sex expression in *C. sativa* remains extremely plastic and can be altered by hormonal factors. Genetic, transcriptomic, hormonal and metabolic networks validated ethylene as an important regulator of sex expression. Recent few studies highlighted promotion and inhibition of the ethylene regulatory pathway have both been shown to be effective in manipulating sexual phenotypes in *Cannabis sativa*. In this review, we survey the new advances in hormonal and genetic control of sex determination in cannabis, control which establishes the ethylene biosynthesis and signaling genes as being those that determine the floral meristem towards a male, female or hermaphrodite flower. We underline the significance of this scientific progress with regard to breeding programs for economically-important sex-associated traits.

Keywords: *Cannabis sativa* L., sex determination, ethylene biosynthesis, sexual plasticity, floral meristem identity

Cover-induced modification of light intensity and spectral quality modulates growth and fruit quality of pepper (*Capsicum annuum* L.)

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Abstract

The quantity and spectral quality of solar radiation are the key factors regulating plant growth, photosynthesis and fruit quality. Protective covers can modify the intensity and spectrum of light potentially modulating the plant growth and fruit quality in pepper (*Capsicum annuum* L.). This study evaluated how protective covers modulate the light environment and influence growth, physiology and fruit quality of pepper under winter growing conditions. Plants were established under four cover conditions: Control (no cover), red polyethylene cover (RP), white polyethylene cover (WP) and 50% shade net (SN). The photosynthetic photon flux density (PPFD) largely varied among these treatments and recorded as 1200, 500, 600 and 450 $\mu\text{mol m}^{-2}\text{s}^{-1}$, respectively. RP markedly altered the spectral distribution increasing the proportions of red and far-red radiations with lower blue and UV, whereas WPC provided a comparatively balanced spectral environment affecting plant performance. The plant growth in relation to root-shoot length, number of leaves, root-shoot fresh and dry weight were significantly higher in RP-grown plants followed by WP. The photosynthetic efficiency and quantum yield of photosystem II (PSII) were also enhanced under RP and WP covers compared to control modulating plant growth and fruit quality. The RP and WP-induced light modifications further influenced leaf proline, chlorophyll, carotenoids and antioxidants contents. WP promoted early flowering while RP produced the heaviest fruits (approximately 20% greater than the control). Fruit nutritional and

functional quality including total phenolics, flavonoids, anthocyanin, ascorbic acid, soluble solids ($^{\circ}\text{Brix}$) and DPPH radical-scavenging activity were also improved under RP and WP compared with the control and shade-net treatments. Thus, cover-induced light modification substantially influenced growth, photosynthetic functions, antioxidative defense, flowering and fruit quality in pepper. Among the tested covers, RP was most effective in promoting vegetative growth, photosynthetic performance, fruit yield-related traits, while WP promoted earlier flowering, antioxidants activities and improving fruit quality. These findings suggest that spectral and intensity modification through polyethylene covers can be a useful strategy for improving pepper growth and fruit quality during winter cultivation in Bangladesh.

Keywords: Pepper, light spectrum, polyhouse, plant growth, photosynthesis, antioxidants, fruit quality

Ferric chloride stress alters early seedling growth and germination responses of wheat (*Triticum aestivum* L.)

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Abstract

Iron is essential for plant metabolism, but excessive soluble iron can become phytotoxic. Seedlings could be more vulnerable to iron toxicity than mature plants. Hence, this study evaluated wheat seedling responses to ferric chloride (FeCl_3) under controlled laboratory conditions. A completely randomized design comprising five FeCl_3 treatments (0, 50, 100, 150, and 200 μM), with three replicates of 10 seeds per treatment, was used to test the effect of FeCl_3 . Seeds were surface-sterilized with 30% ethanol for 30 seconds and rinsed thoroughly with distilled water, then primed for 24 hours in the assigned FeCl_3 solution for that treatment group (distilled water for the control), grown for 7 days on filter paper, and assessed for root length, shoot length, fresh weight, dry weight and germination. Results showed a marked reduction in root length at 150 and 200 μM (5.73 and 6.37 cm) compared with the control (9.73 cm), whereas shoot length remained comparatively stable (12.10–12.97 cm) across all treatments. Fresh weight increased from 0.053 g in the control to 0.080 g at 150 μM and was 0.077 g at 200 μM . Dry weight varied between 0.130 and 0.150 g for 0 to 150 μM FeCl_3 but declined to 0.063 g at 200 μM . Germination varied between 95.1 and 100% for 0 to 100 μM FeCl_3 , followed by 66.7% at 150 μM , and increased to 95% at 200 μM . The responses were parameter-specific and non-linear rather than uniformly dose-dependent. Root elongation and dry biomass were the clearest indicators of high- FeCl_3 stress in wheat seedlings. The results provide baseline information for more rigorous genotype screening and mechanistic work using replicate-level physiological and biochemical measurements.

Keywords: Ferric chloride, iron toxicity, wheat, root growth, biomass, germination

Photosynthesis rate and light use efficiency of different crops under shade condition

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Abstract

The shade conditions may reduce plant biomass production and growth, though it largely depends on the nature of the crops in terms of light demand and use efficiency. A field experiment was conducted to measure the photosynthesis and light utilization by five crops viz., Spinach, Red amaranth, Radish, French Bean, Mustard and Pea under ambient and shaded conditions. Photosynthesis rate (P_n), Transpiration rate (T_r) and stomatal conductance (G_s) was measured using a gas analyzer, and the quantum yield (Φ_{II}), regulated heat dissipation (Φ_{NPQ}), non-regulated heat dissipation (Φ_{NO}), PSII open center (q_L), linear electron flow (LEF) and quantum efficiency (F_v'/F_m') were measured using a PAM fluorometer (MultispeQ V.2) under ambient (aroused natural light condition) and a fixed 800 PPFD ($\mu\text{mol m}^{-2}\text{s}^{-1}$). The result shows that broad-leaf plants like French bean, Mustard, Radish, and Spinach have the highest level of P_n rate under ambient conditions, with moderate levels in red amaranth and lower in Pea. For all the crops, P_n rate significantly drops by the shaded condition. The Two-way ANOVA confirms the shade has a very strong effect ($p < 0.001$), crop has a moderate effect, and the Crop $\times$ shade interaction effect was not significant; thus, the shade penalty is similar across the crops. The biggest drops were observed in radish, red amaranth and mustard plants, with moderate drops in French bean, pea, and a small difference in spinach. The transpiration (T_r) and stomatal conductance (G_s) were reduced in all crops except spinach, keeping its stomata open in shade. The shaded plants utilized absorbed light more efficiently, evident by higher Φ_{II} , q_L and F_v'/F_m' with lower Φ_{NPQ} measured in ambient PPFD in both conditions. At the common measuring PPFD (800 $\mu\text{mol m}^{-2}\text{s}^{-1}$), the

shade-grown plants coped worse with high light, as unregulated energy loss (Φ_{NO}) increased without changing the regulated one (Φ_{NPQ}). The overall Φ_{II} was higher in shaded plants when measured in ambient PPFD, but it reversed, and the value was actually higher in naturally light-grown plants when measured in fixed PPFD, evidently implying that plant photosynthesis is not only limited by light intensity, but also that plants adapt to that light and result in poor yield.

Keywords: photochemistry, light response, photosynthesis, fluorescence

Deficit irrigation and water-use efficiency in soilless and intensive berry production under semi-arid conditions: A critical review with implications for North Africa

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Abstract

Berry production is expanding rapidly in the semi-arid regions of North Africa, almost exclusively in soilless substrates under protected structures, where the crop depends on irrigation applied several times a day and has no buffer of stored soil water. Deficit irrigation has been quantified for soil-grown berries, but the evidence for substrate-grown systems, in which drainage fraction, container volume and substrate hydraulics govern the response to any water reduction, has not been consolidated. We screened Scopus (2000–2026) with two complementary queries covering deficit irrigation of berries in soilless or container systems and, as a physiological reference, soil-based trials on blueberry (*Vaccinium*) and raspberry (*Rubus*) in Mediterranean and semi-arid climates. Of 144 unique records, 65 primary studies (48 soilless, 17 soil-based) and three reviews met the inclusion criteria. Strawberry accounts for 37 of the 48 soilless studies; no multi-season study reports a yield–water function or water-use efficiency for blueberry or raspberry grown in substrate. Across the corpus, mild deficits (70–90 % of crop evapotranspiration, or substrate tension set-points with a defined lower bound) maintained yield while raising water-use efficiency by 20–25 %, whereas deficits at or below 50–60 % reduced fruit number and fruit weight in all three species. In coir, sustained drying below ~30 % volumetric water content induced hydrophobicity and lowered both yield (–36 %) and water-use efficiency, indicating that deficit in substrate must be expressed as a bounded set-point rather than a fraction of evapotranspiration. Partial root-zone drying preserved yield in raspberry and hydroponic strawberry. Sensor- and model-based scheduling that corrected over-irrigation delivered water savings of 17–41 % without yield loss, exceeding those obtained by deficit irrigation itself. No study from Africa met the inclusion criteria. We define species- and substrate-specific research priorities for North African berry systems, with emphasis on blueberry and raspberry, water-quality interactions, and the elimination of over-irrigation as the first-order lever.

Keywords: Regulated deficit irrigation, substrate water tension, coir hydrophobicity, partial root-zone drying, berry

The integration of flower strips on insect community dynamics and crop performance in eggplant (*Solanum melongena* L.)

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Abstract

Floral strips have key impacts on the abundance and diversity of beneficial arthropods; hence, they enhance conservation biological control in agricultural crops. However, their role in vegetable crops such as eggplant (*Solanum melongena* L.) remains unexplored. Therefore, we aim to explore the effects of flower strips on arthropod community structures, key herbivorous and beneficial insect communities, pollinator abundance, their visitation, and crop yield. We performed a large field experiment at Horticultural Research Centre (HRC), Sylhet, Bangladesh that consists with 42 plots (total 210 plant @ 5 plant per plot) in three replicates using two eggplant varieties (viz; Shingnath and Tal). The experiment consisted of seven treatments, viz., control, insecticide, cosmos, marigold, sylvia, zinnia, and mixed flowering strips. Arthropods were monitored at seven-day intervals until the end of the experiment. They were classified into major functional guilds; herbivores, predators, parasitoids, and pollinators, respectively. Our results revealed that floral treatment significantly altered arthropods community composition especially floral resources favour predator, parasitoids, and pollinators abundance than conventionally treated plots suggested the benefits of the integration of floral strips in eggplant field. Alternatively, the addition of floral strips reduced herbivore abundance compared with control or insecticides treated plots. The response of individual

herbivores such as leafhopper, Epilachna beetle, and aphid was significantly reduced with floral crop but was specific to floral species and herbivore life stages. A similar trend was also observed for predatory Ladybird beetles. The percent infestation of brinjal shoots and fruits borer significantly reduced across floral species than control or insecticides plots particularly in the Tal. The pollinator abundance and flower visitation increased with floral strips inclusion, where cosmos and marigold supported greater pollinator activity than other treatments. Total yield per plot increased with floral treatments but significantly increased in the plot with zinnia than in the control in Shingnath. Our findings showed that flower strips can restructure arthropod communities, improve pollinator functions, and strengthen the conservation biological control approach for management of eggplant insect pests. This study suggested that integration of flower strips with vegetable crops enhanced biodiversity-based integrated pest control, enhance pollinator and natural enemy diversity for sustainable and safe vegetable production.

Keywords: Conservation biological control, floral strips, arthropod community, pollinators, predators, parasitoids, natural enemies

The cucumber pest complex in SAARC nations: molecular insights and advances in biological control for sustainable IPM

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Abstract

Cucumber (*Cucumis sativus* L.) is major vegetable crop in South Asia, but its production constrained by several pests and diseases that together cause yield losses ranging from 30% to complete failure. In cucumber, major insect pests include whiteflies, thrips, aphids and leaf miner cause direct damage to the plant and fruits as well as being vectors for plant pathogens while major diseases include downy and powdery mildews, anthracnose, bacterial wilt, fusarium wilt and cucumber mosaic virus. Cucumber growers rely heavily on chemical pesticides and their calendar-based sprays may result in pesticide resistance, disruption of natural enemies and secondary pest outbreaks. Considering the fact, biological control and plant-mediated defenses are a key part of an integrated pest and disease management (IPDM) strategy for sustainable cucumber production. Predators, parasitoids, entomopathogenic fungi, bacteria and nematodes, together with biopesticides, suppress pests through predation, parasitism, infection and induced plant defense. Cucumber responds to herbivory through interconnected reactive oxygen species, MAPK, jasmonic acid (JA) and salicylic acid (SA) signaling networks, and JA–SA crosstalk is exploited by sap-feeding insects. Molecular tools, including DNA barcoding, population genetics, resistance-allele monitoring, multi-omics, RNA interference (RNAi) and CRISPR/Cas-based functional studies, together with nanotechnology and AI-assisted remote sensing, provide new opportunities for precise pest detection and management. Integrating molecular diagnostics with host-plant resistance and classical biological control may enable a diagnostic-to-management pipeline that reduces pesticide dependence while sustaining productivity. This review summarizes cucumber production, cultivars, major pests and pathogens, chemical control limitations, biological-control options, molecular mechanisms of cucumber–pest interactions, emerging technologies, policy and regional collaboration needs, and future opportunities for integrating biological and molecular approaches into sustainable cucumber production in South Asia.

Keywords: Biological control, host-plant resistance, molecular diagnostics, RNAi, CRISPR

Integrated fungicide application and seed treatment synergistically improve rice seed quality and reduce grain discoloration

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Abstract

Applying fungicides to rice (*Oryza sativa* L.) could suppress seed-borne fungal pathogens to improve seed quality, germination, seedling vigor, overall seed health, and yield. The experiment was conducted at Chiknagul, Sylhet from May to September 2025, using BRRI dhan92 rice variety in Randomized Complete Block Design with seven fungicide treatments (Amister top 0.1%, Nativo 0.08%, Trooper 0.1%, Trichoderma 0.1%, Score 0.1%, Contaf 0.1%, and Turbo 0.1%) and an untreated control, replicated three times to assess their efficacy on seed health and quality of rice. Data were collected on plant height, total effective and non-effective tillers per hill, filled and unfilled grains per panicle, spotted seed percentage, thousand grain weight, biological yield and economic yield. Significant differences were observed among the treatments in yield contributing traits, seed quality, yield and seed health.

Amister Top 0.1% showed the highest seed germination (95%) and the lowest spotted seed incidence (3%), whereas the control recorded 86% germination and 47% spotted seeds. Nativio 0.08% recorded the highest grain yield (6.83 t ha⁻¹). Eight seed associated fungal species were identified (*Alternaria padwickii*, *Aspergillus niger*, *Bipolaris oryzae*, *Aspergillus flavus*, *Rhizopus* sp., *Curvularia lunata*, *Fusarium oxysporum*, and *Penicillium* sp.), and Amister Top 0.1% showed broad spectrum effectiveness in reducing fungal incidence, achieving complete suppression of *A. flavus*, *Rhizopus* sp., *C. lunata*, and *Penicillium* sp. The findings indicate that appropriate fungicide applications can improve rice seed quality and reduce seed associated fungal infection. Overall, Amister Top 0.1% and Nativio 0.08% showed promising effects on seed quality, seed health, and yield of BRRI dhan92 rice.

Keywords: Seed quality, seed health, germination, fungicide application, grain discoloration, yield, BRRI dhan92

A new brinjal root endophyte *Klebsiella* sp. without acquired resistance or hypervirulence loci, sustains tomato yield under 70% reduced urea

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Abstract

Klebsiella pneumoniae is both a critical-priority nosocomial pathogen and a common plant endophyte, yet plant-derived isolates are usually judged by genus rather than by genome. We characterised HSTU-BF3R2, an endophyte of surface-sterilised brinjal roots from Dinajpur, Bangladesh, and evaluated it in tomato. The 5,318,912 bp draft assembly (67 contigs; 57.40% G+C; 4,996 coding sequences) is *K. pneumoniae* sensu stricto (98.96% average nucleotide identity to the type strain) and defines the previously undescribed sequence type ST172818, distinguished by a single-nucleotide variant in *tonB*. No acquired resistance gene or canonical hypervirulence locus was detected, whereas 50 complete reference genomes carried 0–33 acquired genes, and the single IncFIB plasmid is non-mobilizable and carries only metal- and heat-stress determinants. Trait calls were verified by reciprocal BLASTp and absences by tBLASTn. Nutrient acquisition dominates the verified repertoire, including a complete *pqqA–F/gcd* route for gluconate-mediated phosphate solubilization and a 14-gene phosphonate uptake and C–P lyase complement, whereas nitrogenase, canonical auxin biosynthesis, ACC deaminase and the chemotaxis and flagellar genes are absent. In the field trials, inoculation with 70% less urea increased shoot length by 63.3% and fruit number 3.5-fold over fully fertilized controls. Rhizosphere soil of inoculated tomato plants held 1.25–1.66-fold more total N, available P, exchangeable K and available S, and leaves showed higher phenylalanine ammonia-lyase (2.71-fold), peroxidase (2.25-fold) and total phenolics (2.35-fold) but 87% less proline; treatment explained 96.2% of the combined soil–leaf variation (PERMANOVA, $P = 0.008$). Strain-resolved genomics, rather than species identity, should govern how plant-derived *Klebsiella* isolates are assessed.

