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GROWTH, YIELD AND ADAPTABILITY ASSESSMENT OF SPRING ONION (*ALLIUM FISTULOSUM*) IN SYLHET REGION

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Abstract

Three genotypes of spring onion (*Allium fistulosum*) were evaluated across a range of growth and quality criteria to ascertain their relative yield, quality performance and adaptability in Sylhet region. Results revealed that the tallest plant was BARI Pata Piyaz-1 with 56.78 cm, followed by JAF-2 (46.1 cm) and minimum value was recorded for JAF-1 (42.1 cm). The number of leaves per plant was the highest in JAF-2 (16.32) followed by BARI pata piaz-1 (11.56) and JAF-1 (7.32). The BARI pata piaz-1 had the highest pseudo stem diameter (1.43 cm), weight (5.81 g/pseudo stem), and dry matter (DW) content (13.19%), whereas the JAF-1 had 1.09, 4.32cm, 13.12%, and the JAF-2 had 1.11, 3.88 cm, 11.06%, respectively. Notably, JAF-2 produced the highest yield with a value of 11.34 ton/ha, which was considerably greater than BARI Pata Piyaz-1 (10.71 ton/ha) and JAF-1 (7.11 ton/ha). In terms of quality metrics, BARI Pata Piyaz-1 and JAF-2 had the identical total phenolic content ranging from 3.23-3.34 mg GAE/g DW, while JAF-1 had significantly less phenolics at 2.93 mg GAE/g DW. Significant amounts of flavonoids were detected in each genotype, ranging from 3.11 to 3.19 mg QE/g DW. The Vitamin C content of BARI Pata Piyaz-1 was significantly higher than that of other two genotypes. The current findings indicated that spring onion more specifically JAF-2 has successfully adapted in the Sylhet region with remarkable yield indicating tremendous scope in popularize this spice in future.

Keywords: Spring onion, Growth, Yield, Quality parameters, Adaptation

Introduction

Onions are one of the most important and widely grown vegetables and spices in the world (Mishra *et al.*, 2013; Eksi *et al.*, 2020). It is known for its unique flavor, and it is used in many dishes from different countries to make them taste better. In Bangladesh, it has become customary to use onion in nearly all prepared dishes, making onion the most popular spice (Rashid *et al.*, 2016). Therefore, in terms of both land area and total output, onion is the most valuable spice crop in Bangladesh (BBS, 2019). To satisfy its ever-increasing demand, Bangladesh imports more than 1 million tones of onion each year despite its substantial domestic production. Severe scarcity of onion has occurred during off season which are mostly fulfilled by import from neighboring country. Sometimes the price become beyond the limit of consumers. The government of Bangladesh wants to overcome such situation and agricultural scientists are trying to find alternatives to onions. To combat onion shortage in the country, spring onion (*Allium fistulosum* L.) can be a very good option as it has a similar taste profile. Green bunching onions, Japanese bunching onions, salad onions, and Welsh onions are also alternate names for spring onions (Kayat et al., 2021). The spring onion is perennial crop and believed to have originated in the Far East. It has been cultivated for generations in China and Japan and is currently cultivated in many regions across Europe, America, and Asia (Kuo and Ho, 1992; Yamasaki and Tsukazaki, 2022). Spring onion, unlike onion and shallot, has a small pseudobulb and is grown for its crisp green leaves (Wang *et al.*, 2020). Spring onion is an excellent source of vitamins (A, B6 and C), dietary fibers and minerals (calcium, potassium, copper, chromium, manganese, iron) (Memon *et al.*, 2020). Due to low cholesterol and low-calorie content (31 calories per 100g of fresh leaves), it can help prevent heart attacks and strokes (Suleria *et al.*, 2015). In addition, it has been reported that antioxidant potential of spring onion is more than that of onion (Aoyama and Yamamoto, 2007). Moreover, it can be grown year-round with less fertilizer and pesticide due to developed root system and less pest infestation compared to onion (Shikoli, 2022).

