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INTEGRATED NUTRIENT MANAGEMENT FOR SUSTAINABLE CULTIVATION OF BLACKGRAM (*Vinga mungo* L.) IN THE CHARLAND AREA OF CHAPAINAWABGANJ BANGLADESH

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Abstract

An experiment was conducted to study the effect of organic and inorganic fertilizers on the growth, yield, and yield components of blackgram in charland area of Chapainawabganj district. The experiment comprised of seven treatments viz. T_1: Control, T_2: 100% RFD (Recommended Fertilizer Dose), T_3: Cow dung (5 t/ha) + 100% RFD, T_4: Compost (3 t/ha) + 100% RFD, T_5: Vermicompost (3 t/ha) + 100% RFD, T_6: 1/3 Cow Dung + 1/3 Compost + 1/3 Vermicompost + 100% RFD, and T_7: Farmer's practice. The experiment was laid out in a randomized complete block design with three replications. Yield contributing characters of blackgram like number of clusters per plant, days to maturity, number of pods per plant, pod length, number of seeds per pod were significantly influenced by the different treatments. Results indicated that most yield contributing characters had the maximum values in treatment T_6 (1/3 Cow Dung + 1/3 Compost + 1/3 Vermicompost + 100% RFD). The highest grain yield of 13.06 q ha^{-1} was observed in treatment $T_{6,}$ and the lowest grain yield of 9.56 q ha^{-1} was in T_1 treatment. Application of cow dung, compost, vermicompost, and fertilizer at recommended dose had a significant and positive effect on the growth and yield of blackgram. Among the treatments, the application of cow dung, compost, vermicompost with chemical fertilizers was found to be the most effective practice for blackgram cultivation in charland area of Chapainawabganj district.

Keywords: Blackgram, Compost, Vermicompost, Inorganic fertilizer, Sustainable production.

Introduction

Blackgram (*Vigna mungo* L.) is a pulse crop that belongs to the family Leguminosae. It is the oldest and well-known principle pulse crop in Asia (Kokani *et al.*, 2014). Generally, it was originated from India, and the secondary origin was central Asia and extended from India to Myanmar (Tateishi, 1996). It is the most widely grown crop, and its cultivation is generally dominated in lowlands tropics, sub-tropics, and 1828 m above sea level (Singh *et al.*, 2017). This pulse crop has been cultivated for a long time in the Indian subcontinent, especially in Bangladesh. The total cultivated land under pulse crops are 885700 hectares and the total production of pulse in our country is 1005100 metric ton, which is less than the country's requirement (Biswas, 2020). Pulse cultivation covers 2.22% of the total cultivated land in Bangladesh (BRAC, 2016; BER; 2017BBS, 2019; Hajong *et al.*, 2020).

Pulses constitute an integral part of the human diet and a potential source of protein for the millions of people of Bangladesh. Pulses provide significant nutritional and health benefits and are known to reduce several non-communicable diseases such as colon cancer and cardiovascular diseases (Kumar *et al.*, 2020; Jukanti *et al.*, 2012). Blackgram is one of the highly prized pulses in Bangladesh. The dried seeds contain approximately 9.7% water, 23.4% protein, 1% fat, 57.3% carbohydrate, 3.8% fiber, and 4.8% ash. It is also used as green manure and cover crop or fodder crop and as a short-lived forage. It is mainly grown for human consumption, though widely used as fodder for cattle and green manuring crops to improve soil fertility (Niaz et al., 2013; Hamjah, 2014).

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Integrated Nutrient Management (INM) aims at maximizing the efficiency of plant nutrient supply to crops through the better association of organic and inorganic sources to ensure sustainable agricultural production. However, the sustainable agriculture practice is being hampered persistently due to the decreased soil fertility arising from the inappropriate and injudicious application of inorganic fertilizers in recent years. However, inorganic fertilizer is usually immediate and fast access to the plants because of containing all necessary nutrients which can be easily available to uptake. However, the continuous and imbalanced use of the chemical fertilizers under intensive cropping systems has been considered to be the main cause for declining crop yield and environmental degradation. Kumar (2019) and Chowdhury (2004) reported that the use of chemical fertilizer has undoubtedly enhanced the production of vegetable crops, but it is now causing serious concern about a decline in productivity due to deteriorating effects on soil's physical and chemical environments. Depletion of soil organic matter is considered one of the most serious threats to the sustainability of agriculture. Organic matter content in Bangladesh soil is very low and around one percent in most and two percent in few soils; whereas it should be maintained at least three percent that, is conducive to high crop productivity. The use of organic fertilizers and their proper management may reduce the need for chemical fertilizers allowing the small farmers to save on the cost of production (Tarafder, 2020).