Keywords: *Klebsiella pneumoniae*, endophyte, novel sequence type, biosafety genomics, phosphate solubilization

Brinjal root endophytes *Serratia* sp. strains (HSTU-BF1R4, HSTU-BF3R4) enable pesticide-free tomato cultivation with reduced urea input under field conditions

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Abstract

Reducing agrochemical inputs without sacrificing yield or quality remains a key challenge in tomato production. We isolated two endophytic bacteria from brinjal roots collected in two villages of Dinajpur, Bangladesh, and identified them by biochemical profiling and whole-genome sequencing as *Serratia* sp. HSTU-BF1R4 and *Serratia* sp. HSTU-BF3R4. Phylogenies based on four housekeeping genes (*recA*, *gyrB*, *tonB*, *rpoB*) and whole genomes placed both strains on a sister node, apart from their closest relative, *Serratia* sp. LS-1 (CP033504), and multiple-genome alignment and pangenome analysis revealed extensive divergence in locally collinear block organization. HSTU-BF1R4 shared 98.96% average nucleotide identity (ANI) with *S. marcescens* RSC-14 (CP012639.1) and 97.1% digital DNA–DNA hybridization (dDDH) with CP033504.1, whereas HSTU-BF3R4 shared 98.93% ANI and 97.3% dDDH with *S. marcescens* SL267 (AP024916.1). The strains differed biochemically: HSTU-BF1R4 was VP-negative, MR-positive and MIU-negative, whereas HSTU-BF3R4 showed the reverse pattern. Both strains fixed nitrogen and solubilized phosphate *in vitro*; HSTU-BF1R4 and HSTU-BF3R4 produced indole-3-acetic acid (IAA)

at 4.16 ± 0.4 and $5.50 \pm 0.3 \mu\text{g mL}^{-1}$ and showed ACC deaminase activity of 0.52 ± 0.02 and $0.58 \pm 0.01 \mu\text{M mL}^{-1} \text{h}^{-1}$, respectively. Their genomes encoded genes for nitrogen fixation, siderophore biosynthesis, ACC deaminase (*acdS*), IAA production, phosphate metabolism, stress tolerance and pesticide degradation. In the field, foliar application of the two-strain co-culture, with no pesticides and only 30% of the recommended urea, increased tomato yield per hectare 4.44-fold, lycopene content 3.6-fold, and Ca^{2+} , Mg^{2+} , Zn^{2+} and Cu^{2+} contents 1.3-, 1.4-, 1.54- and 8.66-fold, respectively, relative to control plots receiving standard fertilizers, supplements and pesticides. At the reproductive stage, treated plants showed 1.65-fold lower proline content, 3.33-fold lower peroxidase activity and 60% higher superoxide dismutase activity. These strains combine multiple plant growth-promoting traits and allowed pesticides to be omitted and urea to be cut by 70%, making them promising biostimulants for sustainable tomato cultivation.

Keywords: *Serratia* sp., tomato plants, lycopene, minerals, pesticides free cultivation

Bridging the gap between toxicity and sustainability: A critical review of pesticide residues, ecotoxicological risks and good agricultural practices in south Asian agro-ecosystems

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Abstract

South Asian agriculture constantly encounters the challenges of feeding over 1.9 billion people associated with widespread application of agro-chemicals and pesticides leading to ecological degradation, loss of biodiversity and hazards for workers. Application pattern, residue dynamics, ecotoxicological threat and health hazards of the prevalent synthetic pesticides across 4 major South Asian agrarian ecologies (Bangladesh, India, Sri Lanka and Pakistan) are systematically analyzed for the first time with a critical overview of their eco-toxicity for the non-target flora and fauna. Exceedance above FAO/WHO recommended Maximum Residue Limit (MRL) for banned or restricted Organochlorines (73% in Bangladesh, 11% in India, 9.6% in Srilanka and 20.1 in Pakistan), Organophosphate and neonicotinoids in the major crops and fruit basket directly affect its microdiversity and on non-target pollinators in South Asia and the river basin's (mainly Indus, Ganges and Brahmaputra) which are also documented and discussed. These risks may be heightened on smallholder farms, where farmers can be exposed to pesticides during application. Therefore, improving pesticide management practices and promoting environmentally responsible farming approaches are essential to reduce ecological and human health risks while maintaining agricultural productivity. However, the adoption of Good Agricultural Practice (GAP) frameworks (e.g. GlobalGAP, Bangladesh GAP, India GAP, Sri Lanka GAP etc.) remains slow among resource-constrained smallholders due to limitations in farm size, inadequate institutional support, limited access to resources and weak enforcement mechanisms, creating challenges for achieving sustainable crop production pathways in the future. Agro-ecological practices (Biopesticides and Integrated Pest Management–IPM), appropriate technological support system (precision spraying drones and biosensors, bio block chain – integrated tracking system) along with effective policy framework toward sustainable food security with unified for SAARC is integrated in this review article.

Keywords: Maximum residue limit (MRL), smallholder farmers, south asian agro-ecosystem, ecotoxicology

Varietal differences in infestation by cucumber moth (*Diaphania indica*) on bottle gourds in Sylhet, Bangladesh

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Abstract

Bottle gourd (*Lagenaria siceraria*) is an important cucurbitaceous vegetable in Sylhet region, valued for its adaptability, nutritional content and year-round demand. Majority of bottle gourd farmers of Sylhet region cultivate hybrid bottle gourd variety and facing challenges due to the infestation of cucumber moth (*Diaphania indica*), an emerging pest. The larvae of this moth scrape the bottle gourd fruit skin and reduce the marketability of fruits. The study aimed to explore the relationship between the emerging pest and cultivated bottle gourd varieties, and to determine whether infestation levels differ among them. This study evaluated four bottle gourd varieties against *D. indica* infestation: T1 = Hybrid Lau (Thai), T2 = Hybrid Lau (BD), T3 = High Yielding Variety (Khet Lau) and T4 = Local (Gaibandha). Data were recorded weekly on larvae per male flowers, female flowers, older leaves, younger leaves and twigs; larvae per immature and mature fruit; and the number of fruits spotted by larval damage. The four

varieties did not differ in larval infestation on flowers, leaves and twigs. In contrast, fruit infestation differed among the varieties. Larvae on immature and mature fruits, and the number of spotted fruits, were higher in the Thai hybrid (T1) and lower in the local variety (T4). These findings indicate that bottle gourd varieties differ in their susceptibility to fruit damage by *D. indica*, and that the hybrid Thai variety is more susceptible. These findings will support the selection of bottle gourd variety in Sylhet region and thus contribute to pest management in bottle gourd cultivation.

Keywords: *Lagenaria siceraria*, *Diaphania indica*, varietal susceptibility, north-eastern region

Biopriming with endophytic *Serratia marcescens* enhances defense responses against blast disease of rice

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Abstract

Rice blast, caused by *Pyricularia oryzae*, is a major threat to rice production in Bangladesh, leading to severe yield losses. This study aimed to isolate, identify, and evaluate endophytic bacteria for their biocontrol potential against the pathogen. Among 100 isolated endophytic bacteria, seven bacterial isolates demonstrated strong antifungal activity against the pathogen. Among them, BDISO_08 showed positive response in all plant growth-promoting traits, including Indole-3-Acetic acid (IAA), siderophore, phosphate solubilization, hydrogen cyanide, and ammonia production. Molecular characterization confirmed the isolates as *Serratia marcescens*. In greenhouse conditions, the efficacy of BDISO_08 was assessed under three biopriming techniques (Seed biopriming, seedling biopriming, and combined biopriming) in two blast susceptible varieties, BRRI dhan34 and US-2. Combined biopriming significantly enhanced the antioxidant defense system in rice, increasing the activities of superoxide dismutase (SOD), peroxidase (POD), polyphenol oxidase (PPO), and ascorbate peroxidase (APX) by 119.3%, 275.58%, 351.51%, and 826.09%, respectively, compared to the control. In BRRI dhan34, combined biopriming also upregulated the expression of defense-related genes, with *OsPOD*, *OsPR5*, and *OsPAL1* showing fold increases of 6.20 ± 0.40 , 18.56 ± 0.36 , and 6.79 ± 1.01 , respectively. Additionally, combined biopriming treatment in BRRI dhan34 significantly improved vegetative growth and yield-contributing traits, with shoot length, root length, root dry weight, and 1000-seed weight increasing by 15.68%, 87.5%, 134.35%, and 75.69%, respectively. These findings suggest that *Serratia marcescens* can be a promising biocontrol agent that can suppress blast disease and increase yield in rice cultivation.

Keywords: *Pyricularia oryzae*, siderophore, gene expression, biopriming and endophytic

Effects of tenebrionid insects frass on insect pest complex of cucumber

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Abstract

Cucumber (*Cucumis sativus* L.) is a fast-growing and frequently harvested vegetable crop, making intensive use of chemical pesticides a concern because pesticide residues may remain in fruits and pose risks to human health and the environment. Therefore, sustainable alternatives are needed to reduce pest infestation while maintaining crop productivity. Insect frass, a nutrient-rich by-product of insect rearing, has gained potential to enhance plant defense and reduce insect pest pressure. However, information on the effects of tenebrionid frass on insect infestation of cucumber, particularly under Bangladeshi conditions, remains limited. Therefore, this study evaluated the effects of three tenebrionids insect including superworm (*Zophobas morio*), mealworm (*Tenebrio molitor*), and buffalo worm (*Alphitobius diaperinus*) frass on insect pests complex of cucumber. Three soil application rates, 25, 50, and 100 g, of each frass type were evaluated together with an untreated control in a randomized complete block design with three replications. Preliminary results showed that frass application reduced overall insect abundance compared with the untreated control. At the 100 g application rate, insect abundance decreased by 36.83% with superworm frass, 34.17% with mealworm frass, and 35.65% with buffalo worm frass. A similar response was observed for aphids, where reductions reached 35.9%, 34.8%, and 39.5%, respectively. In addition to pest suppression, pollinator visitation increased in several frass-amended treatments, with the highest visitation recorded in the 100 g buffalo worm frass treatment. Chemical analysis further indicated that frass application enhanced leaf flavonoid content compared with the control, suggesting a possible stimulation of plant biochemical responses. The positive effects of

frass were also reflected in crop productivity, as frass-treated plants generally produced more fruits and higher total yield than the untreated control. The 100 g buffalo worm frass treatment produced approximately 6.33 fruits plant⁻¹ compared with 2.67 fruits plant⁻¹ in the control. Overall, these preliminary findings suggest that tenebrionid frass has promising potential as a sustainable soil amendment for reducing pest infestation while supporting pollinator activity, plant biochemical responses, and cucumber productivity.

Keywords: Tenebrionid frass, cucumber, insect infestation, aphid, pollinator visitation, sustainable pest management

Effects of *Trichoderma* and insecticides on chewing and phloem-feeding herbivores in cucumber

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Abstract

Cucumbers (*Cucumis sativa* L.) are economically important vegetable crops globally. Chewing and phloem-feeding herbivores cause significant damage to the cucumber. Insecticides are widely used to control herbivores but cause severe health hazards. Studies have suggested that *Trichoderma* may provide an alternative approach for controlling herbivores. Hence, this study explored the effects of *Trichoderma* and insecticides for controlling aphid (*Aphis gossypii* Glover), whitefly (*Aleurodicus disperses* Russell) and red pumpkin beetle (*Aulacophora foveicollis* Lucas) in cucumber. A semi-field pot experiment was conducted using *Trichoderma asperellum* (OR125623) (@ 2×10⁶ CFU/gm) and *Trichoderma harzianum* (@ 2×10⁶ CFU/gm) sprayed on the cucumber @ 5gm/liter water. Two insecticides, Cord 10% EC and Cartap 50 SP, and a control were also sprayed on the cucumber. Aphid, whitefly and red pumpkin beetle population densities were higher in insecticide-treated plots than in *Trichoderma*-treated plots, indicating a significant reduction. *T. harzianum* showed the highest efficacy for the reduction of herbivore populations. The foliar application of *Trichoderma* showed more positive effects on parasitoids than chemical control. Cucumber mosaic virus was reduced by 8–10% than control in the dual application of *Trichoderma*, suggesting a synergistic effect between the species. Total chlorophyll and carotenoid content in the leaf remains unaffected. The number of trichomes per leaf, fruit length and yield per plant increased significantly in both the *Trichoderma*-treated and insecticide-treated groups compared to the control group. Our research has broader implications for cucurbits, insect and disease management with less reliance on insecticides, considering *Trichoderma* as a potential alternative.

Keywords: Biopesticide, biocontrol, *Cucumis sativa*, Insect herbivores, *Trichoderma asperellum*, *Trichoderma harzianum*.

The role of floral strips on arthropod population dynamics in rice ecosystem

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Abstract

Floral strips at field margins are well known to attract and support natural enemies of insect pest populations to reduce pest pressure in agroecosystem. While the benefits of floral strips have been widely studied in many crops, their role in rice-based ecosystems remains largely unexplored. We performed a field experiment using four rice varieties to investigate the role flower species Rongon (*Ixora coccinea*), Allamanda (*Allamanda cathartica*), Hasnahena (*Cestrum nocturnum*) and Madhobilota (*Hiptage benghalensis*) established as floral strips adjacent to rice plot on arthropods population dynamics. Herbivorous and predatory arthropods were sampled from each plot every seven days from vegetative to reproductive maturity. Arthropods communities were categorized according to taxonomic groups. Data on pollinator attraction towards floral species were recorded through visual count. Rice bug and rice stem borer infestation and yield parameters were also recorded. The abundance and diversity of Orthopterans, Hemipterans and Dipteran were reduced significantly with floral strips than control plot. Coleopterans population also decreased with floral strips but species-specific. The predatory Arachnids population increased with flower strips suggested that addition of flower resources benefits predators over control. Principal component analysis summarized that flower species distinctly separated arachnids and pollinators communities. Rice stem borer (% whiteheads) and rice bug (%) infestation also reduced with flower strips than control but differed among varieties.

Dry grain weight increased with floral strips than control plot across varieties. Our research has wider application to promote conservation biological control to reduce insecticides application for the management of herbivorous insects in rice agroecosystem.

Keywords: Habitat management, floral resources, herbivores, predators, arachnids, pollinators

The effects of silicon supplementation on two-spotted spider mite (*Tetranychus urticae*) biology, plant physiological traits and plant growth parameters in strawberry

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Abstract

Strawberry is an economically important fruit crop in Bangladesh and worldwide because of its taste, nutritional value, and antioxidant properties. However, strawberry production is threatened by several pests, including the two-spotted spider mite (*Tetranychus urticae* Koch), which feeds continuously on leaves and reduces plant growth and yield. The increasing worldwide resistance of *T. urticae* to pesticides highlights the need for sustainable and environmentally friendly pest-management strategies. Therefore, we conducted a pot experiment to evaluate the effects of foliar silicon application on *T. urticae* biology, predatory mite abundance, plant growth, and reproductive traits in strawberry. Two strawberry varieties and three levels of foliar silicon were evaluated. Data on *T. urticae* life stages and predatory mites were collected at two sampling times, while leaf pigments and plant growth and reproductive traits were measured to assess plant responses. Silicon application reduced the numbers of eggs, protonymphs, deutonymphs, and adults compared with the control. Adult mite abundance was significantly lower in silicon-treated plants, with the 2 mM treatment producing the greatest reduction. Predatory mite abundance was also significantly higher in silicon-treated plants than in control plants, suggesting the benefits of attracting natural enemies. In contrast, silicon application had no significant effect on photosynthetic pigments, including chlorophyll a, chlorophyll b, total chlorophyll, and carotenoids. Principal component analysis showed that silicon application significantly affected several plant traits, including leaf number, plant height, and reproductive traits such as flower, runner, and fruit production. Overall, silicon application enhanced plant defence against *T. urticae* without reducing plant growth or reproductive performance. Foliar silicon application could therefore be incorporated into integrated pest-management programs for *T. urticae* in strawberry.

Keywords: *Tetranychus urticae*, silicon supplementation, predatory mites, integrated pest management, plant resilience, strawberry

Comparative assessment of silicon fertilization and plant extracts with insecticide for leaf miner and tomato fruit borer management in tomatoes

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Abstract

Tomato (*Solanum lycopersicum* L.) is one of the most consumed vegetables in the world. However, its production is highly affected by insect pests, especially the tomato leaf miner (*Tuta absoluta*) and the tomato fruit borer (*Helicoverpa armigera*). Although synthetic insecticides are widely used to manage pests, their frequent use results in resistance and environmental risks. Sustainable approaches like silicon fertilization and botanical extracts may offer effective alternatives to reduce pests and improve plant health. A field experiment was conducted to evaluate the comparative efficacy of silicon fertilization, plant extracts, and insecticide treatments in the management of insect infestation in tomato. Two varieties of tomato, BINA Tomato-10 (Cherry) and BARI Tomato-2 (Raton), were evaluated under seven treatments: foliar silicon, soil silicon, both (soil and foliar) silicon, neem extract, water pepper extract, insecticide, and untreated control. The experiment was conducted in a randomized complete block design (RCBD) with 3 replications. We recorded insect abundance, fruit infestation, yield-related traits, chlorophyll content, carotenoids, and foliar silicon concentration. The results showed that silicon supplementation and botanical extracts had a significant effect on the abundance of insect pests and on the physiological characteristics as well as yield parameters. Both silicon applications (soil & foliar) significantly suppressed tomato fruit borer infestation. Both silicon application increased fruit production by reducing insect attack, increased the number of healthy fruits as well as fruit weight, while reduced the proportion of infested fruits. Silicon treatments reduced leaf miner population as compared to the control. Neem extract was also found to be effective in reducing insect damage. The application of

silicon promoted the accumulation of photosynthetic pigments, including chlorophyll content, and improved the physiological performance of the plants. Soil and foliar applications, as well as botanical extracts, can help in sustainable pest management in tomato production. Our results suggested that silicon and plant extract-based practices can reduce the use of synthetic insecticides while maintaining effective pest suppression and improving yield and physiological performance in vegetable crops.

Keywords: Silicon fertilization, neem extract, integrated pest control, insecticide resistance, plant extract, leaf miner, tomato fruit borer.