Despite its high food value and potential to grow in Bangladeshi climatic condition, growers and consumers know very little about this nutritious crop. Although the Bangladesh Agricultural Research Institute (BARI) developed BARI Pata piyaj-1, a spring onion variety, in 2014, its adaptability in diverse regions of Bangladesh, including Sylhet, has not yet been adequately examined. Sylhet is designated as a special agricultural zone in Bangladesh. Around twenty percent of

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the cultivable land is left fallow in the Sylhet region of Bangladesh; this percentage is higher than in any other part of the country (Ahmad, 2022). Therefore, assessing and adapting spring onions in the Sylhet region may be able to match the demand for onions in the domestic market, which would result in a significant reduction in the amount of money spent each year on onion imports. Considering these issues, the experiment was conducted to identify the best spring onion genotype in terms of yield and quality for Sylhet region.

Materials and Methods

Location and Plant materials

The experiment was carried out at the research field and laboratory of the Horticulture department, Sylhet Agricultural University, Sylhet, Bangladesh, from November 2022 to July 2023. Three spring onion genotypes—BARI Pata Piyaz-1, JAF-1, and JAF-2 were used to assess their growth and yield in the Sylhet region. The seeds of BARI Pata Piyaz-1 were obtained from the BARI regional station, Faridpur, Bangladesh. Seeds of other two Japanese genotypes, JAF-1 and JAF-2 were collected from Japan through the international seed agency.

The land was prepared by removing weeds, stubbles, and crop residues. It is widely acknowledged that most of the soil in the Sylhet region exhibits an acidic nature. Experimental field has been subjected to testing, revealing the presence of acidic soil along with other soil characteristics, which are succinctly presented in Table 1. Consequently, vermicompost and rice straw biochar were applied two months before to the commencement of the experiment in the field, at a rate of 6 tons/ha, corresponding to 432 g of each organic amendment per plot to neutralize the soil. It has been postulated that the incorporation of organic amendments can enhance soil quality, as indicated in Table 1. The experimental design employed in this study was a Randomized Complete Block Design (RCBD), consisting of three replications. The dimensions of the unit plot were 2 m by 1 m. Various organic fertilizers were also added in the plot, as indicated in the Table 2. During the initial land preparation, the complete amount of Triple Super Phosphate (TSP), Muriate of Potash (MoP), Gypsum, and one quarter of Nitrogen (N) were applied as the basal dose. The rest of the nitrogen was added at three separate times during the growing season. The seeds were planted on February 15, 2022, and the seedlings were cared for in the nursery. Forty days old healthy, diseases free and uniform seedlings were transplanted in the main field at a spacing of 25 cm x 20 cm. The heavy rains in the Sylhet region necessitated the use of polythene tunnels supported by bamboo sticks. The polytunnel had a central height of 6 feet, tapering to 5 feet on either side. Weeding, irrigation, and mulching were done as required. All other prescribed management protocols were duly adhered to for every individual plot.

Table 1: Soil properties before and after organic amendments (vermicompost and biochar)

Organic amendments	**Soil Properties**		
	pH	EC(µs/cm)	Organic Carbon(OC)
Before applying vermicomost and biochar	4.8	86.6	1.60
After two months of using vermiculite and biochar	6.1	268.8	2.22

Table 2 : Doses of inorganic fertilizer and organic amendments

Fertilizer and organic amendments	**Dose(Kg/ha)**	**Dose(g/Plot)**
Urea	250	36.0
TSP	275	39.6
MoP	150	21.6
Vermicompost	6 ton/ha	432
Rice Straw Biochar	6 ton/ha	432

Estimation of Morphological parameters

Since the leaves of spring onions are typically harvested after two months of transplanting, significant yield and quality attributes were documented 60 days after transplanting. The study assessed various characteristics that contribute to crop productivity, including the number of leaves per plant, plant height, tillers per hill, length, and diameter of pseudostem, weight of pseudostem and leaf, and yield.