Land in the char region of Bangladesh is not suitable for all types of crops. In Chapainawabganj, there are vast areas of Charland under AEZ-11 (High Ganges River Floodplain). Soil of charland is coarse textured having low water holding capacity, low nutrient and organic matter content. Farmers of charland in Chapainawabganj generally grow a local variety of blackgram with no or limited fertilizers. For this reason, the yield of blackgram in this region is much lower than that of potential yield. Balanced fertilization can play a major role in enhancing the present yield level. Experimental evidence reveal that the crop is highly responsive to different fertilizers, and its yield can be increased remarkably through judicious fertilization (Senthilvalavan, 2020; Chatterjee, 2020). Fertilizer recommendation solely based on crop response data often fails to show economic viability. In this context, reported that the response of yield should be supported by economic evaluation for judicious fertilizer recommendation. Therefore, judicious application of fertilizer along with economic evaluation is important for blackgram cultivation (Amruta, 2015; Anupama, 2012). Considering these contemporary researches, the current study was designed to screen out a suitable combination of chemical fertilizers and organic manures for sustainable blackgram production in the northern Ganges floodplain soils of Bangladesh.

Materials and Methods

Geographical location of study area

Chapainawabganj is the most western district of Bangladesh. It is situated between the latitude 24'22 to 24'57 and longitude 87'23 to 88'23 (Fig. 1).

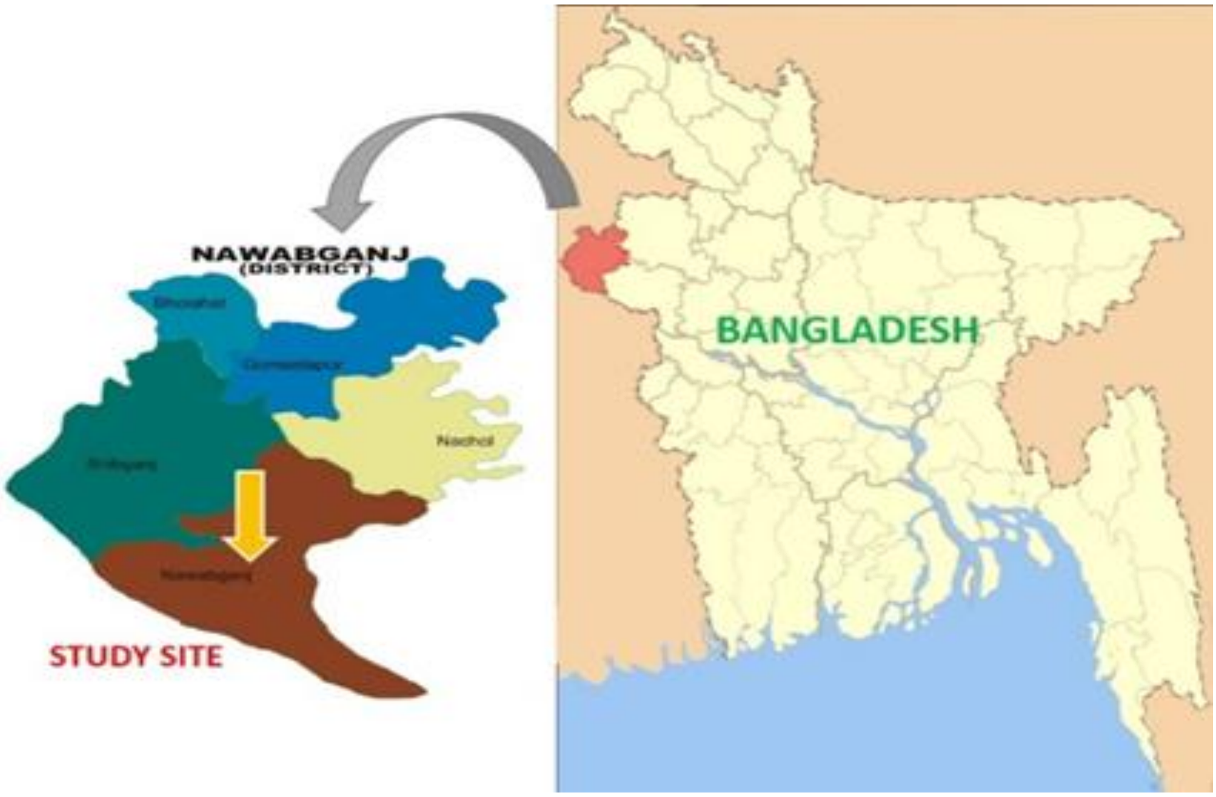

Fig. 1: Study area

Climatic condition

Chapainawabganj has a tropical wet and dry climate. The climate of Nawabganj is generally marked by monsoons, high temperature, considerable humidity, and moderate rainfall (Fig. 2).

