INFLUENCE OF ORGANIC MANURE, PHOSPHORUS - POTASSIUM ON GROWTH, YIELD AND SEED QUALITY OF BLACKGRAM

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CERTIFICATE

*This is to certify that the thesis entitled **"INFLUENCE OF ORGANIC MANURE, PHOSPHORUS AND POTASSIUM ON GROWTH, YIELD AND SEED QUALITY OF BLACKGRAM"** submitted to the Institute of Seed Technology, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (M.S.)** in **SEED TECHNOLOGY,** embodies the results of a piece of bonafide research work carried out by **SHARMIN AKTER,** Registration No. **14-6000** under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.*

I further certify that such help or sources of information as has been availed of during the course of this investigation have been duly acknowledged.

Date: June, 2021
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Dedicated to My parents & teacher who laid the foundation of my success

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INFLUENCE OF ORGANIC MANURE, PHOSPHORUS - POTASSIUM ON GROWTH, YIELD AND SEED QUALITY OF BLACKGRAM

ABSTRACT

A pot experiment was conducted at the net house of the Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka during the period from April 2019 to August 2019 to investigate the growth, yield performance and seed quality of blackgram as influenced of organic manure, phosphorous and potassium. The experiment was laid out in two factors following Completely Randomized Design (CRD) with three replications. Factor A: Organic manure-3; viz. OM_0 = Control, OM_1 = Cowdung, OM_2 = poultry litter and Factor B: Chemical fertilizer-4; viz. F_0 = Control, F_1 = Recommended dose of chemical fertilizer, F_2 = 25% higher recommended dose of P+K fertilizer, F_3= 50% higher recommended dose of P+K fertilizer. The rate of urea-40kgha^{-1}, TSP-70 kgha^{-1} and mop-35 kgha^{-1} and the rate of cowdung and poultry litter were 10 and 5 t ha^{-1} respectively.The resuls revealed that effect of poultry litter (OM_2) showed its superiority by producing highest yield (1419.5 kg ha^{-1}), which may be attributed to higher blackgram pods plant^{-1} (23.81), seeds pod^{-1} (5.49), seed weight plant^{-1} (3.89), weight of 1000 seed (39.83 g) as well as highest pod length (5.11 cm), pod diameter (5.21 dm), plant height (49.68 cm), branches plant^{-1}(7.35) and dry weight plant^{-1} (36.94 g) in this treatment. On the other hand, 50% higher recommended dose of P+K fertilizer seems promising in blackgram cultivation as this treatment (F_3) gave the highest seed yield (1372.6 kg ha^{-1}) along with highest pod length (5.08 cm), pod diameter (5.19 dm), pods plant^{-1} (25.15), seeds pod^{-1} (5.44), seed weight plant^{-1}(4.09 g) and 1000 seed weight (39.49 g). Among the interactions, OM_2F_3 out yielded by producing highest yield (1529.4 kg ha^{-1}) than other interactions. This interactions also produced the tallest plant (53.17 cm), highest number of branches plant^{-1} (7.75) maximum dry weight plant^{-1} (40.51 g), pod length (5.4 cm), pod diameter (5.43 mm), pods plant^{-1} (29.65), seeds pod^{-1} (5.76), seed weight plant^{-1} (4.95g), 1000 seed weight (44.15 g), seed yield (1529.4 kg ha^{-1}), strover yield (1759.4 kg ha^{-1}), biological yield (3288.8 kg ha^{-1}), harvest index (46.60%), germination percentage (96.83%), seedling length (23.053cm), seedling dry weight (0.038 g) and lowest EC test value (1621.1 mS cm^{-1}). The study clearly indicated that poultry litter as organic manure and 50% higher recommended doses of P+K fertilizer and their interaction seem promising for producing maximum seed yield and the best quality seed of Blackgram.

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LIST OF ACRONYMS

Acronyms	Full word
AEZ	Ecological zone
BARI	Bangladesh Agricultural Research Institute
BBS	Bangladesh Bureau of Statistics
cm	Centimeter
CV	Coefficient of Variation
DAS	Days After Sowing
et al.	And others (*et alibi*)
FAO	Food and Agriculture organization
g	Gram
ha	Hectare
HI	Harvest Index
kg	Kilogram
kg ha^{-1}	kg per hectare
LSD	Least Significance Difference
m^2	Square Meter
MS	Master of Science
no.	Number
%	Percent
pH	Hydrogen ion concentration
$plant^{-1}$	per plant
SAU	Sher-e- Bangla Agricultural University
SMI	System of mustard intensification
SRDI	Soil Resources and Development Institute
tha^{-1}	Ton per hectare
CRD	Completely Randomized Design
Cont'd	continued
EC	Electric conductivity
INM	Integrated Nutrient Management
PM	Press Mud