Measurement of Quality attributes

The quantification of ascorbic acid content was conducted with slight modifications following the methodology outlined by Gao *et al.* (2022). The 100 mg of pure dry crystalline ascorbic acid was diluted to 100 ml with 4% oxalic acid to make the stock solution. A 10 ml stock solution was diluted to make the 100 ml standard solution with 4% oxalic acid. 5 ml of standard solution and 4% oxalic acid were pipetted into a conical flask and titrated against the dye solution. The following equation was used to determine the amount of ascorbic acid (mg) present in 100 g of sample.

Ascorbic acid(mg/100 g)= $(\frac{0.5}{V1}) \times (\frac{V2}{5}) \times (\frac{100}{Vs}) \times 100$
where V1, V2, and Vs stand for the volume of dye used, volume of dye, and volume of the homogenized leaf.

The measurement of total phenolic content and flavonoid content was conducted according to the methodology described by Ola-Mudathir *et al.*(2018). Total phenol content was determined using the oxidizing reagent folin ciocalteu's. 100 µL of each leaf extract (10 mg/mL) was added into different test tubes and Follin's reagent were pipetted into the test tubes. After incubating the test tubes at room temperature for 90 minutes, the absorbance was measured at 750 nm. The results were expressed as mg GAE/g dry weight (DW).
Total flavonoid content was measured based on the aluminium chloride colorimetric assay using quercetin as a standard. The total flavonoid in each leaf extract was determined as quercetin equivalents per gram extract (mg QE/g DW).

Data Analysis

The experiments were conducted with three repetitions, and the results were presented as the Standard Error of the Mean. The study employed a one-way analysis of variance (ANOVA) followed by Tukey's multiple comparison test in SPSS version 22 to determine if there existed a statistically significant difference among the samples. The statistical significance of the observed difference was assessed at a significance level of $p \leq 0.05$.

Results and Discussion

Assessment of genotypes against yield attributes

The maximum plant height was recorded in BARI Pata Piyaz-1 having 56.78 cm followed by JAF-2 (46.1 cm) and the minimum was recorded in JAF-2 (42.1 cm) JAF-2 (42.1 cm) (Fig. 1 and 2). Plant height is a genetic trait, and different lines/genotypes generate plants with varying heights based on their varietal traits. Uddin *et al.* (2014) also reported that during the initial harvesting phase, spring onion plants reach heights of 50 to 60 cm. The genotypes differ significantly in the number of tillers per hill.

Figure 1. Pictorial view of vegetative growth of spring onion genotypes (From left to right BARI Pata Piyaz-1, JAF-1 and JAF-2, respectively.