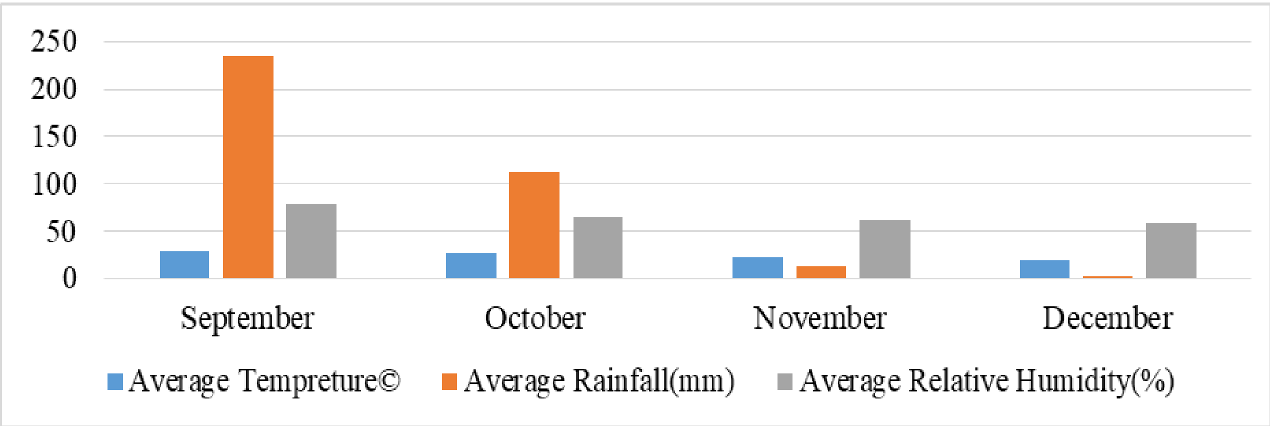

Fig. 2: Monthly recorded air temperature, rainfall, and relative humidity on the production of blackgram in Chapainawabganj during the experimental period (September-December, 2020).

Layout and treatments

The experiment was laid out in the Randomized Complete Block Design (RCBD) with three replications and consisted of 7 treatments (T). The unit plot size was 5 m X 4 m.

T_1= Control

T_2 = 100% RFD

T_3 = Cow dung (5 t/ha) + 100% RFD

T_4 = Compost (3 t/ha) + 100% RFD

T_5 = Vermicompost (3 t/ha) + 100% RFD

T_6 = 1/3 Cow dung + 1/3 Compost + 1/3 Vermicompost + 100% RFD

T_7 = Farmer’s Practice

Intercultural operations

Intercultural operations (Irrigation, weeding, mulching, pest management, fertilizer management) were done to ensure and maintain the normal growth of plants.

Procedure of recording plant data

Plant height (cm)

Plant height was measured in centimeters from the ground level to the tip of the longest stem, and the mean value was calculated. Plant height was recorded at 30 days after sowing (DAS), 60 DAS, and 85 DAS.

Number of leaves per plant

The number of leaves per plant was counted from 8 randomly selected plants at 30, 60, and 85 days DAS and their average were taken as the number of total leaves per plant.

Number of branches per plant

The number of branches per plant was counted from 8 randomly selected plants at harvest, and their average was taken as the number of total branches per plant.

Number of nodules per plant

Plants without nodules were included in the calculation of the *number of nodules per plant* shoot weight but not in the calculation of the average nodule diameter.

Days to flowering

Days to flowering was recorded from showing day to flowering day. From flowering to the pod development stage, there is a need for sufficient moisture in the field.

Days to maturity

Blackgram was mature when 70-80 % of pods matured , and most of the pods turned black. The date was recorded from seedling day to pods are mature from the plant.

Number of clusters per plant

The number of clusters per plant was counted from time to time.

Number of pods per plant

Diameter of all the marketable pods from each plot was measured at the middle portion with a slide caliper.