Insect abundance and diversity of cruciferous vegetables in north-eastern part of Bangladesh

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Abstract

Cruciferous vegetables belong to the family Brassicaceae (also known as Cruciferae) with numerous genera, species, and cultivars that are commercially grown as vegetable crops under diverse regions. They are important *rabi* season vegetable crops that include cabbage, cauliflower, broccoli, radish, turnip, and other vegetables and edible oil plants like mustard. These vegetables are an excellent source of protein, carbohydrates, vitamins, minerals, ascorbic acid, folic acid thus contribute to dietary nutrition also provides income to growers. However, they are attacked by a wide range insect pests about more than 30 major species, causing substantial yield losses. Despite their importance, there is no current record of the insect communities (i.e. abundance and diversity) of these groups in north-eastern part of Bangladesh. Hence, we performed common garden field experiment in Entomology field with five species of cruciferous vegetables viz. radish, mustard, turnip, cabbage, and cauliflower to assess insect abundance, diversity and timing of major pest infestation across plant ontogenetic stages (seedling, vegetative and reproductive) in winter season. We collected the data at seven day intervals after seedling emergence to reproductive stage. Based on our visual and sticky trap observation, we found that cruciferous vegetables likely to be more susceptible at reproductive stage than vegetables stage. We also found that insects belonging to Lepidoptera, Hymenoptera, Coleoptera, and Hemiptera were more abundant and diverse among the cruciferous crops while significantly varied among the cultivars. Among the insects, parasitoids, mustard sawflies, aphids, flea beetles, cabbage butterfly, mealy bugs and white flies were very abundant and diverse and destructive across cruciferous crops. Shannon Diversity Index (H) was highest in cabbage while insect species richness (S) highest in radish than other cruciferous crops tested in this study. Our study provides clear and detailed information about the insect community and their abundance of cruciferous vegetables. This study will provide critical information to the growers about the abundance, diversity, and time and nature of insect's attack on cruciferous vegetables and facilitate their further management approaches for better production of cruciferous crops.

Keywords: Cruciferous crops, insect abundance and diversity, vegetative stage, reproductive stage and integrated pest management

Assessment of metallic ions and *Trichoderma asperellum* HSTUT1 for sustainable management of sheath blight (*Rhizoctonia solani*) of rice

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Abstract

Sheath blight of rice caused by *Rhizoctonia solani* is a major threat to rice cultivation in Bangladesh. Farmers almost entirely depend on synthetic fungicides to control the disease, which creates long-term environmental risks and accelerates pathogen resistance. To develop a safer and eco-friendly alternative, the current field trial evaluated the potential of *Trichoderma asperellum* HSTUT1 along with metal ions (Cu^{++} and Ag^+) against sheath blight of rice. The experiment was conducted following a Randomized Complete Block Design with nine treatments, including single and combined applications of *T. asperellum* HSTUT1, Cu^{++} , and Ag^+ ions. Foliar sprays were applied at 30, 50, and 70 days after transplanting. Among the treatments, the combined application of *Trichoderma* sp. and Cu^{++} ions significantly reduced sheath blight pressure in the field. At 80 days after transplanting, the similar combination recorded the lowest sheath blight incidence (19.22%), severity (20.69%), and Area under Disease Progress Curve (AUDPC, 613.90) compared (41.21% DI, 34.91% severity, and 1338.50 AUDPC) to control. In terms of crop growth and final harvest, *Trichoderma* sp. in combination with Cu^{++} ions produced the highest plant height (124.17 cm) and effective tillers (86.15%), longest panicles (28.11 cm), highest filled grains (80.91%), and maximum 1000-grain

weight (13.75 g). Because of this improved growth, the combination of *Trichoderma* sp. and Cu⁺⁺ ions resulted the highest grain yield (4.84 t/ha) compared to control (3.18 t/ha). The study demonstrates that combined application of *Trichoderma* sp. and Cu⁺⁺ ions could be a promising alternative for managing sheath blight diseases.

Keywords: Metal ions, *Rhizoctonia solani*, sheath blight, *Trichoderma asperellum*, eco-friendly

Beneficial bacteria on growth promotion and suppression of damping-off and foot rot disease of selected vegetables

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Abstract

Damping-off and foot rot caused by *Fusarium oxysporum* are a serious concern in the production of vegetable seedlings in the country. As an alternative tools to chemical, the study aimed to explore the impact of some isolated beneficial bacteria for the sustainable and eco-friendly management of the disease. Previously isolated bacteria namely *Enterobacter ludwigii* HSTUB 16, *Enterobacter tabaci* HSTUB 20, *Bacillus cereus* HSTUB 17, *Enterobacter cloacae* HSTUB 12, and *Serratia marcescens* HSTUB 8 were evaluated against country bean, red amaranth, spinach, radish, and mustard. In laboratory conditions, seed treatment with all kinds of bacteria increased seed germination, shoot length, and root length by ~100%; decreased seed associated pathogen infection from ~83%. However, the maximum growth promotion was observed in country bean by *E. cloacae* HSTUB 12, red amaranth by *E. tabaci* HSTUB 20, spinach by *E. tabaci* HSTUB 20, radish by (*E. tabaci* HSTUB 20 & *B. cereus* HSTUB 17), and mustard by (*E. ludwigii* HSTUB 16 & *B. cereus* HSTUB 17). In net house conditions, bacterial seed treatment increased germination, vigor index, shoot length and root length from 26~100%. Bacterial seed treatment also reduced pre and post emergence damping-off by 32%. The bacteria reduced damping-off incidence and severity in country bean (86.67% & 89.17%), red amaranth (77.27% & 56.70%), spinach (80.56% & 85.62%), radish (100% & 100%), and mustard (84.61% & 90.72%), respectively. Similarly, all the bacteria also decreased foot rot incidence and severity in country bean (71.43% & 85.62%), red amaranth (44% & 100%), spinach (71.71% & 69.87%), radish (58.33% & 62.82%), and mustard (54.04% & 58.16%), respectively. The study demonstrated the potentiality of the selected bacteria for the further disease control program.

Keywords: Beneficial bacteria, damping-off, foot rot, *Fusarium oxysporum*, eco-friendly management.

Physiological and biochemical defence responses of wheat to boron, zinc and silicon against *Bipolaris* leaf blight

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Abstract

Bipolaris leaf blight, caused by *Bipolaris sorokiniana*, is an important disease of wheat that can affect plants at different growth stages and reduce crop performance. This study evaluated whether soil and foliar application of boron (B), zinc (Zn), and silicon (Si) could suppress *Bipolaris* leaf blight and enhance defence responses in wheat. Nine combinations of micronutrient treatments were evaluated using the susceptible wheat cultivar Kanchan. Micronutrients were applied through the soil and/or foliage at the seedling, tillering, and booting stages. Plant growth, disease incidence and severity, yield-contributing traits, and selected biochemical and antioxidant defence responses were assessed. Micronutrient treatments significantly improved vegetative growth and influenced disease development and yield-related traits. Among the treatments, T₇, consisting of 50% of the total micronutrients applied to the soil together with foliar application of 0.30 g Zn and 0.30 g Si, produced the lowest disease incidence and severity. This treatment also showed the strongest biochemical response, with total phenol content reaching 401.79 µg/g and increased levels of H₂O₂ and malondialdehyde at 21 days after treatment. Activities of the antioxidant enzymes catalase and ascorbate peroxidase were also highest in T₇. These findings indicate that combined soil and foliar application of B, Zn, and Si can strengthen defence-related biochemical responses while improving growth and yield-associated traits of wheat. Appropriate micronutrient management may therefore provide a useful complementary approach for managing *Bipolaris* leaf blight in wheat.

Keywords: *Bipolaris sorokiniana*, wheat, boron, zinc, silicon, defence response, *Bipolaris* leaf blight

Plant-derived cardiac glycosides as potential multi-target biopesticide leads for sustainable management of major rice diseases: An in-silico study

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Abstract

Bacterial leaf blight caused by *Xanthomonas oryzae* pv. *oryzae* (Xoo) and rice blast caused by *Magnaporthe oryzae* can cause substantial yield losses under epidemic conditions in Bangladesh. Extensive use of synthetic pesticides also contributes to resistance development and environmental concerns. This study evaluated cardiac glycosides from selected locally available Apocynaceae species as potential molecular leads for sustainable biopesticide development. The selected plants were *Calotropis gigantea*, *Cascabela thevetia*, *Cerbera odollam*, and *Nerium oleander*. Eight cardiac glycosides were docked against three pathogen-associated protein targets. These were Xoo DNA gyrase B, *M. oryzae* scytalone dehydratase, and trehalose-6-phosphate synthase (Tps1). The gyrase B structure was obtained from a homology model with a GMQE of 0.85, while the other targets corresponded to PDB IDs 1STD and 6JBI. Molecular docking was performed using AutoDock Vina in PyRx. Protein–ligand interactions were subsequently analysed in Discovery Studio, and ADMET properties were predicted using SwissADME and pkCSM. Uscharin, thevetin A, and thevetin B showed the most favorable predicted binding energies for gyrase B (–11.1 to –11.8 kcal/mol) and scytalone dehydratase (–10.2 to –10.5 kcal/mol). These values were more favorable than those of the reference compounds docked under the same protocol (approximately –5.5 to –8.8 kcal/mol). Binding to Tps1 was comparatively weaker, ranging from –7.7 to –8.1 kcal/mol. The top-ranked poses formed hydrogen bonds and hydrophobic interactions with active-site residues. These included TYR16, GLN84, and HIS104 in scytalone dehydratase. The thevetins were large and highly polar molecules, with molecular weights of 859–873 Da and TPSA values of 273–290 Å². They also showed low predicted absorption. Uscharin was comparatively smaller, with a molecular weight of 588 Da. Overall, uscharin and the thevetins emerged as promising computational leads from locally available plant sources. However, the evidence remains entirely computational. Their large and polar structures may limit uptake, while the known mammalian toxicity of cardiac glycosides associated with Na⁺/K⁺-ATPase inhibition remains an important safety concern. Enzyme assays, *in vitro* pathogen studies, and comprehensive toxicity evaluations are therefore required before further development or field application.

Keywords: Cardiac glycosides, *Xanthomonas oryzae* pv. *Oryzae*, *Magnaporthe oryzae*, molecular docking, biopesticides, sustainable rice protection

Screening of country bean genotypes for anthracnose resistance in the field and its *in vitro* management

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Abstract

Anthracnose of bean, caused by *Colletotrichum lindemuthianum*, can damage leaves, stems, and pods. It reduces the marketable yield. This study aimed to screen 22 country bean genotypes for anthracnose resistance in the field and to test the *in vitro* management of the pathogen using three chemical fungicides (mancozeb, kurennox, and tilt) and one biofungicide (chitosan). Both field and lab experiments were conducted to test the effects of different chemicals and biofungicide. The field experiment was conducted at Sylhet Agricultural University, and disease development was recorded at 7-day intervals in December 2025. Among the 16 affected genotypes, disease incidence ranged from 70% to 95%, while six genotypes (G1, G3, G7, G11, G14, and G17) showed no symptoms. The overall disease index increased from 16.0% to 29.2% by the last observation. A total of four treatments, where three chemical fungicides and one biofungicide were arranged in a completely randomized design with three replications under laboratory conditions. Here, the colony diameters of the control and treatment plates were recorded over 9 days. On the final day (day 9), the colony diameter was 85.0 mm in the control, 25.33 mm with mancozeb, 5.33 mm with kurennox, 0 mm with tilt, and 21.17 mm with chitosan, corresponding to growth inhibition of 70.2%, 93.7%, 100%, and 75.1%, respectively. The six symptom-free genotypes were primarily detected as resistance genotypes. Here tilt showed the strongest *in vitro* inhibition of the pathogen and is a promising candidate for field evaluation to manage bean anthracnose.

Keywords: Anthracnose, *Colletotrichum lindemuthianum*, disease management, fungicidal inhibition, genotype screening

Screening of tropical maize inbred lines for disease resistance

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Abstract

Maize (*Zea mays* L.) is one of the world's leading cereal crops and is widely cultivated as a food and feed crop. Maize production in the country is constrained by various environmental, nutritional and biotic stresses. To overcome the limitations, the identification of disease-resistant maize germplasm is essential for developing high-yielding and disease-resilient hybrids. Therefore, the present study was conducted to evaluate tropical maize inbred lines for disease resistance and identify promising inbred lines for future breeding programs. A total of 29 tropical maize inbred lines were evaluated for disease incidence, severity and agronomic traits under field conditions. Diseased samples were collected for laboratory diagnosis and associated pathogens were identified through microscopic examination, blotter tests and culture on Potato Dextrose Agar (PDA) and Nutrient Agar (NA). The major diseases observed during field screening included Turicum leaf blight, Southern leaf blight, Stalk rot of maize, Rust, Downy mildew and other diseases. Study revealed that 26 inbred lines, namely Ag-0267, Ag-0268, Ag-0269, Ag-0270, Ag-0271, Ag-0272, Ag-0273, Ag-0274, Ag-0276, Ag-0277, Ag-0278, Ag-0279, Ag-0280, Ag-0281, Ag-0282, Ag-0283, Ag-0284, Ag-0286, Ag-0288, Ag-0289, Ag-0290, Ag-0291, Ag-0292, Ag-0293, Ag-0294 and Ag-0295 were identified as resistant to the diseases. The obtained resistant lines exhibited comparatively superior agronomic performance including higher pollen shedding, silking, plant height, ear height and grain yield. Among the lines, Ag-0275 was identified as moderately resistant and showed intermediate growth characteristics whereas Ag-0285 and Ag-0287 were classified as moderately susceptible and susceptible. The findings demonstrate substantial variation among the evaluated maize inbred lines in their responses to diseases and agronomic performance. The superior disease resistance and yield performance of the 26 resistant inbred lines likely reflect genetic variation in their ability to withstand the prevailing pathogen pressure while maintaining better growth and reproductive performance. The promising lines can therefore serve as valuable genetic resources for breeding disease-resistant, high-yielding maize hybrids.

Keywords: *Zea mays* L., inbred lines, disease resistance, genetic variation, agronomic traits

First report of giant redeye (*Gangara thyrsis*) as a pest of dwarf date palm (*Phoenix roebelenii*) and identification of its potential natural enemy

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Abstract

The dwarf date palm, *Phoenix roebelenii* (Arecaceae), is a widely planted ornamental plant grown both in indoors and outdoors. The Giant Redeye, *Gangara thyrsis* (Fabricius) (Lepidoptera: Hesperidae), is a palm-feeding skipper recorded from several Arecaceae, however till today no research was evidenced on the infestation of this insect in dwarf date palm. This study aims to document the nature of damage of Giant Redeye on ornamental dwarf date palm and records its natural enemy(s). Results revealed that larval damage occurs in two distinct ways: direct and indirect damages. Direct damage occurs by feeding initially, the ventral sides of leaflet tips toward the inner tissues and indirect damage occurs due to the rolling of leaflets by the mature larvae during pupation as a protective shelter. A larval parasitoid wasp belongs to Hymenoptera order also found to parasitize the Giant Redeye mature larvae. Future studies should focus on molecular identification of the pest and its natural enemy, as well as pest biology, the extent of damage on the host plant, and the parasitization efficiency of the natural enemy.

Keywords: *Phoenix roebelenii*, *Gangara thyrsis*, parasitoid, larval host plant, palm pest

Plant biodiversity and natural regeneration status of Itchari para village common forest, Khagrachari, Bangladesh

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Abstract

Village Common Forests (VCFs) are important community-managed forest ecosystems in the Chittagong Hill Tracts of Bangladesh, providing essential ecological, environmental, livelihood, medicinal, cultural and social benefits to local communities. However, increasing population pressure, illegal tree felling, overexploitation of forest resources, land-use changes and weakening of traditional management practices have contributed to forest degradation and biodiversity loss. Therefore, the present study was undertaken to document the floristic composition, tree diversity, natural regeneration status and indigenous management practices of Itchari Para VCF in Khagrachari Hill District, Bangladesh, with a view to supporting biodiversity conservation and sustainable community-based forest management. Field surveys were conducted using stratified random sampling. A total of 30 sample plots, each measuring 20 m × 20 m, were established to assess tree species diversity and quantitative vegetation characteristics, and 2 m × 2 m regeneration subplots were established at the centre of the sample plots to assess natural regeneration, considering seedlings with ≤2 cm DBH as regeneration. Floristic surveys and transect walks were conducted to record plant species, habitat and habit forms. Vegetation characteristics were analyzed using density, relative density, frequency, relative frequency, abundance, relative abundance and Importance Value Index (IVI). Shannon-Wiener, Simpson, Margalef and Pielou's evenness indices were used to assess biodiversity. The study recorded 128 plant species belonging to 55 families, comprising 80 tree, 13 shrub, 21 herb and 14 climber species. Euphorbiaceae was the most species-rich family with 13 species, followed by Moraceae with 11 species. Tree species diversity was relatively high, with Shannon-Wiener index 3.88, Simpson's diversity index 0.97, Margalef's richness index 10.20 and Pielou's evenness index 0.89. *Grewia nervosa* was the most dominant tree species, having the highest density (110 stems ha⁻¹) and IVI (13.23). Natural regeneration included 42 tree species from 23 families, with Shannon-Wiener index 3.38, Simpson's index 0.97, Margalef's index 6.13 and evenness 0.90. Regeneration occurred mainly through seed (89%), while 11% occurred through coppice. *Grewia nervosa*, *Mitragyna parvifolia* and *Protium serratum* showed particularly high regeneration importance. The findings demonstrate that Itchari Para VCF retains considerable plant diversity and natural regeneration potential. Strengthening community-based management, controlling illegal extraction, promoting assisted natural regeneration and maintaining traditional conservation practices are recommended for sustaining biodiversity and ecosystem services. The study provides useful baseline information for conservation planning, policy formulation and sustainable management of VCFs in the Chittagong Hill Tracts.

Keywords: Biodiversity, village common forest, floristic diversity, natural regeneration, Chittagong hill tracts.