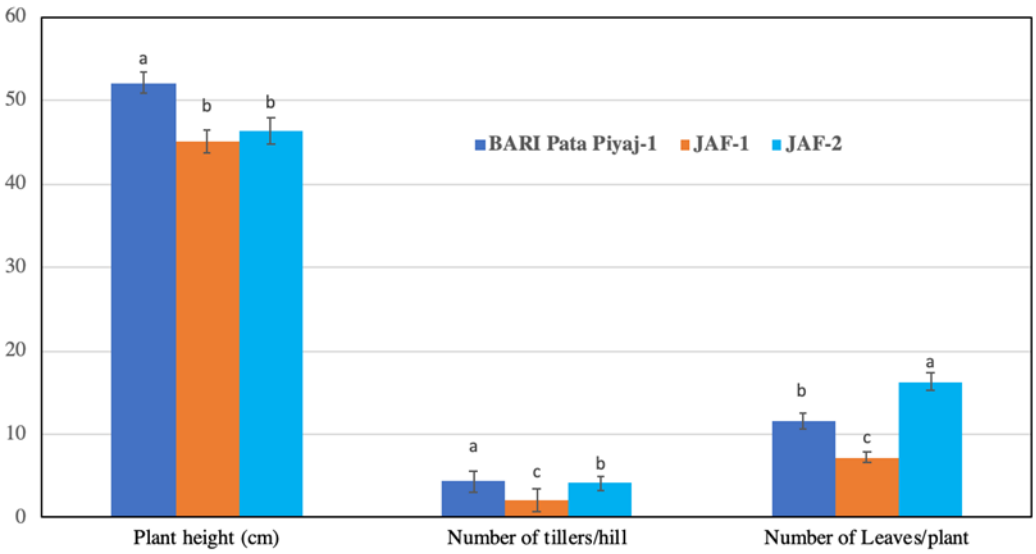

Figure 2: Variation among the spring onion genotypes on plant height, number of tillers/hill and number of leaves per plant. Vertical bars represent standard error of the mean. Different letters indicate significant differences according to Tukey's multiple range test ($p < 0.05$).

According to the figure 2, tiller number of BARI Pata Piyaz-1 and JAF-2 are identical with a value of 4.32 and 4.12, respectively whereas the number of tillers per hill was nearly half for JAF-1 genotype. The number of leaves also varied according to genotype differences. The highest number of leaves was found in JAF-2(16.32) while the lowest number of leaves was recorded for JAF-1(7.32). However, BARI pata piaz-1 produced 11.56 leaves per hill. Pseudostem length was the highest for BARI pata piaz-1(52.12 cm) which is statistically higher than JAF-1(45.19 cm) and JAF-2 (46.36 cm).

In case of other pseudostem characteristics, diameter of pseudostem (2.43 cm), weight of single pseudostem (5.81 g), dry matter content of pseudostem (13.19%) were observed the highest in the genotype of BARI pata piaz-1 followed by the genotype of JAF-1 with the values of 2.09, 4.32cm, 13.12 % and regarding JAF-2 the values were as 2.11, 3.88 cm, 11.06 %, respectively (Figure 3). However, leaf dry matter was found the highest in BARI Pata Piyaz-1 having 12.78% followed by JAF-1 (12.31%) and JAF-2 (11.08%). It is important to note that JAF-2 produced the highest yield with a value of 11.34 ton/ha which is significantly higher than BARI Pata Piyaz-1 (10.71) and JAF-1(7.11). The highest number of leaves per tiller might be contributed to produce the higher yield in JAF-2 genotypes though several growth parameters were lower than the BARI Pata Piyaz-1. Meanwhile, this feature can also be illustrated as the other factors those are also involved during the growing season, different lines/variety responded differently to input supply, culture method, and the prevailing environment (Jamal Uddin et al., 2014). Similar findings for onion were also reported by several other researchers (Gautam *et al*., 2019; Ratan *et al.*, 2017) who argued that the variation in different parameters under their studies among the genotypes might happen due to the differences in genetic makeup of the respective studied genotypes.

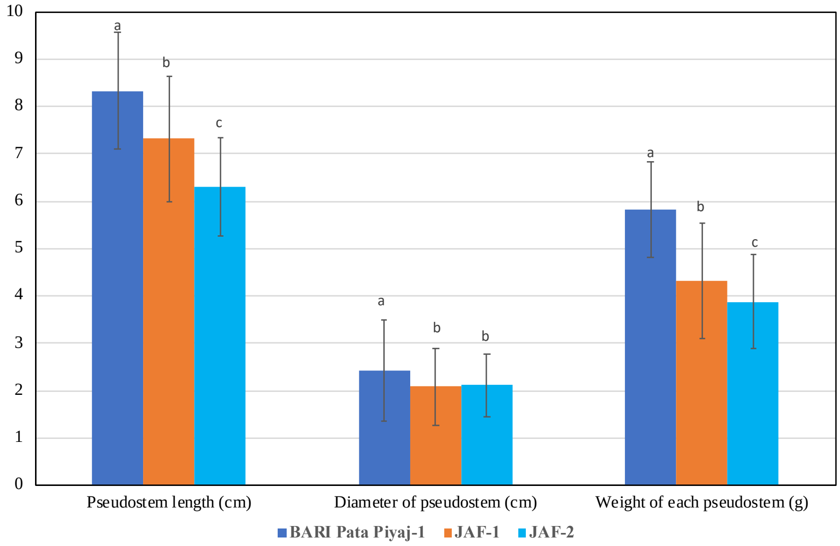

Figure 3: Performance of spring onion genotypes on pseudostem characteristics.