Pod length (cm)

Pod length was measured to the ten random pods from 10 sample plants and recorded to the average length from 10 pods.

Number of seeds per pod

The number of seeds from 10 random pods of 10 sample plants was recorded with the average number.

100 Seeds weight (g)

The seed weight was measured when the moisture was 8-13 %. The 100 seed was taken from 10 sample plants.

Processed seeds yield (t/ha)

The yield from the harvested area was measured when the moisture was 8-13 %.

RESULTS

Soil sample analysis

The soil samples were collected from 0 to 15 cm depth of the experimental plots. After collecting, the sample was prepared for laboratory analysis.

Table 1: Nutrient status of initial soil sample (0-15 cm depth) of experimental plots at charland area of Chapainawabganj

Soil properties	Values	Interpretation
Soil P^H	7.4	Slightly alkaline
Organic matter content (%)	0.78	Very low
Total N (%)	0.05	Very low
Available P (μgg-1 soil)	11.6	Low
Available S (μgg-1 soil)	9.3	Low
Available Zn (μgg-1 soil)	0.56	Low
Exchangeable K (meq %)	0.18	Medium
Soil Textural Class	-	Sandy Loam

Before sowing, initial soil samples (0-15 cm depth) were collected from the experimental plots and were analyzed. The analytical results indicated that soil was sandy loam with very low organic matter content (0.78%) and soil P^H (7.4) is slightly alkaline in nature. N content (0.05) of soil was very low, and P (11.6), S (9.3), and Zn content (0.56) were also low. K content (0.18) of the soil was medium (Table 1).

Plant data analysis

Plant vegetative parameters

Table 2: Plant vegetative parameters of blackgram under different nutrient management

Treatments	Plant height (cm)			Number of leaves per plant			Number of branches per plant		Number of nodules per plant
	30 DAS	60 DAS	85 DAS	30 DAS	60 DAS	85 DAS	30 DAS	60 DAS	
T_1	16.94	25.03	42.87	8.93	20.73	17.10	2.40	7.99	4.77
T_2	21.51	27.17	46.37	10.13	25.60	17.73	3.88	13.92	4.82
T_3	18.88	28.67	48.42	09.97	24.53	18.33	2.45	11.80	4.76
T_4	20.87	29.13	49.71	09.92	22.67	17.00	3.44	10.33	4.91
T_5	20.95	32.27	49.11	10.20	25.61	17.03	2.36	12.67	4.83
T_6	21.60	33.23	50.78	11.93	26.13	19.45	3.96	14.11	5.98
T_7	19.76	28.90	49.84	10.83	25.73	18.22	2.68	12.73	5.26
F test	*	**	*	*	*	*	-	*	*
S. Em±	0.867	0.754	1.092	0.338	0.705	0.407	0.40	1.23	0.02
C.D @ %	2.62	2.28	3.30	1.02	2.13	1.23	NS	3.72	0.04

Notes: DAS indicates Days After Sowing, CD: Critical Difference, SEm: Standard Error of Means, F-test: Statistical test, NS: Non-Significant, *: 5% Level of Significance, **: 1% Level of Significance

Plant height (cm)

Plant height of blackgram was recorded at three different intervals (30, 60, and 85 DAS), and the influence of organic and inorganic sources is depicted in (Table 2). The plant height observations recorded at 30, 60, and 85 DAS were significantly different among the treatments. The highest plant height at 30 DAS was recorded in T_6 (21.60 cm), and the lowest plant height was observed in T_1 (16.94 cm). At 60 DAS the highest plant height was also recorded in T_6 (33.23 cm), and the lowest plant height was recorded in T_1 (25.03 cm). Similarly, the highest plant height at the time of harvest (85 DAS) was recorded in T_6 (50.78 cm), and the lowest height was recorded in T_1 (42.87 cm). The maximum increase in plant height was observed in those plots treated with 1/3 Cow Dung + 1/3 Compost + 1/3 Vermicompost + 100% RFD. The possible reason for this could be because the growing pattern and increased seed rate that allows the plant to avoid interplant competition for nutrients (Rathore *et al.*, 2010). A sufficient amount of nutrients from the inorganic fertilizers as well as some from the organic fertilizers improves the cell activities, cell multiplication, and luxuriant growth of the plant, which could explain the increase in plant height of the crop (Thakur *et al.*, 2019). The reduction in the nitrogen at an early growing stage could reduce the rate of photosynthesis which could attribute in the reduction of plant height (Dwivedi, 2020). Similar findings were also reported by Singh *et al.*, (2011).