Prevalence of leaf blight in different tomato genotypes and efficacy of chemical, botanical, biological and bio-products against the pathogens

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Abstract

Tomato (*Solanum lycopersicum* L.) is a nutritionally important fruit vegetable in Bangladesh, and most cultivars are highly susceptible to leaf blight, leading to the injudicious use of chemical fungicides, which threatens food safety. The experiments were conducted to investigate the prevalence of leaf blight in promising tomato lines, identifying the causal organism and alternative means of control other than chemical fungicides. Disease severity (%) and incidence (%) of leaf blight were collected from eight promising tomato genotypes (BARI-15, C-11, C-41, C-51, Kalo, Khoyari, WP-7, and WP-10). After conducting pathogenicity tests of the isolates, the morphological identification was done using a brightfield microscope (model: OPTIKA B10 with C-B10+ camera). The mycelial growth inhibition in PDA plates by commercial chemicals (e.g., Indofil, Cudenox, & Ridomil Gold MZ- at 0.2% and Score, Tilt, and Amistar Top- at 0.1%), Botanicals (e.g., Clove, Garlic, Ginger, Mint, Neem, Mahogany seeds, Lemongrass, and Akanda- all at 10%), Biological (e.g., *Trichoderma harzianum*; at 0.5%), and Bio-products (e.g., Chitosan; at 0.5%) were studied, and mycelium & conidia were subjected to microscopic study with trypan blue (0.06%) to know its effects on the pathogen. All of the tomato genotypes were susceptible to varying degrees (incidence: 80-100%, Severity: 3.99-29.15%), and the causal organisms were not limited to *Alternaria solani*, but

also caused by *Curvularia lunata*, confirmed by a pathogenicity test – possibly the first report from Bangladesh. The conidial length and width of *Alternaria solani* were 29.1- 141.9 μm (69.6 ± 28.1) and 6-20 μm (13.3 ± 2.8), while it was 17-29 μm (23.1 ± 2.7) and 7.1-12.1 μm (9.6 ± 0.9) for *Curvularia lunata*. Fungicides like Amistar Top, Score, Tilt, and Indofil were found to control more than 95% of mycelial growth, while botanicals like garlic and clove, and bio-products chitosan have a similar level of effect. The mechanism of control was destroying mycelial cell content, abnormal modifications like swelling, short-thickening, or long-thinning. Phenomena like hypertrophy, hyperplasia, tip rupture, cell burst, and decay were observed in conidia. Botanicals (clove and garlic @10%) and bio-products (chitosan @0.5%) have the same effects as chemical products for controlling leaf blight pathogens, are safer alternatives to chemical fungicides, and has potentiality for safe tomato production.

Keywords: Antagonism, inhibition, mechanism, management, genotypes, pathogens

Biology and management of *Stenchaetothrips biformis* Bagnall (thysanoptera: thripidae) using different insecticides under laboratory conditions

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Abstract

Rice thrips, *Stenchaetothrips biformis* (Bagnall, 1915) (Thysanoptera: Thripidae), is a major pest causing significant economic damage during seedling and early vegetative stages. An experiment was conducted in the Entomology Laboratory of HSTU, Dinajpur, Bangladesh, to determine the biology of *S. biformis* on three country bean (*Lablab purpureus*) varieties and evaluate the toxicity efficacy of five commercial pesticides: Thiamethoxam (Actara 25 WG) @ 0.04 g (T_5), Spinosad (Success 2.5 SC) @ 0.14 ml (T_2), Lufenuron (30%) + Emetectin Benzoate (10%) (Denim Fit 50 WDG) @ 0.02 g (T_4), Matril (Biotrin) @ 0.13 ml (T_3), and Hexythiazox (Mileage 10 EC) @ 0.1 ml (T_1) under controlled laboratory conditions ($25 \pm 1^\circ\text{C}$, $60 \pm 5\%$ RH, 16:8 h photoperiod). Developmental studies revealed that egg to adult period ranged from 14.46 days Kartika (Local Variety) to 16.93 days (IPSA Sheem-2). The second instar larval stage showed greatest variation (4.46 to 5.56 days across varieties). Sex ratio analysis revealed female biased populations: BARI Sheem-1 (53.3%), IPSA Sheem-2 (60.0%), and Kartika (Local Variety) (56.7%). In insecticides efficacy trials, average mortality percentages significantly differed among treatments ($P < 0.05$). T_5 achieved highest mortality (83.33%) with fastest lethal action ($LT_{50} = 18.30$ h), followed by T_2 (78.89%, $LT_{50} = 24.72$ h), T_4 (77.78%, $LT_{50} = 23.29$ h), T_3 (67.78%, $LT_{50} = 27.85$ h), and T_1 (43.33%, $LT_{50} = 60.45$ h). Mortality at 72 HAT showed T_2 achieving complete mortality (100%), while T_5 and T_4 reached 96.67%. Toxicity index values ranked treatments as $T_5 (9.51) > T_4 (7.47) > T_2 (4.54) > T_3 (2.96) > T_1 (2.88)$. The overall pesticidal toxicity ranking was $T_5 > T_4 > T_2 > T_3 > T_1$. T_5 (Actara 25 WG) and T_2 (Success 2.5 SC) demonstrated superior high mortality and rapid toxicity against *S. biformis* and can be recommended as primary components of integrated pest management (IPM) programs for rice thrips control. T_4 (Denim Fit 50 WDG) provides a viable rotation alternative with complementary modes of action to delay resistance development. Cultivation of IPSA Sheem-2 with extended development time (16.93 days) and higher female proportions (60%) may reduce population growth rates and pesticide application requirements when integrated with chemical management strategies for sustainable rice production.

Keywords: *Stenchaetothrips biformis*, *Lablab purpureus*, developmental period, mortality, LT_{50} , sex ratios, toxicity. Index

Toxicity and sub-lethal impacts of chlorantraniliprole on the demographic parameters of *Coccinella septempunctata* L. (Coleoptera: Coccinellidae)

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Abstract

Coccinella septempunctata L. (Coleoptera: Coccinellidae) is a key bio-control agent in agro-ecosystems, feeding on aphids and other soft-bodied insects. We investigated the toxicity and sublethal impacts of chlorantraniliprole on *C. septempunctata* under controlled conditions at $27 \pm 2^\circ\text{C}$, 65–70% RH, and a 16:8 h (L: D) photoperiod through age-stage, two-sex life table analysis. Our findings showed that chlorantraniliprole sublethal concentrations (LC_{10} : 4.56 mg a.i./L and LC_{30} : 14.84 mg a.i./L) caused significantly impaired development and reproduction. Sublethal exposure at LC_{10} and LC_{30} significantly extended larval (particularly second and fourth instars) and pupal development, while

adult longevity was significantly reduced. In contrast, adult and total pre-oviposition periods were not significantly affected. Fecundity declined markedly in a concentration-dependent way, resulting in significant reductions in key demographic parameters, including the intrinsic rate of increase (r_m), finite rate of increase (λ), and net reproductive rate (R_0), particularly at LC₃₀. Sublethal treatments also reduced age-stage reproductive value and life expectancy across developmental stages. These findings demonstrate that chlorantraniliprole, even at low concentrations; can disrupt the development, reproduction, and population growth of *C. septempunctata*, stressing the need for careful consideration of its use in integrated pest management programs.

Keywords: *Coccinella septempunctata*, Chlorantraniliprole, Demographic parameters, sublethal effects and Two-sex life table

Mushroom, a hidden component in Bangladesh: Taxonomy and molecular phylogeny

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Abstract

Mushrooms (predominantly belonging to the Basidiomycota) are vital to forest ecosystems, serve as human food, and contain novel compounds useful for drug discovery. Bangladesh, located in tropical South Asia, features widespread and scattered stands of *Shorea robusta* (family: Dipterocarpaceae), a tree known to form symbiotic associations with various fungi. Despite the ecological potential, mushroom-forming fungi in Bangladesh remain poorly understood. The study aimed to investigate the species diversity of *Amanita*, boletes, and related fungal groups in Bangladesh, as well as determine their global evolutionary relationships. Researchers conducted an extensive field survey during the rainy seasons from 2011 to 2022 across eight districts in Bangladesh, gathering over 800 samples from monodominant *S. robusta* stands. Species delimitation was documented using morphological data along with molecular approaches of the four genes (28S+*tefl*- α +*rpb1*+*rpb2*). The survey represented 18 species of boletes belonging to eight genera, 14 species of *Amanita*, and several unique species of other families. Amongst the boletes, two new genera, namely *Borofutus* and *Kaziboletus*, are reported as new to science. In conclusion, this is the first survey and systematics study of mushroom-forming fungi in Bangladesh. This work reveals a great diversity of boletes, *Amanita* and other groups of fungi in Bangladesh, and some of them are unique in their morphology and ecology. Their diversity, distribution, and evolutionary relationships will be addressed during the congress.

Keywords: *Amanita*, cryptic species, new genera, new species, tropical boletes.

Genetic diversity in red rice (*Oryza sativa* L.) landraces of Bangladesh

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Abstract

A study on genetic diversity based on 14 morphological traits with 50 red rice landraces was conducted at Bangladesh Rice Research Institute (BRRI), Gazipur during Aus season in 2024-2025. The 14 quantitative characters showed wide range of genetic variation among the landraces. The analysis of variance showed highly significant differences among the 50 landraces for all of the characters studied. Cluster analysis based on 14 quantitative traits grouped the 50 red rice landraces into five clusters (I to V). Cluster V was the largest and consisted of 17 red rice landraces mostly with the traits of average values. Most of the landraces (14) with lowest values of the traits were included in the cluster III. Landraces with higher values of yield and yield contributing characters like number of filled grains per panicle, grain length (mm), grain breadth (mm), days number for maturity and yield (g/hill) were included in the cluster I and cluster IV with the number of landraces of five and three, respectively. Principal component analysis revealed that three major dimensions could explain around 60% of the total variability, and mainly influenced by number of filled grains, thousand grain weight and grain breadth, respectively. Correlations analysis showed that yield (g/hill) had significant (***) positive correlations with days to maturity (0.76), filled grains number per panicle (0.70) and leaf width (0.56). Landraces Balam (Acc. 1674), Ashina (Acc. 1621), Kali Mughri (Acc. 1637) and Benaful (Acc. 529) were found promising genotypes for most of the traits including yield and yield contributing characters, these could be used in breeding programs for red rice development.

Keywords: Diversity, red rice (*Oryza sativa* L.) and germplasm

Climate resilient sugarcane genotypes under flood stress condition

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Abstract

Climate change has increased the occurrence of extreme weather events, making abiotic stresses such as flooding, water logging, drought and salinity challenges for sustainable crop production. Sugarcane (*Saccharum officinarum* L.), is an important industrial crops, particularly vulnerable to prolonged waterlogging, especially in flood-prone agricultural regions. Therefore, developing flood-tolerant sugarcane varieties with improved physiological resilience is essential to improve productivity and support climate-smart agricultural practices. The experiment conducted to evaluate the adaptive responses, physiological performance and yield stability of sugarcane genotypes under flood stress and to identify potential genetic resources for further breeding programs. During 2024–2025 cropping season, 20 sugarcane genotypes, comprising 19 BSRI-developed clones and one standard check variety (BSRI Akh 46) were evaluated through controlled pot experiments and natural flood conditions at Sirajganj and Lalpur, Natore. The field experiment was laid out in Randomized Complete Block Design (RCBD) with 3 replications. The genotypes from different Zonal Yield Trial (ZYT) stages (I, II, and III) were assessed based on important morphological, physiological and agronomic traits, including plant growth, leaf retention, root development, juice quality and cane yield performance. The evaluated clones showed considerable variation in their ability to tolerate flood stress, indicating differences in physiological adaptation and stress recovery capacity. Several genotypes maintained better vegetative growth, canopy persistence and yield performance under prolonged flooding conditions. In pot and field evaluations, clone I 49-17 & I 141-18 under ZYT-III provide higher percentage cane yield with other major parameters against flood stress condition. Similarly clones I 138-19 & I 190-19 under ZYT-II and clones I 8-20, I 39-20, and I 118-20 under ZYT-I exhibited better performance with major parameters. These findings suggested genetic variation in physiological resilience can be effectively utilized for developing climate-adaptive sugarcane varieties. The experiment highlights the importance of combining plant stress physiology with conventional breeding approaches to improve abiotic stress tolerance in sugarcane. Identification and utilization of flood-tolerant genotypes will help expand sugarcane cultivation in climate-vulnerable areas and reduce yield losses caused by unpredictable environment. This research contributes to climate-smart agriculture by promoting resilient sugarcane production through capable of sustaining productivity under future climate challenges.

Keywords: Sugarcane, flood stress, abiotic stress physiology, climate-smart agriculture

Phytochemical profiling and antioxidant potential of twenty native Bangladeshi medicinal plant species traditionally used against cardiovascular diseases

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Abstract

Cardiovascular diseases (CVDs), including coronary heart disease, stroke, and hypertension, are a leading cause of death globally, with over 20 million fatalities annually. Natural bioactive compounds such as flavonoids, polyphenols, and carotenoids from medicinal plants act as antioxidants and anti-inflammatory agents, helping to protect against and/or prevent CVDs. Traditionally, people in Bangladesh use parts of various native medicinal and aromatic plant species (MAPs) to treat CVDs. This study compared phytochemical profile and antioxidant potential of twenty MAPs of Bangladesh, viz. *Azadirachta indica* A.Juss., *Cynodon dactylon* (L.) Pers., *Aloe vera* (L.) Burm.f., *Andrographis paniculata* (Burm.f.) Wall. ex Nees, *Withania somnifera* (L.) Dunal, *Justicia adhatoda* L., *Camellia sinensis* (L.) Kuntze, *Centella asiatica* (L.) Urb., *Ocimum tenuiflorum* L., *Aegle marmelos* (L.) Corrêa, *Mangifera indica* L., *Cichorium intybus* L., *Mentha spicata* L., *Terminalia arjuna* (Roxb. ex DC.) Wight & Arn., *Bombax ceiba* L., *Cinnamomum verum* J.Presl and *Saraca asoca* (Roxb.) W.J.de Wilde, *Tinospora cordifolia* (Willd.) Hook.f. & Thomson, *Rauvolfia serpentina* (L.) Benth. ex Kurz, and *Asparagus racemosus* Willd., collected from the Botanical Garden of Bangladesh Agricultural University. This study used a completely randomized design (CRD) with three replications to measure various phytochemicals following standard protocols. The following parameters were measured: chlorophyll *a* (Chl *a*), chlorophyll *b* (Chl *b*), total chlorophyll (TChl), Chl *a*: Chl *b*, lycopene, lutein, β -carotene, total carotenoids, xanthophylls, relative chlorophyll content, anthocyanins, total phenolic content (TPC), total flavonoid content (TFC), total tannin content (TTC), and total antioxidant capacity (TAC). The species showed significant variation in phytochemicals. Among them, *C. dactylon* had the significantly highest Chl *a* (2.652 mg g⁻¹

FW), Chl *b* (1.028 mg g⁻¹ FW), TChl (3.726 mg g⁻¹ FW), lycopene (0.0235 mg g⁻¹ FW) and total carotenoids (0.0858 mg g⁻¹ FW), whereas *A. paniculata* contained the maximum amount of TAC (3.086 mg AAE g⁻¹ FW), β -carotene (0.0335 mg g⁻¹ FW), xanthophylls (180.83 mg g⁻¹ FW). Additionally, *C. verum* had the highest TPC (58.205 mg GAE g⁻¹ FW), and *M. indica* had the highest TFC (14.159 mg QE g⁻¹ FW). *C. sinensis* exhibited the highest TTC (39.06 mg GAE g⁻¹ FW) and anthocyanins (1.759 μ g g⁻¹ FW). This study demonstrates broad phytochemical diversity and antioxidant potential among MAPs, indicating strong future prospects for disease prevention and drug discovery.

Keywords: Ethnomedicine, pigments, total flavonoid content, total tannin content, total antioxidant capacity

Bioefficacy and fate of fipronil and its metabolites in Banglamati rice (BRRI Dhan 50) in Bangladesh

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Abstract

The bioefficacy and fate of Fipronil (Regent 50 SC) and its risk assessment for the safety of consumption Banglamati rice (BRRI Dhan 50) were studied. QuEChERS method was used for the extraction and cleanup of samples. The residues analysis of Fipronil and its metabolites were estimated using High-Performance Liquid Chromatography (HPLC) equipped with Photo Diode Array (PDA) detection system. The recovery experiment established the reliability and validity (LOD 0.015 mg.kg⁻¹ and LOQ 0.045 mg.kg⁻¹) of the developed method and its effectiveness (78.00-90.33%). The dissipation studies in Banglamati rice were carried out by application of Fipronil @ five different dosages i.e. 125, 250, 375, 500 and 625 ml. a.i. ha⁻¹, respectively. The bioefficacy of the different doses of fipronil was determined based on reduction of dead heart and white head infestation caused by yellow stem borer (YSB). Fipronil @ 250 ml. a.i. ha⁻¹ was found as the best effective dose for controlling YSB. Fipronil residue degraded below BDL at 40 DAT and 50 DAT when applied at the rate of 125 ml. a.i. ha⁻¹ and 250 ml. a.i. ha⁻¹, respectively. Complete (100%) degradation occurred for remaining higher doses at 60 DAT. More or less Similar trend of degradation was observed in case of its metabolites disulfonyl and sulfide. No sulfone and amide were detected. Half-life (T_{1/2}) of Fipronil in Banglamati rice were observed 18.14, 20.53, 22.60, 24.23 and 26.11 days, respectively @ 125, 250, 375, 500 and 625 ml. a.i. ha⁻¹, respectively. Considering the degradation pattern of fipronil in rice plant systems, the application interval would be 18 to 26 days. Theoretical maximum residues contribution (TMRC) was calculated and compared with maximum permissible intake (MPI) to evaluate the risk level of Fipronil in Banglamati rice. MPI was calculated to be 120 μ g. person⁻¹.day⁻¹ without any appreciable risk of life. The TMRC values reached the MPI at 40 DAT in Banglamati rice @ 125 ml. a.i. ha⁻¹ and at 50 DAT @ 250 ml. a.i. ha⁻¹ and remaining higher dosages. Therefore, the use of Fipronil at recommended dose and two times more recommended dosages does not seem to pose any hazards to the consumers after 50 days of application. However, a waiting period of 50 days might be suggested as pre-harvest interval (PHI) for Fipronil application. These data could provide guidance for the proper and safe use of this Fipronil on Banglamati rice in Bangladesh.