Vertical bars represents standard error of the mean. Different letters indicate significant differences according to Tukey's multiple range test ($p < 0.05$).

Assessment of genotypes against total phenol, flavonoids, and Vitamin C content

The total phenol, flavonoids, and vitamin C amount of each genotype are outlined in Table 3. Phenols include antioxidant qualities and play an essential part in the body's defensive system. It is widely acknowledged that green vegetables are rich source of phenolic compounds. Phenols improve the structure of the host cell, destabilize the structural integrity of pathogen membranes, and limit pathogen infection (Khanam et al., 2012; Tariq et al., 2019). In this investigation, the total phenolic content of BARI Pata Piyaz-1 (3.34 mg GAE/g DW) was identical to that of JAF-2 (3.23 mg GAE/g DW). But significantly lower content of phenolics were observed for JAF-1(2.93 mg GAE/g DW). The concentration of polyphenols in onion is affected by different factors such as genotypes, climate and soil microenvironment and fertilizer regime (Ren *et al*, 2017).

Table 3: Influence of genotypes on total phenol contents, total flavonoid contents and ascorbic acids.
In a column means having dissimilar letters differ significantly at 0.05 level of probability.

Genotypes	**TPC (mg GAE/g DW)**	**TFC (mg QE/g DW)**	**Ascorbic Acid Content (mg/100 g of FW)**
BARI Pata Piyaj-1	3.34 [a]	3.19 [a]	37.13 [a]
JAF-1	2.93 [b]	3.11 [a]	29.34 [c]
JAF-2	3.23 [a]	3.15 [a]	34.23 [b]
LSD (0.05)	1.033	0.61	0.98
CV%	3.50	3.63	5.57

Flavonoids are a broad and diversified class of polyphenolic chemicals that possess antioxidant properties. While the flavonoid content and composition profile clearly reflect the cultivar's genetic heritage, agronomic methods also influence how crops are composed when they are harvested. These molecules, which are known as nutraceutical chemicals, are significant for human nutrition and health due to their medical, pharmacological, and nutritional qualities in addition to their role in plant development and environmental adaptation (Pérez-Gregorio *et al.*, 2014). In several nations, onion has been identified as a key source of dietary flavonoids (Rodrigues *et al.*, 2017). In each genotype considerable amounts of flavonoids were recorded ranges from 3.11-3.19 mg QE/g DW (Table 3). However, the highest amount of flavonoids content was found in for BARI Pata Piyaz-1 followed by JAF-2. But there were no significant differences among the genotypes in terms of flavonoids content.

The vitamin C content was determined in fresh mass ranged from 29.34 mg/100 g FW (JAF-2) to 37.13 mg/100 g FW (BARI Pata Piyaz-1) (Table 3). Our results are in line with the result recorded by Jurgiel-Malecka *et al.,* 2015 who also found different amount of Vitamin C content in different onion varieties. It is interesting to note that Vitamin C content is much higher in BARI Pata Piyaz-1 compared to two Japanese lines which indicate local verities might have some potential to synthesize more ascorbic acid than exotic lines. Literature data on the concentration of ascorbic acid in several onion cultivars exhibited a wide range variation (Colina-Coca *et al.,* 2014).

Conclusion

The experimental results indicate that BARI Pata Piyaz-1 and JAF-2 genotypes exhibited significantly better yield compared to the JAF-1 genotype, despite variations in several growth metrics and quality attributes among these three genotypes. Considering all of the evidence, it can be concluded that BARI Pata Piyaz-1 and JAF-2 are well adopted in the Sylhet area and might have the possibility for commercialization.

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