Number of leaves per plant

The effect of integrated nutrient management on number of leaves of blackgram was found to have no significant difference amongst the treatments at 30, 60 and 85 DAS at the time of harvest (Table 2). At 30 DAS the highest number of leaves were observed in T_6 (11.93), and the lowest number of leaves were observed in T_1 (8.93). At 60 DAS the lowest number of leaves was recorded in T_1 (20.73) and the highest number of leaves recorded in T_6 (26.13). At the time of harvest (85 DAS), the highest number of leaves was recorded in T6 (19.45), and the minimum number of leaves was observed in T_5 (17.03). The increase in number of leaves per plant was either observed in plots treated with 100 % RDF or plots treated with the combination of organic and inorganic fertilizers. Application of integrated nutrient management in a combined form improves the soil fertility level as well as nutrients which enable better root development and root nodules, allowing the plant to take up the nutrients with ease which might be the reason for an increase in the number of leaves (Rathore *et. al.*, 2010). A similar finding was also reported by Vadgave *et al.*, 2010.

Number of branches per plant

The highest number of branches per plant (at 30 DAS) was observed in T_6 (3.96), and the lowest number of branches per plant was observed in T_1 (2.40). At the time of harvest (60 DAS), the highest number of branches per plant recorded in T_6 (14.11), and the lowest number of branches per plant (7.99) was observed in T_1 (Table 2). The increase in number of branches could be possible because of the application of organic and inorganic fertilizers along with bio-fertilizers due to the enhancement of microbial activity in the rhizosphere, which enables the roots for the better uptake of nutrients. Similarly, the application of organic and inorganic fertilizers increases the overall growth attributes of the crop due to their synergistic effect (Jahan, 2020).

Number of nodules per plant

From table 2, it was observed that there was a statistical variation in number of nodules per plant due to different treatments. Results showed that the highest number of nodules per plant (5.98) was obtained from T_6 treatment. The lowest number of nodules per plant (4.76) was found from T_3 treatment.

The growth parameters of black gram i.e., plant height, number of leaves per plant, number of branches per plant, and number of nodules per plant, were significantly varied with different treatments. It was also reported that all growth parameters significantly increased with the increasing doses of 100% with RDF. Amongst all the treatments cow dung, compost and vermicompost with 100% of RFD gave the highest plant growth as compared to other treatments at different growth intervals. It was also reported that during these studies, the recommended doses of fertilizer were significantly higher in plant height at 50.78 cm, number of leaves per plant at 19.45, number of branches per plant at 14.11 at 60 DAS, and number of nodules per plant 5.98 at harvest over control when compared to other treatments.

Plant reproductive parameters

Table 3: Reproductive parameters of blackgram in different treatment combinations

Treatments	Days to flowering	Days to maturity	Number of clusters per plant	Number of pods per plant	Pod length (cm)	Number of seeds per pod	100 seed weight (g)	Processed seeds yield (Quintal/ha)

T_1	42.80	75.07	8.09	33.87	5.18	5.82	4.10	9.83
T_2	42.40	75.80	8.60	36.76	5.38	6.18	5.32	11.11
T_3	43.40	75.60	8.92	36.24	5.46	6.09	5.42	10.56
T_4	43.20	75.40	9.21	35.56	5.58	6.36	4.98	10.83
T_5	43.00	75.07	9.35	37.24	5.63	6.98	4.80	11.39
T_6	44.40	76.13	10.20	41.58	5.70	7.20	5.89	13.06
T_7	42.60	74.80	9.04	36.84	5.56	7.09	5.40	12.50
F test	*	*	**	*	*	*	**	*
S. Em±	0.06	0.13	0.20	0.15	0.10	0.12	0.07	0.06
C.D(P=0.05)	0.17	0.36	0.57	0.43	0.27	0.34	0.33	0.17

Notes: DAS indicates Days After Sowing, CD: Critical Difference, SEm: Standard Error of Means, F-test: Statistical test, *: 5% Level of Significance, **: 1% Level of Significance3.2.2.1 Days to flowering

From Table 3, it was observed that there was a statistical variation in the number of flowers per plant due to different treatment variations. Results showed that the highest days of flowering per plant was observed (44.40) from T_6 treatment. The lowest number of flowers per plant (42.40) was found from T_2 treatment.