Keywords: Banglamati rice, bioefficacy, fipronil, half-life (t_{1/2}), risk assessment

Evaluation of composite beverages from roselle-calyx with tea for physio-chemical traits as affected by different storage temperature and duration

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Abstract

In Bangladesh, very few published information exists on taste, physicochemical traits and storability of composite beverage prepared from 'Chukur'/Roselle (*Hibiscus sabdariffa* var. *sabdariffa* (L.) calyces and black tea. The study was conducted to prepare and evaluate composite beverages formulated from roselle calyces and black tea, with particular emphasis on sensory acceptability, phytochemical composition, and storage stability under varied temperature and duration. The specific objectives were to evaluate the effects of three storage temperatures (4, and -4 & ambient, av. 25°C) and five storage durations (0, 15, 30, 60 & 90 days) on their physicochemical and sensory parameters. Following standard protocol, Roselle plants were cultivated; calyces were harvested at physiological

maturity, sun-dried, and processed into flakes (small pieces) prior to mixing with orthodox black tea. Sensory evaluation was conducted with 60 respondents. Five composite roselle beverage formulations viz., 100% roselle, 30% roselle + 70% tea, 50% roselle + 50% tea, 70% roselle + 30% tea, and 100% tea were assessed to identify the most acceptable blend. The selected formulation (70% roselle + 30% tea), along with two controls (100% roselle and 100% tea), was subsequently stored at the three temperatures; ambient (av. 25°C), 4, and -4°C with five storage durations (0, 15, 30, 60 and 90 days) to evaluate storage stability of phytochemical profile. A two-factor experiment with CRD was conducted using 9 treatments (3 roselle-tea type x 3 temperature) with three replications. Data were analysed separately for each of the five storage durations. Phytochemical analyses included total antioxidant capacity (TAC), total phenolic content (TPC), total anthocyanin content (ANC), total flavonoid content (TFC), and total tannin content (TAN). In addition, pigment compositions such as chlorophylls, anthocyanin and carotene were also determined. Results revealed that among the composite formulations, the blend containing 70% roselle and 30% tea received the highest scores from the respondents for color, aroma and taste. Further, most of the phytochemical traits exhibited a gradual decline with increased storage duration, particularly under ambient conditions (av. 25°C). Conversely, lower storage temperatures, especially -4°C, were more effective in preserving antioxidant compounds, pigment stability, and sensory quality. The composite beverage demonstrated a fairly balanced phytochemical profile and improved overall acceptability compared with the single-component beverages. Overall, the results suggest that roselle-tea composite beverages possess favorable sensory and functional characteristics. Furthermore, low-temperature storage significantly enhances their physicochemical stability and shelf life, highlighting their potential for development as value-added functional beverages.

Keywords: Selection, composite tea (roselle-calyx plus tea), anthocyanins, sensory evaluation

Sensory evaluation of roselle calyx-drinks and roselle composite tea towards their introduction to Bangladesh Agricultural University

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Abstract

‘Chukur’/Roselle (*Hibiscus sabdariffa* var. *sabdariffa* L.) is a multipurpose annual sub-shrub and its stem-bark is used as alternative to bast fibre, leaves as vegetables and souring curry, seeds as animal feed, and most importantly anthocyanin rich fleshy calyx for preparing pickles, jam, jelly, beverages etc. In Bangladesh, no published information is available on sensory evaluation of Roselle calyx-drinks and Roselle composite tea (calyx + tea). The current investigation aimed at formulating of Roselle drinks and Roselle composite tea, and their consumer acceptability at Bangladesh Agricultural University. Following standard protocols, Roselle infusions were prepared using 3g dried roselle calyces (both red & green) boiled in 150 mL of water for 10 minutes. Four different types Roselle drinks; viz., Red roselle beverage unsweetened & unspicy, Green roselle beverage unsweetened & unspicy, Red roselle beverage sweetened & spicy, and Green roselle beverage sweetened & spicy were served to 60 semi-trained participants to evaluate colour, aroma & taste (Panel Test-1) of the drinks. In short, the infusions were named Red original, Green original, Red spicy and Green spicy, respectively. Majority of the participants liked Red original for brilliant colour, and both red and green spicy formulations for aroma and taste. In the panel test-2, five different types of composite roselle-tea formulations; i.e. 100% Roselle, 30% Roselle + 70% Tea, 50% Roselle + 50% Tea, 70% Roselle + 30% Tea, and 100% Tea; were evaluated for aroma, color and taste by 60 semi-trained panelists. Roselle calyces were broken into flakes (small pieces) and mixed with orthodox black tea. Majority of the participants liked the combination 70% Roselle + 30% Tea. This composite Roselle-tea was further evaluated under varied storage periods and temperatures in a separate experiment. Results summarize that Red Roselle calyx drinks prepared unsweetened and unspicy was preferred (panel test-1) while for composite roselle-tea, a combination of 70% Roselle calyx flakes mixed with 30% orthodox black tea excelled others formulations (panel test-2). This research suggests the potentiality of introducing Roselle calyx drinks alone and or mixing with black tea in Bangladesh Agricultural university area.

Keywords: Roselle calyx infusion, roselle calyx plus tea, organoleptic test

Development of active food packaging using Chitosan/Guar gum composites reinforced with carbon quantum dots derived from Satkora peel

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Abstract

There is a growing need for biodegradable and functional food packaging materials due to post-harvest losses of fruits and vegetables and the environmental stress caused by petroleum-based plastic packaging. In this study, an active food packaging film was developed by incorporating Carbon Quantum Dots (CQDs) synthesized from Satkora (*Citrus macroptera*) peel into a chitosan/guar gum (CS/GG) matrix. Simultaneously, the potential for more effective utilization of Satkora peel through a value-added application was explored. Satkora peel derived CQDs were prepared by the hydrothermal method and characterized via Fourier-transform infrared (FTIR) and photoluminescence (PL) spectroscopy. Subsequently, composite films were fabricated using the solution casting method with CQD loadings of 0, 1, 2, and 3 wt% and evaluated for their physicochemical, optical, mechanical, antioxidant, antibacterial, and biodegradation properties. Additionally, packaging performance was evaluated by storing fresh tomatoes at approximately $25 \pm 2^\circ\text{C}$ for 8 days. The incorporation of CQDs significantly improved various functional properties of the films. Tensile strength of the control film increased from 28.92 ± 1.50 MPa to 68.97 ± 1.04 MPa at 3% CQDs, while Young's modulus rose from 1.30 ± 0.05 MPa to 11.50 ± 0.30 MPa. The 3% CQD film demonstrated the ability to block $81.5 \pm 1.2\%$ of UV-A and $97.2 \pm 0.9\%$ of UV-B radiation. Furthermore, the DPPH radical-scavenging activity of the control film increased from $4.07 \pm 4.02\%$ to $53.24 \pm 0.79\%$ at 3% CQDs. The films also exhibited antibacterial activity against *Staphylococcus aureus* and *Escherichia coli*, with inhibition zones of 11.3 mm and 8.6 mm, respectively, at 3% CQDs. All films exhibited biodegradation during soil burial, with $32.98 \pm 1.15\%$ weight loss of the 3% CQD film after 14 days. In the tomato storage experiment, tomatoes wrapped in the 3% CQD film reduced weight loss to $2.54 \pm 0.09\%$, whereas unpackaged tomatoes lost $11.45 \pm 0.42\%$ of their weight and maintained lower color change and browning. Overall, the Satkora peel-derived CQD-reinforced CS/GG films demonstrated enhanced mechanical, optical, antioxidant, antibacterial, and food-preservation properties while maintaining biodegradability. Therefore, this composite film holds promise as a sustainable active food packaging material and represents an effective method for the value-added utilization of Satkora peels.

Keywords: Carbon quantum dots, Satkora peel, Chitosan, Guar gum, Active food packaging, Shelf-life extension

Agronomic performance and adaptability of zinc-enriched rice genotypes for boro (dry) season in Bangladesh

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Abstract

Bangladesh achieved self-sufficiency in producing food grains, but nutrition is still a burning issue as a lot of people suffering from malnutrition. Zinc biofortification of rice is an important approach for improving the micronutrient quality of rice-based diets while maintaining acceptable grain productivity. The present study evaluated the grain yield performance, environmental response, and adaptability of two zinc-enriched advanced rice genotypes, BR7831-59-1-1-4-5-1-9-P1 and BR7831-59-1-1-4-9-1-2-P3, using BRRI dhan28 as the check variety across 12 environments of Bangladesh during the Boro season. Grain yield varied considerably among locations and genotypes, indicating the presence of genotype $\times$ environment ($G \times E$) interaction. The overall mean grain yield was 5.49 t ha^{-1} , while BR7831-59-1-1-4-5-1-9-P1, BR7831-59-1-1-4-9-1-2-P3 and BRRI dhan28 produced mean yields of 5.62, 5.44 and 5.40 t ha^{-1} , respectively. BR7831-59-1-1-4-5-1-9-P1 recorded the highest yield at seven of the 12 locations and attained its maximum yield of 6.51 t ha^{-1} at Barishal. BR7831-59-1-1-4-9-1-2-P3 performed particularly well at Dinajpur and Sunamganj, whereas BRRI dhan28 showed comparatively high performance at Satkhira, Jashore, and Rangpur. Heatmap analysis clearly illustrated the differential responses of the genotypes across environments. AMMI analysis showed that IPCA1 and IPCA2 accounted for 74.47% and 25.53% of the $G \times E$ interaction variation, respectively, together explaining the observed interaction pattern. The results indicate both broad and location-

specific adaptation among the tested genotypes. Overall, BR7831-59-1-1-4-5-1-9-P1 combined the highest mean grain yield with relatively strong performance across diverse environments. Based on our evaluation and recommendation and following the national systems, the genotype BR7831-59-1-1-4-5-1-9-P1 was released in 2017 as zinc enriched rice variety named BRRI dhan84. The findings demonstrate the potential of zinc-biofortified rice to contribute to improved nutritional security while maintaining competitive agronomic performance.

Keywords: Zinc biofortification, grain yield, AMMI analysis, BRRI shan84

Roselle (*Hibiscus sabdariffa*) leaf processing, powder preparation and its potential utilization to foods in Bangladesh

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Abstract

‘Chukur’/Roselle (*Hibiscus sabdariffa* var. *sabdariffa* (L.)) is a multipurpose annual sub-shrub and its stem-bark is used as alternative to bast fibre, processed seeds as animal feed, and fleshy calyx for preparing pickles, jam, jelly, beverages. Most importantly, foliage and leaves rich in minerals and phytochemicals of health benefit and is used in vegetables & souring curry in hilly areas of Bangladesh, also in Thailand, Malaysia, Middle East, Viet Nam and African countries. Fresh twigs and leaves are used only during season but sun-drying and powdering and preserving in air tight container offer opportunities to use Roselle leaf in the off-season. To my knowledge, no published information is available in Bangladesh on fresh leaf powder production and its utilization as vegetables and souring curry and soup utilizing Red and Green Morphotypes of Roselle. In Red Morphotype, leaf, flower, stem are red while it is green in Green Morphotype. The current investigation was, therefore, conducted to investigate the protocol of powder preparation and its potential incorporation into the common vegetables, soup, snack & food. Fresh and healthy leaves were collected from the Roselle plot, Field Laboratory, Department of Crop Botany, BAU, Mymensingh. In red morphotypes, FOUR plants yield a number of 515.66 leaves that produces c. 1 kg fresh leaves (petiole 339 g + leaf lobes 661g). Roselle leaf powder yield (dry wt. basis) ranges 10.5-11.5% in Red and 15.8-21.85% in green morphotypes. Roselle leaf powder production protocol follows. Roselle leaves are harvested and washed in running tap water 3-4 times to removes dust and grit. Leaflets are separated from petiole, and are air dried 3-4 days in metallic tray under fan. Air-dried leaves are powdered using commercial blender and sieved through a mesh to separate coarse fibre and remnants of veins, if any. Roselle leaf powder prepared by the above protocol may be fortified during the preparation of common snacks (samucha, singara, puri, piyaji, chanachur etc.), food (pie, roti, paratha, pizza etc.), pastry (khurma, nimki, cake, biscuits etc.), beverages (tea, drinks, sherbet etc.) and herbal cure (pills, capsules, tablets etc.). Foods prepared using Roselle leaf powder would be enriched with minerals and phytochemicals present there including a little sour taste due to presence of trace organic acids. In conclusion, Roselle leaf powder production protocol appears, easy, cheaper and would have a great potentiality in fortifying our daily common vegetables, snacks, foods in Bangladesh and elsewhere.

Keywords: Red & green roselle, dm content, leaf powder, use in food

Moringa (*Moringa Oleifera*) and roselle (*Hibiscus sabdariffa*) leaf beverages protocol

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Abstract

Both ‘Sajna’/Moringa (*Moringa oleifera* Lam.) and ‘Chukur’/Roselle (*Hibiscus sabdariffa* var. *sabdariffa* (L.)) leaves rich in nutrients, vitamins, minerals and important phytochemicals of health benefit. Researches show that air dried fresh Moringa leaf powder is being widely sold as a superfood in the supermarket and could be used to fortify snack, food and beverages while Roselle fresh leaf powder has also potentiality of using in the varieties of foods and beverage as well. In spite of social, psychological and health benefit orthodox black tea contains caffeine while Moringa and Roselle leaf is reported free from caffeine. To my knowledge, no published information is available on Moringa and Roselle leaf-beverage (drinks) preparation protocol in laboratory scale like orthodox Tea in Bangladesh. The current investigation was, therefore, conducted to study the protocol of drink preparation from fresh foliage and leaves of Moringa and Roselle. Moringa and Roselle leaf beverage production protocol is as follows. Fresh and healthy leaves and twigs were collected from the plot/garden of Field Laboratory, Department of Crop Botany, BAU, Mymensingh. Both Moringa and Roselle healthy leaves were harvested and washed in running tap water 3-4 times

to removes dust and grit. Finally, the leaves were washed with distilled water. Leaflets/leaves are separated from rachis/petiole, and are air dried for 2-3 days in metallic tray under fan. Air-dried leaves are chopped and macerated to allow oxidation into the tissues to enhance aroma and colour. The chopped leaf is smashed using a low-speed blender to make crude paste. The paste is sundried and is ready as hot water infused beverage like black tea. This can be preserved into airtight container for future use. The dry matter content is 10-15% in air dried Roselle leaf-paste and 15-20% in that of Moringa. In short protocol for Roselle and Moringa leaf beverages production appears easy and cheaper, and may have impact to partly supplement caffeine rich black tea.

Keywords: Moringa & roselle, leaf-drink, preparation, dm content

Boosting brain health naturally through L-DOPA-enriched fava bean cultivation in Bangladesh

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Abstract

Fava bean contains L-DOPA (L-3,4-dihydroxyphenylalanine) that can cross the blood-brain barrier (BBB) and convert to dopamine, potentially aiding Parkinson's disease and mood disorders. In Bangladesh, two cultivated genotypes of fava bean (*Vicia faba* L.), namely Kalimotor (black & white), are well known. Being a winter crop, the supply of the beans is season-dependent. However, germination of fava beans that is available during all seasons appears to be an inexpensive and effective method for achieving desirable changes in nutritive crops. In this context, seed is one of the potential sources of L-DOPA from fava beans. Moreover, L-DOPA concentration is generally highest in young sprouts and seedlings—often 20-fold higher than in mature seeds—making them a powerful, sustainable, and accessible alternative to synthetic pharmaceutical treatments. Additionally, the germination of the seeds is easy and not season-dependent, and their ingestion does not cause any adverse digestive effects. Therefore, microgreens of fava bean may be an important vehicle for supplying L-DOPA continuously all year round. Keeping this point in mind, the present study is designed to quantify the L-DOPA content of fava bean seedlings (microgreens) along with total phenolic compounds (TPC) and total flavonoids (TF), as well as to analyze antioxidant (AA) activity *in vitro*. Accordingly, the local Kalimotor seeds were sown, and seedlings were harvested 15 days after emergence. The analyses were performed with UV-Vis spectrophotometry. The black seed fava bean showed the highest yields per plant: TPC (0.25 g plant⁻¹), TF (0.21 g plant⁻¹), and L-DOPA (0.37 g plant⁻¹). This variety also had the highest antioxidant (IC₅₀ = 87.68 µg mL⁻¹) activity. The information provided in this study could be valuable for the possible role of fava bean seedlings (microgreens), rich in L-DOPA, for the treatment of Parkinson's disease and also as a choice ingredient for functional foods or as a nutraceutical.

Keywords: Fava bean, L-DOPA, BBB, Parkinson's disease, mood disorders

Short-term preservation techniques of anthocyanin in pomegranate juice

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Abstract

Room temperature (~25°C) storage significantly accelerates the degradation of anthocyanins since it triggers first order degradation kinetics. The characteristic red color of pomegranate juice is due to flavylum cation of anthocyanins. This juice is very sensitive to pH, temperature, oxygen and losses its color during storage. Chemically, anthocyanins contain the A and B benzene rings, whereas the C ring is an oxygen-containing heterocyclic ring. During preservation, anthocyanins can undergo structural transformations involving the flavylum ion at C-ring system. This study investigated the spectral changes and stability of pomegranate originated juice anthocyanins. Three/Five juice samples were prepared, including an untreated control, ZnCl₂-treated juice, acidified (HCl) metabisulphite-treated juice, and corresponding samples stored for 5 days. Absorption spectra of the treated samples were scanned from 200 to 1100 nm using a UV-Vis spectrophotometer. Freshly prepared pomegranate juice showed an anthocyanin absorption maximum at 507 nm. ZnCl₂ treatment produced a hyperchromic effect with minimal wavelength shift (509nm), while the acidified (HCl) metabisulphite treatment showed the strongest hyperchromic effect (with a 5.7-fold increase in absorbance) and bathochromic shift (8–9 nm). After storage, the ZnCl₂-treated sample showed reduced pigment intensity, whereas the acidified sample retained stronger absorption with a slight

red shift. Overall, better short-term retention of anthocyanin spectral properties was observed under acidic conditions for the tested conditions.