Days to maturity

In (Table 3) the longest days of maturity were observed (76.13) in T_6 treatment. The minimum days of maturity observed (74.80) in T_7 treatment.

Number of clusters per plant

It was observed that there was a statistical variation in number of clusters per plant due to different treatment variations (Table 3). Results showed that the highest number of clusters per plant was obtained (10.20) from T_6 treatment. The lowest number of clusters per plant (8.09) was found from T_1 treatment.

Number of pods per plant

From Table 3, it was observed that there was a statistical variation in the number of pods per plant due to different treatment. Results showed the height number of pods per plant was obtained (41.58) from T_6 treatment. The lowest number of pods per plant (33.87) was found from T_1 treatment.

Pod length (cm)

Pod length was statistically influenced by levels of integrated nutrient management (Table 3). The highest pod length (5.70 cm) was found with T_6 treatment, and the lowest pod length (5.18 cm) was found with T_1 treatment.

Number of seeds per plant

From Table 3 it's observed the number of seeds pods per plant. The highest number of seeds pod per plant (7.20) was found with T_6 treatment, and the lowest number of seeds pod per plant (5.82) was found in T_1 treatment.

100 seeds weight (g)

The 100 seeds weight of 5.89g was recorded as the highest for T_6 treatment and a minimum of 4.10 g for T_1 treatment (Table 3). Blackgram varieties did not show any considerable difference for 100 seeds weight.

Processed seeds yield (q/ha)

Yield (q/ha) varied significantly due to the different levels of integrated nutrient management (Table 4). The highest yield (13.6 q/ha) was produced from T_6 treatment, and the minimum seed yield (9.83 q/ha) was found from the T_1 treatment.

Discussion

Significant differences were noticed in growth, seed yield, and yield attributing characters of blackgram with the application of inorganic fertilizers. Significantly highest plant height (50.78 cm), number of branches per plant (14.11), number of leaves per plant (26.13), number of nodules per plant (5.98) at harvest and days to maturity were recorded with an application of cow dung + compost + vermicompost + 100% RFD compared to other treatments. More number of branches, and leaves might be due to less intermodal elongation, and combined application of inorganic nutrients and vermicompost increase the use efficiency of added nutrients and supply it continuously to the plant throughout the crop growth period and promoted various physiological activities in the plant which are considered being indispensable for proper growth and development.

The highest number of nodules might be due to an increase in integrated nutrient management. Similar finding was reported by Vadgave (2010) in green gram, Dusica *et al.* (2011) in mung bean, and Anupama kumari *et al.* (2012) in field pea. The smaller number of days taken to flowering (42.40 days) was observed with the application of 100% RFD. Induction of early flowering due to the application of bio-fertilizers was mainly ascribed to the process of bioregulators which have an influence on early flower initiation. The results are in agreement with the findings of Mahesh *et al.* (2008) in soybean and Kathiravan *et al.* (2008) in lablab (*Hyacinth bean*). Application of cow dung + compost + vermicompost + 100% RFD ha^{-1} recorded significantly a greater number of clusters per plant, the number of pods per plant, pod weight per plant, pod length, number of seeds per pod, and processed seed yield (13.06 q/ha) as compared to other treatments combination. This might be due to enhanced vegetative growth and synergistic effect of combined use of bio fertilizers and inorganic manures. Similar results were reported by Divyavani (2020) and Dhage *et al.* (2010) in soybean. The processed seed yield was increased due to the influence of nitrogen, the chief constituent of protein, essential for protoplasm, which leads to cell division and cell enlargement given to the parent seed exerted a profound influence on seed filling and a relatively high percentage of well-filled seeds of the largest size. Similar results were reported by Vijaya (2007) in blackgram.

Conclusion

The results revealed that fertilizer packages exerted significant effect on the growth and yield of blackgrams. Blackgram grown with integrated nutrient management produced the highest yield and gave a high economic benefit to the charland area of Chapainawabganj district, Bangladesh. This study illustrates that those combinations of mixed fertilizers produced the best results on plant growth, fruit measurements, and yield. Combined applications of organic and inorganic sources of nutrients are more productive and sustain soil fertility. **The proper use of organic and**

inorganic fertilizers from different sources helps to maintain sustainability in quality production, maintain soil fertility, soil productivity and to ensure sustainable crop production.

Recommendation

Integrated use of 100% recommended fertilizers along with organic manures that improves the soil physical, chemical & biological properties. Adoption of this practice saves inorganic fertilizers and protects the environment from pollution.

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