Keywords: Anthocyanins, flavylum cation, hyperchromic effect, anthocyanin stability

Germination-induced changes in GABA, 2-acetyl-1-pyrroline, amylose and mineral composition of Bangladeshi high yielding rice cultivars

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Abstract

Rice germination can enhance bioactive compounds and modify grain nutritional composition, providing opportunities for the development of functional rice products. This study investigated the effects of pre-germination on γ -aminobutyric acid (GABA), 2-acetyl-1-pyrroline (2AP), apparent amylose content (AAC), and mineral composition of 16 high-yielding Bangladeshi rice cultivars. Brown rice of all cultivars was germinated at 37°C for 48 h, followed by controlled drying and sample preparation. GABA was quantified by LC-MS/MS, volatile compounds including 2AP by GC-MS, mineral elements by ICP-OES, and AAC using a standard colorimetric method. Germination markedly increased GABA concentrations in all cultivars, with fold increases ranging from 2.01 to 23.65. The highest GABA concentrations after germination were recorded in BRRI dhan70 (766.79 mg/100 g), BRRI dhan62 (585.51 mg/100 g), BRRI dhan46 (554.86 mg/100 g), BRRI dhan91 (521.74 mg/100 g), and BRRI dhan31 (514.78 mg/100 g). AAC remained comparatively stable after germination, suggesting limited alteration of this key grain-quality parameter. Aroma profiling identified BRRI dhan70 as having the highest 2AP concentration (142.07 ppb), followed by BRRI dhan34 (53.21 ppb). Germination generally reduced calcium, phosphorus, and zinc concentrations, whereas iron responses varied among cultivars. BRRI dhan84 showed comparatively high calcium retention and a balanced mineral profile. Overall, germination substantially enhanced GABA accumulation while maintaining AAC, although mineral responses were genotype-dependent. BRRI dhan70 and BRRI dhan84 emerged as promising cultivars for further development of GABA-enriched and nutritionally differentiated rice-based functional foods.

Keywords: Germination; γ -aminobutyric acid (GABA); pre-germinated brown rice; 2-acetyl-1-pyrroline (2ap); mineral composition

Postharvest mechanical impact stress alters tomato fruit physico-biochemical and nutritional quality, enabling multivariate identification of impact-tolerant varieties

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Abstract

Mechanical impact during postharvest handling is a major cause of quality loss and economic damage in tomato, yet varietal differences in susceptibility remain poorly characterized. This study evaluated fifteen tomato varieties harvested at the breaker stage under control and simulated mechanical dropping conditions, assessing physicochemical, biochemical, and nutritional quality attributes alongside multivariate approaches to identify impact-tolerant varieties. Mechanical dropping significantly increased bruising severity, pH, total antioxidant capacity, flavonoids, phenolics, and the TSS:TA ratio, while significantly reducing fruit firmness, respiration rate, potassium, calcium, sodium, carotenoids, lycopene, ascorbic acid, titratable acidity, and total soluble solids. These shifts reflect impact-induced stress metabolism and accelerated ripening-associated compositional changes in the fruit. Substantial varietal variation was observed in bruising susceptibility, firmness retention, and respiratory response, indicating differential mechanical resilience among varieties. Hierarchical clustering and principal component analysis resolved distinct trait-response groupings under control and dropped conditions, while multi-

trait genotype-ideotype distance index (MGIDI) analysis consistently identified BT9, together with BT6 and BT22, as the most favorable genotypes across both conditions, whereas BHT8 and BT21 emerged as comparatively resilient specifically under mechanical stress. These findings demonstrate that postharvest mechanical impact induces measurable, multi-dimensional deterioration in tomato fruit quality and that genotype selection can meaningfully mitigate impact-related losses. The identified impact-tolerant varieties represent promising candidates for breeding and postharvest handling programs aimed at minimizing mechanical damage-related losses, supporting more resilient tomato supply chains from harvest through distribution.

Keywords: Phytochemicals; internal deterioration; postharvest stability; MGIDI

Genotype -driven variation in phenology and yield of dragon fruit (*Selenicereus spp.*) under sub-tropical conditions of Bangladesh: Insights from a three year field study

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Abstract

Evaluating agro-morphological diversity and quantitative trait associations is critical for selecting high-yielding and superior-quality genotypes in fruit crop breeding programs. A three years study was conducted at Regional Horticulture Research Centre, Bangladesh Agricultural Research Institute, Shibpur, Narsingdi to evaluate the morphological variability and associations of quantitative morphological traits related to yield, with complex relationships among the traits of six dragon fruit genotypes (SC Nor-001, SC Nor-002, SC Nor-003, SC Nor-004, SC Nor-005, and SC Nor-006) collected from different locations of Bangladesh. A total of 26 quantitative traits related to cladode, flower, fruit and yield were recorded and analyzed. A considerable variations with a complex correlation were found across the genotypes regarding the studied traits. Among the traits, individual fruit weight (g) and pulp weight per fruit (g) ranged from 127 to 303.67 g and 74.33 to 231.67 g with mean value of 253.39 g and 183.00 g, respectively. Among the genotypes SC Nor-004 produced maximum number of fruits (21.33) with corresponding higher yield (47.01 t/ha). Conversely, higher Edible portion (72.33%) and %TSS (14.50%) was observed in SC Nor-001. Moreover, highest co-efficient of variation (%) was obtained for the peel weight (14.03%). Principal component analysis among the traits illustrated that the first PC (PC1) accounted for 49.41% of the variances, which implies a larger proportion of variables. The features that contributed to PC1 were number of calyces flower⁻¹ (CAL), number of petals flower⁻¹ (PET), number of flower to fruit settings (FFS), number of flowers pillar⁻¹ (FPP), canopy spreading N-S (CNS), flower length (FLL), number of fruits pillar⁻¹ (FrPP), yield pillar⁻¹ (YPP), and harvest duration (HD); whereas number of secondary cladodes pillar⁻¹ (SCP), number of flushes (FLU), anthesis duration (AD), fruit weight (FW), fruit breadth (FrB), pulp weight fruit⁻¹ (PW) and edible portion fruit⁻¹ (EP) contributed to the PC2. These suggested that there were significant differences among the dragon fruit genotypes in terms of agro-morphological characteristics. The findings of the current work also suggested that the high yielding genotype SC Nor-004 could be selected for commercial purpose and SC Nor-001 for sweetness.

Keywords: Dragon fruit, morphological variability, quantitative traits, genotype selection

Valorization of roasted jackfruit seed flour blended with jujube flour added cookies and its nutritional, functional, and sensory quality evaluation

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Abstract

This study evaluated the impact of substituting wheat flour with composite jackfruit seed flour (JSF) and jujube flour (JF) on the functional, chemical and organoleptic properties of cookies. Raw and roasted jackfruit seed flours and jujube flour were characterized for functional behavior, where roasting improved flour dispersibility (27.5%) and water-holding capacity (166.9%) compared to raw JSF. Four cookie formulations were prepared: a control (100%

wheat flour) and three composite treatments (T1: 30% Fresh JSF, T2: 30% Roasted JSF, T3: 15% Fresh JSF+ Roasted JSF), each enriched with 5% jujube flour. Proximate analysis revealed that substituting wheat flour significantly increased ($P < 0.05$) ash and crude fiber content of T3, while lowest fat, protein and moisture content observed in all treatments. Physical dimensions showed increased width and spread ratio of T3 accompanied by a darker, reddish-brown color profile driven by Maillard browning compared to others. Functional properties substantially boosted free radical scavenging activity of T2 demonstrating the highest antioxidant activity and elevated total soluble solids (Brix⁰). Sensory evaluation using a 9-point hedonic scale established T3 as the most preferred formulation scoring highest in overall acceptability (7.70) due to superior texture, appearance and taste. These findings highlight the potential of utilizing underutilized jackfruit seeds and jujube fruit to produce value-added, nutrient-dense and antioxidant-rich functional bakery products.

Keywords: Jackfruit seed flour, jujube flour, cookies, valorization, roasting

Fuzzy logic-based shelf-life prediction of Amrapali mango using post-harvest RGB colour tracking

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Abstract

Accurate prediction of the post-harvest shelf-life of Amrapali mango is essential for reducing spoilage losses, maximizing commercial value, and optimizing cold chain logistics. This study aimed to develop an RGB colour tracking and fuzzy logic-based model for predicting the shelf-life of Amrapali mango under controlled post-harvest storage conditions. The colour changes of 120 Amrapali mango fruits were monitored over eight measurement sessions for 14 days after harvest (DAH) using a Keyence CZ-V21 RGB Fiber Optic colour sensor. A Mamdani fuzzy inference system (FIS) was developed using 27 rules, trapezoidal membership functions, and two outputs: the Ripeness Index (RI) (0–100) and predicted remaining shelf-life (days). The performance of the shelf-life prediction model was evaluated by comparing the predicted values with the actual shelf-life determined through expert observation. The model achieved a mean absolute error (MAE) of 0.48 days, root mean square error (RMSE) of 0.61 days, and coefficient of determination (R^2) of 0.981. The classification accuracy across the four ripeness categories was 91.25%. These results demonstrate that longitudinal RGB colour tracking integrated with fuzzy logic inference can provide a reliable, non-destructive, and commercially deployable approach for real-time prediction of the shelf-life of Amrapali mango, with potential applications in post-harvest management and cold chain logistics.

Keywords: Amrapali mango, shelf-life prediction, RGB colour sensor, fuzzy logic, non-destructive

Post-harvest biochemical changes influencing jaggery quality in sugarcane clones: A pathway for sustainable sugarcane value addition

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Abstract

Jaggery (gur) production is a main value-added product of sugarcane that contributes significantly to rural livelihoods and traditional food systems. The quality of jaggery depends largely on the biochemical composition of sugarcane, especially sucrose, reducing sugar, fibre, pH level and maturity status. Therefore, to identify sugarcane genotypes compatible with biochemical properties is essential for improving jaggery quality and promoting sustainable sugarcane utilization. The present study was conducted to evaluate sugarcane clones based on maturity behaviour, biochemical changes and their suitability for jaggery production. During the 2024–2025 cropping season, nine sugarcane clones under ZYT-II and ZYT-III testing stages along with the standard variety BSRI Akh 46 were evaluated at Bangladesh Sugarcrop Research Institute (BSRI). The clones were analysed at regular intervals from September 2025 to March 2026 for important quality parameters, including Brix, pol percentage, reducing sugar, and fibre content. Jaggery was prepared through the traditional open pan boiling method without using chemical clarificants, and the physical and biochemical characteristics of the produced jaggery were assessed. Sucrose content of jaggery varied among genotypes, where I 138-19 recorded the highest sucrose content (81.25%), followed by I

190-19 (80.21%) and I 149-19 (76.45%), which were higher than the standard variety BSRI Akh 46 (72.91%) under ZYT-II test stages. The highest sucrose content of jaggery was observed from the standard variety BSRI Akh 46 (72.91%) then the clone I 141-18 (72.24%) followed by I 49-17 (71.94%), I 94-16 (70.51%) and lastly, I 75-18 (66.20%) under ZYT-III test stages. Some clones had comparatively lower reducing sugar content, which is considered suitable for better jaggery quality. Based on overall biochemical performance and recovery potential, clones I 190-19, I 70-19, I 138-19, I 141-18 and I 94-16 showed better suitability for jaggery production. The result showed that post-harvest biochemical characteristics play an important role in determining jaggery quality. This study provides useful information for future sugarcane improvement programmes aimed at developing varieties specifically suitable for quality jaggery production.

Keywords: Sugarcane, jaggery, sucrose, reducing sugar

Utilization of dragon fruit peel powder as a functional ingredient in crackers: Effects on quality and sensory attributes

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Abstract

The valuable source of dietary fiber and bioactive phytochemicals, making dragon fruit peel as a promising functional ingredient for food applications. Its utilization in bakery products may enhance their nutritional and functional properties while simultaneously promoting the sustainable valorization of fruit-processing by-products and reducing food waste. Effects of incorporation at 0%, 3%, 6%, 9%, and 12% of dragon fruit peel powder (DFPP) on the physicochemical properties, bioactive constituents, antioxidant activity, FTIR spectra, and sensory acceptability of crackers were investigated in this study. Laboratory analyses were done to evaluate proximate composition, color parameters, DPPH radical scavenging activity, total phenolic content (TPC), total flavonoid content (TFC), FTIR spectra, and sensory attributes. Increasing DFPP incorporation reduced moisture from $6.37 \pm 0.02\%$ to $5.07 \pm 0.02\%$, protein content decreased from $8.71 \pm 0.01\%$ to $8.29 \pm 0.01\%$, fat content decreased from $17.87 \pm 0.02\%$ to $16.54 \pm 0.02\%$, while ash content increased from $0.66 \pm 0.01\%$ to $1.84 \pm 0.02\%$ and crude fiber content rose from $0.71 \pm 0.01\%$ to $1.66 \pm 0.01\%$ in the developed crackers. The incorporation of DFPP from 0% to 12% produced substantial modifications in color parameters, with L* value (lightness) declining from 73.18 to 46.92, a* value increasing from 5.29 to 16.30, and b* value decreasing from 27.00 to 21.08. The DPPH radical scavenging capacity of control crackers was minimal at $18.11 \pm 0.48\%$, whereas crackers formulated with the highest concentration (12% DFPP) demonstrated the maximum scavenging activity of $30.26 \pm 0.59\%$, with progressive enhancement observed across intermediate levels. The total phenolic content (TPC) and total flavonoid content (TFC) demonstrated substantial increases, ranging from 29.97 ± 0.67 mg GAE/100g to 293.08 ± 0.12 mg GAE/100g and from 11.84 ± 0.10 mg QE/100g to 153.78 ± 0.30 mg QE/100g, respectively. DFPP incorporation did not substantially modify the fundamental chemical composition of the cracker matrix as the Fourier Transform Infrared (FTIR) spectroscopic analysis indicated comparable spectral characteristics across all formulations. Among treatment groups, the sensory characteristics of DFPP-enriched crackers exhibited statistically significant differences ($p < 0.05$). The T₂ formulation reflected superior sensory preference because of the achievement of the highest ratings for color, taste, aroma, mouthfeel, appearance, and overall acceptability in this treatment. The most favorable sensory characteristics were observed in moderate DFPP incorporation particularly in T₂ (6% DFPP) formulation, whereas higher substitution levels enhanced fiber, phenolic, flavonoid, and antioxidant properties of the crackers. These findings indicate that promoting the effective utilization of fruit-processing by-products, DFPP can serve as a sustainable functional ingredient for the development of value-added crackers.

Keywords: Dragon fruit peel, *Hylocereus undatus*, crackers, functional food

Valuation of bioactive and antinutritional compounds in fenugreek seeds during sprouting

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Abstract

Fenugreek (*Trigonella foenum-graecum*) has a long history in culinary and medicinal use. Fenugreek seeds were collected from the local market in Bangladesh for quality assessment. Centrifugation and IPA (isopropyl alcohol) spirit precipitation were used to extract and purify galactomannan (soluble dietary fiber in the endosperm) from fenugreek seeds. Our approach effectively removed the majority of the galactomannan's debasements with a satisfactory final yield. The Molisch test indicated the presence of carbohydrates, but Fehling's test revealed the absence of reducing sugar. Galactomannan, is the polymer of galactose (α -1 $\rightarrow$ 6) and mannose β -(1 $\rightarrow$ 4) linkage and C=O is not free. The fenugreek seeds were germinated under dark conditions for 24 h, 48 h, 72 h, and 96 h. Raw and processed fenugreek seed flours were analyzed for bioactive compounds and anti-nutritional factors. Germination significantly ($P < 0.05$) enhanced total phenolic, flavonoid, and vitamin C content, and the antioxidant activity of fenugreek seed flour as compared to untreated raw fenugreek seed flour. All the parameters peaked after 96 h of germination. Germination of fenugreek seeds also decreased phytic acid content significantly ($P < 0.05$) as compared to raw seeds, and the highest reduction was observed after 96 h of germination. Therefore, the use of germinated fenugreek seed flour can be exploited in functional foods as well as a therapeutic agent regularly, as they improve the nutritional attributes and reduce the anti-nutrients.

Keywords: Fenugreek, germination, galactomannan, phytic acid, bioactive compounds

Development of taro starch/gum arabic based active packaging film enriched with neem leaf extract for food packaging

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Abstract

The proliferation of synthetic polymeric materials has created substantial environmental challenges, including bioaccumulation within trophic networks, ecological degradation, and the release of potentially harmful chemical compounds, adversely affecting human health and biodiversity. Consequently, the development of biodegradable polymeric films for food packaging applications has attracted considerable academic and commercial interest. This study investigated the effect of incorporating neem leaf extract (NLE) into a film-forming solution containing taro starch and gum arabic to enhance the functional properties of active packaging films. NLE was incorporated into the film-forming solution at different concentrations (0%, 1%, 2%, 3%, and 4% v/v). The physical, mechanical, antioxidant, and antimicrobial properties of the resulting films were evaluated. The incorporation of NLE affected the mechanical and physical properties of the films, with tensile strength ranging from 11.61 to 7.23 MPa, water solubility from 34.13% to 20.24%, moisture content from 35.89% to 32.11%, and elongation at break from 31.43% to 40.53%. The film containing 4% NLE exhibited enhanced color saturation, greater elongation at break, and improved antioxidant and antimicrobial activities compared with the control film. Furthermore, all films demonstrated complete biodegradability under the conditions evaluated. Overall, the incorporation of NLE, particularly at 4%, improved the functional properties of taro starch–gum arabic films, highlighting their potential for application as biodegradable active food packaging materials.

Keywords: Antimicrobial, composite films, biodegradable films, taro starch

Effects of drying methods on the grapefruit peel flour's physicochemical properties, functional characteristics and nutritive values

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Abstract

Grapefruit peel is a major citrus-processing by-product and frequently discarded despite of its richness in nutritive values and potential in bioactive compounds and antioxidant capacity. However, the quality attributes of the grapefruit peel-derived flour are strongly influenced by drying conditions. Therefore, this study aimed to evaluate the effects of four different drying methods on the physical attributes, functional properties, nutritive values, and antioxidant potential of a local pink variety grapefruit peel powder (GPP). Grapefruit peels were subjected to vacuum drying (VC), cabinet drying (CD), oven drying (OD), and microwave oven drying (MOD), followed by milling and characterization. The drying method substantially affected the functional and quality attributes of GPP. Vacuum-dried GPP exhibited the highest water-holding capacity (5.58 g/g), oil absorption capacity (2.77 g/g), and swelling capacity (8.82 mL/g). It also demonstrated favorable powder-flow behavior, with a Carr index of 8.13%, Hausner ratio of 1.08, and angle of repose of 28.48°. The water activity was as low as 0.10, indicating improved storage stability. Among the treatments, VD retained the highest levels of key bioactive compounds, including total phenolic content (66.35 mg GAE/100 g DW), total flavonoid content (36.80 mg QE/100 g DW), and tannin content (8.16 mg TAE/100 g DW), together with the highest DPPH radical-scavenging activity. Overall, vacuum drying provided the most favorable balance between functional performance, physicochemical stability, bioactive retention, antioxidant activity. The findings demonstrate that vacuum drying can facilitate the valorization of grapefruit peel as a functional, antioxidant-rich ingredient for value-added food applications while supporting agro-industrial waste reduction and sustainable food processing.

Keywords: Grapefruit peel, drying methods, nutritional quality, bioactive compounds, antioxidant activity

Valorization of immature dates (*Phoenix dactylifera* L.) for value-added food processing and reduction of post-harvest losses

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Abstract

Dates are an economically important fruit crop in many arid and semi-arid regions; however, immature fruits generated during thinning, harvesting, and production are frequently underutilized or discarded. This represents a considerable opportunity for post-harvest valorization through innovative food processing approaches. Immature dates contain carbohydrates, dietary fiber, minerals, phenolic compounds, and other bioactive constituents that may provide functional and nutritional value. The present study explores the potential of immature dates (*Phoenix dactylifera* L.) as a sustainable raw material for value-added food product development. The proposed approach involves characterization of physicochemical, nutritional, phytochemical, and antioxidant properties of immature dates followed by their incorporation into processed food products, particularly functional beverages. Processing conditions can be optimized to improve product stability, sensory acceptability, nutritional quality, and retention of bioactive compounds. The study also considers the influence of processing and storage on physicochemical characteristics and functional properties. Valorizing immature dates could reduce post-harvest losses while extending the utilization of seasonal fruit resources and creating additional economic opportunities for growers and food processors. Furthermore, converting an underutilized agricultural resource into stable, marketable food products supports resource efficiency and sustainable food processing. This approach demonstrates how post-harvest physiology and food processing can be integrated to minimize losses, enhance food value, and promote sustainable utilization of horticultural resources. Further work should focus on process optimization, shelf-life assessment, consumer acceptance, and techno-economic feasibility for potential commercial application.

Keywords: Immature dates; postharvest losses; food processing; valorization; functional foods; sustainable food systems

Physical properties of selected tea soils and their relationships with chemical properties and tea yield in Bangladesh

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Abstract

Soil condition plays an important role in sustaining tea production, particularly in plantations that remain under cultivation for many years. This study examined the physical and chemical characteristics of soils from selected tea estates located in the major tea-growing valleys of Sylhet and Chattogram, Bangladesh, and explored how these properties were associated with tea yield. Soil samples were collected from 34 tea estates during 2017–2022 from a depth of 0–23 cm. The analyses included soil texture, moisture content, bulk density, particle density, total porosity, water-holding capacity, pH, organic carbon, total nitrogen, and available phosphorus, potassium, calcium, and magnesium. The results showed clear differences in soil properties among the studied valleys. Soil texture ranged from sandy and sandy loam to sandy clay loam and clay loam. Bulk density varied from 1.60 to 1.85 g cm⁻³, while particle density ranged from 2.30 to 2.53 g cm⁻³. Total porosity varied between 23.06 and 33.14%, and water-holding capacity ranged from 53.00 to 70.00%. All of the studied soils were acidic, with pH values between 4.43 and 4.98. Organic carbon ranged from 1.02 to 1.29%, whereas total nitrogen ranged from 0.049 to 0.104%. Available phosphorus varied from 7.48 to 40.91 mg kg⁻¹, while available potassium ranged from 55.32 to 99.76 mg kg⁻¹. The correlation analysis showed significant positive relationships between clay content and total nitrogen, between organic carbon and total nitrogen, and between available calcium and magnesium. Tea yield also differed among valleys. Monu Doloi recorded the highest calculated yield, while Chattogram had the lowest. Water-holding capacity, soil pH, total nitrogen, and clay content were positively associated with tea yield, although these relationships were not statistically significant at $p < 0.05$. Overall, the findings show that the tea-growing soils of Bangladesh differ considerably in both physical condition and nutrient status. The results also provide useful baseline information for developing better soil and nutrient management practices for sustainable tea production.

Keywords: Soil physical properties, soil chemical properties, soil fertility, tea soil, tea yield

Morphological and quality assessment of drought-tolerant tea clones in Bangladesh

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Abstract

Morphological characters and liquor quality of selected 8 tea (*Camellia sinensis*) clones were compared in the nurseries of Chandpore tea estate and Nalua tea estate, Habiganj district and Tea Germplasm Center of Sylhet Agricultural University, Sylhet from 2021 to 2024. Single leaf stem cuttings of 8 selected tea clones from 6 tea estates were collected and raised in two nurseries. Growth performance of cuttings was recorded with environmental parameters. The highest survivability rate was observed in C4 (78%), while the highest mortality rate was recorded in C5 (62%). Under 70% field capacity, C21 showed the best results in leaf number (93), where C7 and C11 showed the best results in leaf length (12cm). C11 showed the best results in leaf breadth (5cm). The highest number of branches was recorded in C7 (16). Survivability studies of 8 selected tea clones with 02 check varieties (BT2, BT19) were conducted at controlled conditions (screen house) as well as at natural field conditions providing normal and supplementary watering with 03 replications. Treatment 1 was conducted with normal watering; 100% field capacity and Treatment 2 with supplementary watering; 70% field capacity. One of our main objectives was to evaluate drought tolerance of the tea clones where root performance played a vital role. Study of root was conducted from the initiation of root. C5 produced the highest root volume (132ml) where C19 had highest length of root (20.7cm). Data-logger was used to record the microclimatic data. In organoleptic taste, C7 was found as the best green tea producing clones among others.

Keywords: Tea, drought, morphology, liquor quality

Assessment of soil physical, chemical and biological properties of tea gardens

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Abstract

Land use intentionally shapes the soil biogeochemical properties that dictate soil health and long-term productivity. Tea is grown predominantly as a multi-decade monoculture. While tea production has drawn significant attention from estate owners, researchers, and policy stakeholders, the underlying soil health status under long-term tea cultivation remains understudied. This study aimed to assess the physical, chemical, and biological properties of soil under tea cultivation compared to fallow land. Soil samples were collected from seven tea gardens (SAU Campus, Lakkatorrah, Chanbagh, Habibnagar, Khan, Afifanagor, and Lala Khal) and one adjacent fallow land. From each site, three random soil samples were collected at two distinct depths (0–10 cm and 10–20 cm). Key parameters measured included soil texture, organic matter, pH, electrical conductivity (EC), total dissolved solids (TDS), soil respiration, and total bacterial count. Among the tea gardens, Chanbagh exhibited the highest sand content and acidity (pH 3.87), whereas Lala Khal hosted the highest bacterial load (6.97×10^{10} CFU). Habibnagar recorded the lowest water retention capacity (30.4–30.7%). Compared to the tea gardens, the fallow land possessed finer-textured soil with lower sand content (67.0% vs. an average of 77.6% in tea gardens) and approximately twice the silt content (14.3–14.8% vs. 7.8–8.5%), yielding a substantially higher field capacity (105.4% vs. ~41%). Chemically, both land uses were strongly acidic (pH ~4.3–4.4) with comparable EC, TDS, and organic matter levels (fallow: 4.06% in topsoil; tea gardens: 3.27% average). Biologically, soil respiration (3.28 vs. $2.76 \mu\text{g CO}_2 \text{ g}^{-1} \text{ h}^{-1}$) and bacterial counts (5.48×10^{10} vs. 4.46×10^{10} CFU) showed no statistically significant differences. Overall, soil health parameters varied widely across individual tea gardens, whereas land-use conversion from fallow to tea monoculture primarily altered textural properties, shifting topsoil toward sandier conditions, and reduced water retention capacity and organic matter levels.

Keywords: Tea garden, soil respiration, soil organic matter, bacterial population, Land use, soil properties

Biochemical and antimicrobial characterization of camellia oil comparative to olive oil

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Abstract

This study explores the comparative analysis of physiochemical properties and antimicrobial activity of tea seed oil extracted from seeds collected from the Sylhet region of Bangladesh and olive oil. The *Camellia* oil was extracted using Soxhlet apparatus, and various analyses were conducted to determine its total phenolic content (TPC), total flavonoid content (TFC), saponification value, antioxidant activity, vitamin A and D composition, fatty acid content. The values for olive oil was taken as references from extant literature. The antimicrobial activity of both olive oil and tea seed oil was determined using disc diffusion method by using gentamicin 10 as a positive control against *Salmonella*. The yield of the tea seed oil was 13.99%. The saponification value was 210.37 mg KOH/kg, TPC and TFC of tea seed oil were 322.91 mg/kg and 12.42 mg/kg respectively, whereas it was 106 and 276.6 mg/kg for olive oil, respectively. Free radical scavenging activity of 1, 1-diphenyl-2-picrylhydrazil (DPPH) was 63.67% for tea seed oil against 72.7% for olive oil. Vitamin A and D was 43.1 mg/kg and 46.58 ng/g for tea seed oil and it was minimal in olive oil. Fatty acid composition were similar for both type of oils, with tea seed oil being primarily composed of oleic acid (40.95%), linoleic acid (29.79%) and palmitic acid (22.37%) and olive oil being primarily composed of oleic acid (76.2%), linoleic acid (8.57%) and palmitic acid (10.23%). The antimicrobial activity of tea seed oil and olive oil was minimal with no zone of inhibition being formed against a positive control of gentamicin 10.

Keywords: Tea seed oil, olive oil, physiochemical properties, antimicrobial activity, *salmonella*

Effects of alkushi (*Mucuna pruriens*) and bhuikumra (*Ipomoea mauritiana* jacq.) on male fertility, reproductive hormones and serum metabolites in albino mice

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Abstract

Infertility is a major global reproductive health problem affecting approximately 10–15% of couples attempting to conceive, with male factors contributing to nearly 30–40% of infertility cases. The major causes of male reproductive dysfunction are decreased sperm production and quality, hormonal disturbances, environmental and lifestyle factors. There are several therapeutic approaches available with limited efficacy, which increases the interest in medicinal plants as potential natural agents to improve male reproductive health. *Mucuna pruriens* (velvet bean), locally called Alkushi, is a medicinal legume, which has L-3,4-dihydroxyphenylalanine (L-DOPA) as one of the major bioactive constituents in the seeds, apart from bufotenine, glutathione, gallic acid, β -sitosterol, fatty acids, squalene and ascorbic acid. These compounds may contribute to antioxidant defense, hormonal regulation and protection against oxidative damage to spermatozoa. *Ipomoea mauritiana* Jacq. (giant potato), locally called Bhuikumra, whose rhizomes contain alkaloids, flavonoids, tannins, saponins, steroids, terpenoids, β -sitosterol, taraxerol, taraxerol acetate, scopoletin and 7-O- β -D-glycopyranosyl scopoletin. In spite of their traditional uses and reported pharmacological properties, comparative experimental evidence remains limited. Therefore, this study was conducted to evaluate their effects on male fertility-related parameters, reproductive hormones and serum metabolites in albino mice. A total of 27 twenty-day-old male Swiss albino mice were randomly assigned to three groups: control (T1), Alkushi-treated (T2) and Bhuikumra-treated (T3), with three replicates and three mice per replicate. The treatment groups received 5% aqueous extracts prepared separately from powdered Alkushi seeds and Bhuikumra rhizomes, respectively, through drinking water for 30 days, while the control group received normal drinking water. Growth performance, hematological parameters, sperm count, testicular histopathology and serum biochemical parameters were evaluated. Serum testosterone levels, along with cholesterol, triglycerides, HDL, LDL, creatinine, SGPT and SGOT, were measured. The results showed that treatment with Alkushi and Bhuikumra produced favourable changes in reproductive and biochemical parameters compared with the control group. Testosterone increased from 2.10 ng/mL in controls to 3.25 and 2.95 ng/mL in Alkushi and Bhuikumra groups, respectively. Cholesterol decreased from 130 to 97 and 94 mg/dL, LDL from 64 to 42 and 37 mg/dL, and triglycerides from 123 to 90 and 92 mg/dL. HDL, Creatinine, SGPT and SGOT levels showed no statistically significant change following treatment. Increased sperm count and favourable testicular histological changes were also observed. The results in general showed positive effects of Alkushi and Bhuikumra on male reproductive, hormonal and serum biochemical parameters suggesting the possibility of their utilization as medicinal plant-based candidates for male reproductive health.

Keywords: *Mucuna pruriens*, *Ipomoea mauritiana*, male fertility, reproductive hormones, serum metabolites

Screening tea varieties for tea leaf spot disease caused by *Fusarium equiseti*

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Abstract

Tea (*Camellia sinensis*) is an economically important beverage crop that contributes significantly to the economy, employment generation and rural livelihoods. In Bangladesh, however, emerging fungal diseases threaten tea productivity, leaf quality, and biochemical composition. Therefore, identifying tolerant varieties and understanding pathogen-induced biochemical responses are essential for sustainable tea production. This study aimed to evaluate the varietal response of 21 BT-released tea varieties/genotypes against newly emerging leaf spot disease caused by *Fusarium equiseti* and to assess associated biochemical alterations in infected leaves. The tested varieties were evaluated under natural infection conditions based on disease severity, followed by analysis of antioxidant activity, total phenolic content, and total tannin content. Significant variation in disease response was observed among the evaluated varieties, with disease severity ranging from 29.99% to 49.77%. BT6 exhibited the lowest disease severity (29.99%), indicating comparatively higher tolerance, whereas BT21 showed the highest severity (49.77%),

indicating greater susceptibility. BT15 and BT18 also demonstrated higher disease development with severities of 46.11% and 44.44%, respectively. *F. equiseti* infection significantly reduced biochemical defense components, with antioxidant activity declining as indicated by an increased IC₅₀ value from 39.6 to 61.9 µg/mL. Total phenolic and tannin contents also decreased from 130.65 to 81.36 mg/g and 36.52 to 32.08 mg/g, respectively. The study demonstrates considerable genetic variation among tea varieties in response to *F. equiseti* infection. The lower disease severity and comparatively better biochemical performance of BT6 suggest its potential as a tolerant genetic resource for future breeding and integrated disease management programs. These findings provide valuable information for selecting resistant tea varieties and developing sustainable approaches for managing emerging leaf spot disease in tea cultivation in Bangladesh.

Keywords: Tea varieties, Disease reaction, Biochemical responses, *Fusarium equiseti*

Effect of pre-sowing seed treatments on seed germination and seedling growth of *Dimocarpus longan* lour

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Abstract

Dimocarpus longan Lour., commonly known as longan or kathlichu, is a subtropical evergreen fruit tree belonging to the family Sapindaceae with considerable nutritional, medicinal and economic importance. Its fruits are traditionally valued for stomachic, febrifuge, vermifuge and restorative properties and contain bioactive compounds such as flavonoids, polyphenols and vitamin C, which contribute to antioxidant and potential neuroprotective effects. However, propagation is often constrained by poor and irregular seed germination. The present study was conducted at the Bangladesh Forest Research Institute (BFRI), Chattogram, from July 2023 to June 2026 to evaluate the effects of different pre-sowing seed treatments on germination, seedling growth, vigor and subsequent field performance of *D. longan*. The experiment was laid out in a Completely Randomized Design (CRD) with seven treatments and three replications, using 50 seeds per replication. Treatments included soaking seeds in normal water for 12, 24 and 36 hours, soaking in hot water at 100°C for 10 and 20 seconds, scratching the seed coat on a cemented floor, and an untreated control. Germination was recorded at two-day intervals, while seedling growth parameters were evaluated under nursery conditions. Significant differences ($p \leq 0.05$) were observed among treatments. Seeds treated with hot water at 100°C for 10 seconds showed the highest germination (78%), with germination occurring between 16 and 28 days after sowing. This treatment also produced the highest seedling vigor index (1801.8), root length (8.7 cm), shoot length (14.4 cm), and number of leaves (12.3). In contrast, untreated seeds recorded the lowest germination (48%) and vigor index (960), with delayed and uneven germination. Hot-water treatment for 20 seconds and soaking in normal water for 24 hours also performed comparatively well but were less effective than the 10-second treatment. Further nursery evaluation showed satisfactory establishment and growth, with seedlings attaining an average height of 81.2 cm and 95% survival at 24 months. Field evaluation under different planting spacings indicated that 2.0m×2.0m spacing provided optimal growth, with seedlings reaching 92.95 cm height and approximately 90% survival after two years. Overall, hot-water treatment at 100°C for 10 seconds proved to be a simple, effective and practical technique for improving seed germination, seedling vigor, nursery establishment and field survival of *D. longan*. The technique can be recommended for efficient nursery propagation and large-scale plantation establishment of this economically and medicinally important tree species.

Keywords: *Dimocarpus longan*, seed germination, pre-sowing treatment, hot-water treatment, seedling vigor, planting spacing

From underutilized crop to functional food: Nutritional, metabolomic and bioactive profiling of buckwheat (*Fagopyrum esculentum* Moench)

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Abstract

Common buckwheat (*Fagopyrum esculentum* Moench) is an underutilized pseudocereal, but with great potential as a nutritious and health-promoting functional food. Its grains are naturally gluten-free and contain high-quality proteins, essential amino acids, minerals, antioxidants, and various bioactive compounds, including rutin, quercetin, and D-chiro-inositol. Despite these nutritive advantages, buckwheat remains relatively underutilized in Bangladesh. Therefore, the present study aimed to characterize locally available buckwheat germplasm and evaluate the nutritional, antioxidant, metabolomic, and bioactive properties of different buckwheat tissues and processed grain products to assess their potential for functional food development. Twenty common buckwheat landraces were cultivated at the research farm of Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur, Bangladesh, during the winter growing season. Superior landraces were identified based on morphological and physiological traits. Representative materials were subsequently processed into whole-grain powder, dehulled buckwheat groat powder, and cooked buckwheat groat powder (CBGP). Total antioxidant capacity, total phenolic content, total flavonoid content and DPPH radical-scavenging activity related to antioxidant properties were determined in buckwheat leaves and products derived from grain. Whole-grain samples were further subjected to amino-acid profiling, GC-MS, and LC-MS analyses, while LC-MS was also used to characterize bioactive metabolites in leaves, groats, and CBGP. The analyses validated that buckwheat has a nutritionally valuable amino-acid profile with notable lysine content. Metabolomic analyses showed the presence of important bioactive constituents including rutin and quercetin, essential fatty acids and other metabolites with potential health benefits. Antioxidant, phenolic, flavonoid, and DPPH analyses confirmed the presence of antioxidant-related bioactivity both in the buckwheat leaves and grain-derived products. Importantly, bioactive compounds were detected in whole grain, dehulled groats as well as cooked buckwheat groat powder which indicates the retention of nutritionally relevant phytochemicals after processing. However, integrative pan-cancer analysis of AKT1 (AKT Serine/Threonine Kinase 1) and structure-based drug designed indicated that buckwheat derived compounds have potential anticancer activities. AKT1 is a serine-threonine protein-kinase involved in tumour cell proliferation, survival, metabolism, and therapeutic resistance via activation of the PI3K/AKT/mTOR pathway. Overall, the results not only emphasize the nutritional and functional potential of the locally available buckwheat germplasm but also support the utilization of buckwheat leaves, whole grains, groats, and cooked groat products as promising raw materials for the development of value-added and gluten-free functional foods and discover the new drugs.

Keywords: Buckwheat, bioactive compounds, metabolomics, antioxidant activity, gluten-free, drug design

Clinicopathological, endocrinological and haemotobiochemical profile linked to reproductive potentialities in medicinal plant induced mice

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Abstract

The proposed study was carried out to evaluate the clinicopathological, endocrinological and haemotobiochemical profile linked to reproductive potentialities in medicinal plant induced mice. A total of 27 mice was acclimatized under relatively sound environmental conditions and categorized into three experimental groups (Group T₁: Untreated control, and T₂: Treated with a mixture of different medicinal plants, T₃: Treated with shimul only) (n=9 per group). The mice were euthanized for necropsy, haematological profile of testosterone and lipid, and for the testicular histomorphology. The datas were systematically recorded and organized for the statistical analysis. The

mice of T₂ and T₃ groups showed highly excitement with cutaneous biting injuries and fertility testing was done by offspring production. The cholesterol, triglyceride and LDL were significantly reduced in T₂ and T₃ groups but the level of HDL, SGOT, SGPT, serum creatinine levels were statistically insignificant among the groups. The testosterone level was significantly increased than that of T₁ group. There was none remarkable level of functional activity recorded in T₁ group but the great functional activity with histologically stratification of lining epithelia, stored spermatozoa at the luminal centres of the seminiferous tubules were well marked in both T₂ and T₃ groups. Behavioral sexual excitement, hypocholesterolemia, increased level of testosterone, functional histomorphological status of the testes and none undue health hazardous issues were closely indicative for the medicinal justifications of both shimul and mixture of different medicinal plants in the reproductive performances.

Keywords: Albino mice, lipid profile, shimul, testosterone, medicinal plant

Comparative evaluation of mixed-formulated medicinal plant powder and *Withania somnifera* (ashwagandha) on growth performance, blood biochemistry, and reproductive function in male albino mice

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Abstract

Medicinal plants have been used traditionally for medicinal purposes for a long time and are an important source of biologically active phytochemicals. However, the effectiveness and safety of many medicinal plant preparations remain insufficiently validated through controlled scientific studies. Infertility is a serious reproductive health problem affecting approximately 10–15% of couples worldwide, with male factors contributing to nearly 30–40% of infertility cases. Impaired spermatogenesis, hormonal disturbances, metabolic abnormalities, and oxidative stress are some of the important factors associated with male reproductive dysfunction. *Withania somnifera* (Ashwagandha) is a traditionally used medicinal plant known for its potential reproductive and metabolic benefits, mainly due to its bioactive withanolides. Similarly, mixed formulations containing multiple medicinal plants can offer diverse phytochemical effects. Nevertheless, comparative experimental evidence for their effects on reproduction remains limited. Therefore, the present study was conducted to comparatively evaluate the impacts of a mixed formulated medicinal plant powder (MFMPP), consisting of 16 medicinal plants, and *W. somnifera* on growth performance, feed conversion ratio (FCR), hematobiochemical parameters, serum testosterone concentration, and testicular histomorphology in male albino mice. A total of 27 male albino mice were randomly divided into 3 treatment groups (n = 9/group). The control group (T₁) received commercial pelleted feed (CPF) and water, whereas T₂ and T₃ received CPF supplemented with 5% aqueous extracts of MFMPP and *W. somnifera*, respectively, twice daily for 30 days. Body weight, feed intake, FCR, and mortality were recorded during the experimental period. At the end of treatment, serum total cholesterol, triglycerides (TG), HDL, LDL, SGPT, SGOT, creatinine, and testosterone were analyzed, and testicular tissues were examined histopathologically. Total cholesterol decreased from 143.33 mg/dL in T₁ to 103.33 and 96.66 mg/dL in T₂ and T₃, respectively. LDL decreased from 77.33 mg/dL to 44.33 and 30.33 mg/dL. Serum TG was also reduced in T₂ (121.33 mg/dL) and T₃ (119.00 mg/dL) compared to T₁ (141.66 mg/dL). Serum testosterone levels increased from 2.33 ng/L at T₁ to 4.40 ng/L at T₂ and 4.60 ng/L at T₃. Testicular histology revealed comparatively well-organized seminiferous tubules and good spermatogenic features in treated groups. There were no apparent adverse changes in SGPT, SGOT or creatinine. Overall, MFMPP and *W. somnifera* were associated with positive metabolic and reproductive alterations, suggesting beneficial effects on male reproductive health. Larger sample sizes, dose-response studies, longer treatment durations, and mechanistic studies are needed to prove their efficacy and safety.

Keywords: Medicinal plants, *Withania somnifera* (ashwagandha), male fertility, testosterone, hematobiochemical parameters, testicular histomorphology

Evaluation of growth, morphological traits and leaf yield potential of stevia genotypes

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Abstract

A field experiment was conducted at the Bangladesh Sugarcrop Research Institute (BSRI) Farm, Ishwardi, in May 2025 to evaluate growth, morphological traits and leaf yield performance of five stevia genotypes. The experiment was laid out in a randomized complete block design (RCBD) with three replications and the crop was maintained for 120 days. Data on plant height, number of primary branches, number of leaves, fresh leaf weight, dry leaf weight, and moisture content were recorded at harvest. Significant genotypic variation was observed for the measured traits. Stevia-1 produced the tallest plants (97.6 cm) and the highest number of primary branches (17.8 plant⁻¹), while BSRI Stevia-1 produced the maximum number of leaves (625 plant⁻¹). Stevia-2 recorded the highest fresh leaf weight (36.5 g plant⁻¹), followed by Stevia-1 (34.4 g plant⁻¹). However, Stevia-1 produced the highest dry leaf weight (17.0 g plant⁻¹), which was statistically comparable with BSRI Stevia-1 (16.6 g plant⁻¹). In contrast, Stevia-3 and Stevia-4 produced substantially lower dry leaf weights of 8.2g and 8.5 g plant⁻¹, respectively. Moisture content varied markedly among genotypes, ranging from 33.6% in BSRI Stevia-1 to 70.89% in Stevia-4. The comparatively high dry leaf production of Stevia-1 and BSRI Stevia-1, together with their favorable branching and leaf production characteristics, indicates their greater potential for commercial leaf production under the agro-climatic conditions of Ishwardi. These findings demonstrate considerable genetic variability among the evaluated stevia genotypes and provide a basis for selecting promising materials for further yield evaluation and varietal improvement.

Keywords: Stevia, phenotypic variability, germplasm and yield

Exploring micromorphology, yield and fruit quality of water caltrop (*Trapa spp.*) in Bangladesh

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Abstract

Water caltrop (*Trapa spp.*) is an underutilized, floating-leaved aquatic crop with potential for climate-resilient agriculture in flood-prone regions of Bangladesh. This study compared white- and red-pigmented genotypes collected from three representative wetlands, evaluating yield attributes, nutritional composition, and anatomical adaptations. Both genotypes exhibited broadly similar fruiting branches, fruit weight, and yield per plant, with Mokosh Beel consistently providing optimal environmental conditions for growth and productivity. Nutritional profiling revealed high moisture content (80–82%), moderate soluble solids (7.9–8.15%), sugars (4.95–5.50%), and protein (1.98–2.10%), highlighting the crop's potential as a sustainable starch source. Anatomical analyses indicated that the white genotype possessed larger vascular bundles, thicker palisade mesophyll, more extensive aerenchyma, and higher trichome density, suggesting superior adaptation for nutrient transport, photosynthesis, buoyancy, and stress tolerance. These findings underscore the ecological and functional diversity within *Trapa spp.*, supporting its promotion as a resilient crop in the context of climate change.

Keywords: Hydrophytic fruit, environmental adaptation, nutrition, anatomy, water caltrop

Introduction and cultivation of low-vicine faba bean (*Vicia faba* L.) for dietary favism risk reduction in Bangladesh

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Abstract

Favism is characterized by acute hemolytic anemia found in glucose-6 phosphate dehydrogenase (G6PD) deficient individuals after eating broad bean/faba beans and/or exposing to anti-malarial drug (quinone). Pythagoras first recognized the danger of broad bean/faba beans in the 5th century and he stated emphatically to his followers 'be far from the consumption of faba beans'. In the 20th century, medical doctors discovered that symptoms of favism appeared in the person who is lacking of G6PD during malaria treatment. After that underlying biochemical mechanisms of favism were figured out. Recently, sex-linked or X-linked inheritance of the G6PD gene was identified along with its variants and their geographic distribution. No drug is available to cure favism yet. Hence, prevention is better than cure for the management of favism. Considering food safety issue, favism-friendly diet plan is essential. Faba beans contain vicine that triggers hemolytic anemia in people with an inherited G6PD deficiency but this bean contains 30-35% dietary protein. The nutritional value of faba bean is nevertheless accompanied by a specific food-safety concern. However, the study is not a clinical trial and does not expose to G6PD-deficient individuals to faba beans. The present study therefore connects local and introduced faba beans, local agronomy, seed chemistry and nutrition, and food safety. The growth and yield of local and exotic faba beans were promising in the climatic condition of Bangladesh. Due to less number of seeds of exotic cultivars were available, we only used local varieties for chemical investigations. This study evaluated two locally sourced varieties, V1 (white) and V2 (black), at the Department of Crop Botany, Bangladesh Agricultural University, Mymensingh, sown on 24 November 2025. Morphological traits, seed proximate composition, phytochemicals, germination and vicine content were measured, and vicine was estimated spectrophotometrically. V1 had significantly greater shoot length, pod length and pod diameter than V2 ($p < 0.01$). Its estimated seed yield was 13.51 g per plant (3.76 t/ha) against 8.32 g per plant (2.16 t/ha) for V2, and it had higher crude protein (32.48% vs 26.42%), ash (4.6% vs 5.03%) and germination (86% vs 54%). Vicine content was similar in the two varieties (17.67 ± 0.95 and 18.27 ± 1.02 mg/g), and both were about three times higher than the reference seed (5.92 ± 1.21 mg/g). V1 is the better-performing local variety, but neither variety is low in vicine. The results support introducing and evaluating verified low-vicine genotypes as the main strategy against diet-induced favism in Bangladesh.

Keywords: Faba bean, vicine, favism, G6PD deficiency, Bangladesh

Does Contract Farming Improve Food Security? Causal Evidence from Bangladesh

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Abstract

In spite of the substantial advances in agricultural production, food security remains a key concern in smallholder farming household populations in developing countries. The effect of the participation of Boro rice farmers in the contract farming on food security of the rice producing households was explored through this study in Dinajpur District in Bangladesh. The study was about to understand if institutional linkage through contract arrangements has positive impacts on food access, dietary diversity, and livelihood conditions of the households. Primary data were gathered from Boro rice farmers and descriptive statistics, Household Food Insecurity Access Scale (HFIAS), Household Dietary Diversity Score (HDDS), Double-Hurdle Count Data Model and Marginal Treatment Effect (MTE) approach were used to estimate the determinants and causal impact of contract farming participation. The study examined the effect of socio-economic and institutional factors such as farm size, access to credit, extension service, involvement in cooperative and market information on the decision of the farmers participation. The results

offer lessons on the role of contract farming in mitigating market uncertainties, improving farmers' access to agricultural services, and supporting farmers' participation in organized value chains to enhance food security of rice producers' households. The study also has policy implications to encourage inclusive agricultural commercialization and sustainable rural development in Bangladesh.

Keywords: Agricultural production, food security, boro rice farmers, household dietary diversity score, contract farming

The effect of agronomic management on the maturity of black pepper

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Abstract

The maturity of the berry of Black pepper determines its phytochemical and spicy quality, which varies in different agro-climatological regions; thus, there is an illusion about flowering time and physiological maturity in Bangladesh, affecting harvest by the farmers of this racemose type of catkin. Moreover, changing physiological maturity (maximum dry matter deposition in fruits) by different agronomic management is a common phenomenon in crops. The study assessed the effect of different agronomic management on the maturity of black pepper. We tagged the black pepper inflorescence and investigated berry growth and development till ripening in twenty-four (24) regularly yielding plants, under two water management (Irrigation and non-irrigation during dry winter) and nutritional management (farmer's practice, well-decomposed cow dung, NPK and NPK + WDC) treatments. The regular bearing plants started to bear flowers with the onset of monsoon in the month of May (varies April-May based on the previous year's harvest) and may continue till June for full bearing. The growth of fruits from 11 weeks to 30 weeks shows a sharp increase in the dry matter accumulation after 18 weeks and a drop between 27 and 29 weeks, depending on the treatments. In the study period, the fresh weight per 100 seeds roughly doubled while dry weight per 100 seeds rose about 3-fold, with a %DM from about 20-22% to about 33-40%. The pattern suggests early growth due to mostly water and cell expansion, and dry matter amassed as seeds mature. The irrigation of the plants increased harvestable fruit (%recovery based on weight), while non-irrigation increased the %DM, which might be associated with limited moisture and higher dry matter in the same size, and might speed up early maturity. Non-irrigated and farmers' practice (control) had the highest dry weight and %DM, which was not much different from other nutritional management under this water regime, suggesting that under drought, the amendments did not influence dry matter more than the control.

Keywords: Physiological maturity, flowering, assimilates, agronomic management, spice

Plant based meat patties: formulation, processing, compositional analysis and quality evaluation

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Abstract

As global demand for nutritious, sustainable, and plant-based foods continues to accelerate, the valorization of underutilized agricultural by-products has emerged as a key focus in food science. This study evaluated the nutritional, functional, physicochemical, oxidative, and sensory properties of germinated jackfruit seed flour (GJSF) and assessed its suitability for hybrid and plant-based patties. Five distinct formulations were evaluated: T1 (100% beef + 0% GJSF), T2 (75% beef + 25% GJSF), T3 (50% beef + 50% GJSF), T4 (25% beef + 75% GJSF), and T5 (0% beef + 100% GJSF). Nutritional profiling revealed that GJSF contains 11.54 g/100 g protein, 75.96 g/100 g carbohydrates, 3.28 g/100 g dietary fiber, 2.37 g/100 g ash, 1.25 g/100 g fat, and 5.61% moisture. Qualitative GC-MS analysis confirmed the presence of valuable bioactive compounds, while functional characterization demonstrated superior water-holding capacity, swelling power, and gelation behavior. The inclusion of GJSF significantly influenced ($p < 0.05$) key physical and chemical attributes of the patties. Cooking loss decreased markedly from $44.74 \pm 3.67\%$ in the all-beef control (T1) to $14.76 \pm 1.67\%$ in the fully plant-based formulation (T5), indicating superior matrix retention during thermal processing. Additionally, GJSF exerted a clear antioxidant effect, reducing lipid oxidation from 0.27 ± 0.02 mg MDA/kg (T1) to 0.17 ± 0.02 mg MDA/kg (T5) as measured by TBARS

assay. T5 exhibited the highest dietary fiber content ($5.10 \pm 0.14\%$) and impressive potassium concentration (245.05 ± 1.30 mg/100 g uncooked and 253.50 ± 0.71 mg/100 g cooked). Sensory evaluation demonstrated that consumers favored T5 over all other treatments, awarding it the highest scores for color, flavor, taste, texture, and overall acceptability. Ultimately, formulation T5 proved to be the most promising candidate for developing nutritionally fortified, sensorially appealing plant-based patties. These findings demonstrate that germinated jackfruit seed flour serves as an effective, eco-friendly ingredient capable of elevating the functional quality and consumer acceptance of next-generation plant-based food.

Key words: Germinated jackfruit seed flour (GJSF), functional food, proximate composition, GC–MS, meat alternative

Low temperature management for the sustainable production of Sweet Pepper (*Capsicum annuum* L.) using polyhouse

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Abstract

A research was conducted during October 2022 to May 2023 to manage low temperature effect for sustainable production of sweet pepper (*Capsicum annuum* L.) using polyhouse. Two growing conditions (Polyhouse and open field) and four genotypes (Green bell, Lalima, Yolo Wonder, and purple beauty) were evaluated based on their morpho-physiological, biochemical characteristics and yield attributes at research field and laboratory of the Department of Crop Physiology and Ecology, HSTU, Dinajpur. The experiment was laid out in a Split Plot Design with three replications. Main plot treatment comprised of two growing conditions mentioned above and subplot treatment included four varieties of sweet pepper such as green, orange, red and yellow varieties. Polyhouse condition played a significant role on regulation of temperature and relative humidity (%) which ultimately control the production of sweet pepper. Result revealed that the poly house condition always showed better performance in production of sweet pepper than that of open field condition. All the varieties performed equally in terms of fruit yield. Lalima contained the maximum vitamin C (74.1mg/100ml) but the yellow variety contained the highest total carotenoid (30.48 μ /g). Poly house growing condition significantly influenced the yield and yield traits. Lalima with polyhouse field condition produced the highest yield (12.33 tha^{-1}) but the best market quality of fruit (fruit length-105.95 mm and diameter- 100.53 mm) was produced by green variety in poly house field condition which was statistically similar with red variety. Therefore, polyhouse field condition could be used for sweet pepper production at farmer's level as a low-cost sustainable technique.

Keywords: Sweet pepper, sustainable technique, polyhouse, low temperature