CHAPTER I

INTRODUCTION

Blackgram (*Vigna mungo* L.) 2n=24 is a self-pollinated crop which grows up to 35 to 50 cm in height having yellow flowers with an auxiliary inflorescence, belongs to the family Fabaceae sub-family Papilionaceae. It ranks third among the pulses in Bangladesh with an area of about 98006 acres with production of 35151 Tons (BBS, 2016). It is a soil nourishing crop which fixes nitrogen from the atmosphere through symbiotic process. After the removal of pods, the green plants can be used as fodder. It is an oldest and welknown principle cultivating pulse crop of Asia (Kokani *et al.,* 2014). The crop is originated from India and secondary origin in Central Asia (Vavilov, 1951) extended from India to Myanmar (Tateishi, 1996) which later spreads throughout the Asia during trading spreads to other parts of the world as staple food grain legumes.It plays an important role the agroeconomy and human health of Bangladesh. This is a good source of proteins, vitamins and minerals. It is widely grown for its numerous uses.It contains 59% carbohydrate, 24% protein ,10% moisture, 4% mineral and 3% vitamins (Khan,1981; Kaul,1982). Since animals' proteins are costly and scarce in the developing countries, cultivation of food legumes is the best and quickest way to augment the production of food proteins. Pulses are the most important crops in Bangladesh because of its low-cost of production and highquality protein. They play a major role in providing a balanced protein component in the diet of the people. Pulses contain a higher level of quality protein, nearly three times as much as cereals; therefore, they are the cheapest and rich source of protein and essential amino acids and thus share a major protein of the vegetarian diet. As an excellent source of plant protein, it is cultivated extensively in the tropics and subtropics. Among pulses, blackgram (*Vigna mungo* L.), occupies an unique place for its use as vegetable, and it is grown both as pure and mixed crop along with maize, cotton, sorghum and other millets. It is a major component of the daily Bangladeshi diet and serves as a rich protein source (23.9%) besides, it also contains 60.4% carbohydrates. As per the World Health Organization, every man needs 80 g of pulses per day and every man needs minimum consumption of 47 g of protein per day to meet requirement of the body. But at present, the per capita availability of pulses is only 30~35 g/d. Besides, the crops enrich the soil fertility and soil health in terms of addition of nitrogen and organic matter. Therefore, there is a need for three-folds increase in pulse production as that of current production. Blackgram yield in our country is far below than the other country. The national production of the pulses is not adequate to meet our national demand. Domestic pulse production satisfies less than half of our countrymen demands. The yield of blackgram is poor as compared to many other legume crops (Wahab *et al*.,1981). There are many reasons of lower yield of black gram among them fertilizer management is very crucial regarding the growth and yield. Depending on the fertility status of the soil addition of adequate and balanced nutrient greatly can influence the growth, development and yield of this crop. Yet the nutrient requirement is relatively very low in pulse crop for its successive growth, development and production but their deficiency greatly affects the physiological and metabolic processes involved in the plant that causes drastic yield loss (Meena *et al.,* 2013). The low yield can be improved in various ways. Slow rate of dry matter accumulation during pre-flowering phase, on-set of leaf senescence during the period of pod development and low partitioning efficiency of assimilates to grain are identified as the main physiological constraints for increasing yield. Farmyard manure is known to play an important role in improving the fertility and capacity of soils through its positive effects on soil physical, volatility and biological properties and level of plant nutrition. Poultry manure can be efficiently used for the crops after composting the same to save the nutrients. (Amanullah *et al.,* 2003). Poultry manure/litter, an organic fertilizer, is known to be nutrient rich and is readily available at low costs in rural communities (Ragagnin *et al.,* 2013). Alabama Cooperative plants that collect poultry manure grew taller than other plants possibly more concentrated nutrients or minerals were made readily available and easily absorbable by the receiving plants leading to faster growth and development (Enujeke, 2013). Chemical fertilizer management like potassium and phosphorus is one of the important aspects. Phosphorus (P) fertilizer and potash (K) fertilizers have great effects on growth and yield of black gram. P fertilizers stimulate disease resistance and improve the water and nutrient absorption in the seedling stage. Phosphorus helps in proper root development which increases root nodules and consequently increases organic process. K plays a vital role in activation of enzymes and boost up biological N fixation and protein content of pulse seeds (Bukhsh *et al.*, 2011; Srinivasarao *et al.*, 2003). Application of N and P fertilizer was found to increase 1000 grains weight, grain yield and protein contents of various legumes particularly blackgram (Rajendran *et al.* 1974). Phosphorus has been found very effective altogether soil types and called as vital element for increasing the yield. Aside from its essential role in growth and development of roots, phosphorus is important for growth of Rhizobium bacteria liable for biological N fixation to extend the efficiency of pulses as soil renovator and serve the twin purpose of accelerating yield of the main crops also as succeeding crop. It also improves the standard of grain. It plays a vital role in energy storage and transfer. Phosphorus may be a constituent of nucleic acids (DNA and RNA) and majority of enzymes which are of great importance within the transformation of energy in carbohydrate metabolism and respiration of plants. Phosphorus stimulates the symbiotic organic process because in presence of phosphorus bacterial cell becomes mobile which is a pre requisite for migration of bacterial cell to plant organ for nodulation (Charel, 2006). This finding was further supported by the results reported by Subramanian and Radhkrishnan (1983) who claimed significant increase in yield of blackgram with the use of N and P. Malik *et al.* (1986) reported that N and P combination was essential for having maximum yield of blackgram. K alone or in combination with Nand P did not show significant positive response. But the literature also witnessed that P application in addition to N and K showed beneficial effects on mashbean (Malik et al., 1986). Potassium increases the protein content of plants the starch content in grains and tubers, Vitamin C and the soluble contents in fruits. With a shortage of K, many metabolic processes are affected like the rate of photosynthesis and the rate of translocation and enzyme system (Marschner, 2002; Mengel,1997). If the farmer uses modern technologies as well as appropriate fertilizer doses in blackgram cultivation the yield of the crop will be increasd which can meet up our local demand and able to save foreign currency for importation as like other countries. The use of organic fertilizer is not sufficient(Prasad,1996). Very few research finding are available in our country on influence of organic and in combination of P and K fertilizers on the performance of blackgram. So there is a wide scope to take research on the present study has been conducted with the following objectives:

Objectives of the Research Work

i). to find out the effect of organic manure on the growth yield and seed quality of blackgram,

ii). to observe the performance of P+K fertilizers on growth yield and seed quality of and blackgram, and

iii). to find out the interection effect of organic manure and P+K fertilizers on growth yield and seed quality of blackgram.

CHAPTER II

REVIEW OF LITERATURE

2.1 Effect of organic manure on growth, yield and seed quality of blackgram

The yield potential of blackgram is very low because of the fact that the crop is mainly grown in rain fed conditions with poor management practices and also due to various physiological, and biochemical as well as inherent factors associated with the crop. Apart from the genetic makeup, the physiological factors viz., insufficient partitioning of assimilates, poor pod setting due to the flower abscission and lack of nutrients availabity during the critical stages of crop growth, coupled with a number of diseases and pests (Mahala *et al*., 2001) were the reasons for the poor yield. Organic manures viz., FYM, vermicompost, poultry manure and oilcakes help in the improvement of soil structure, aeration and water holding capacity of soil. Further, it stimulates the activity of microorganisms that makes the plant to get the macro and micronutrients through enhanced biological proceincrease nutrient solubility, alter soil salinity, sodicity and pH. (Alabadan *et al.,* 2009). Though, they contain relatively low concentrations of nutrients and handling them is labour intensive, there has been large increase in their use over inorganic fertilizers as nutrient source.

Kaleeswari and Subramanian (2004) conducted field experiments during the 2000/01 wet season (August to December) at Madurai, Tamil Nadu, India to study the influence of organic manures, i. e. farmyard manure (FYM), poultry manure (PM) and green leaf manure (GLM, *Gliricidia sepium*) at 12.5 t ha^{-1} each, and inorganic phosphatic fertilizer, i.e. single superphosphate (SSP) and Udaipur rock phosphate (URP) at 0, 30 and 60 kg P ha^{-1}. Combined application of GLM at 12.5 t ha^{-1} and inorganic P fertilizers recorded the highest grain yield and N, P and K uptakes.

Reddy *et al.* (2004) conducted a field study for two years (2001 and 2002) on the farmers field in Kolar district (eastern dry zone, Karanataka, India) to study the effect of different organic manures on growth and yield of paddy under tank irrigation. Poultry manure and sewage sludge produced better growth components, *viz*., plant height, number of tillers/hill, panicle length and 1000 grain weight.

(Amanullah *et al.*, 2003). Plants that collect poultry manure grew taller than other plants possibly more concentrated nutrients or minerals were made readily available and easily absorbable by the receiving plants leading to faster growth and development (Enujeke, 2013).

Ghulam *et al.* (2011) reported that different combinations of organic and inorganic fertilizers significantly affected the grain yield of green gram. Maximum grain yield was obtained from the application of DAP at 124 kg ha^{-1} along with 10 t ha^{-1} of poultry litter during both years, while application of DAP at 62 kg ha^{-1} and 10 t ha^{-1} FYM ranked second for grain yield.

The efficacy of poultry litter applications to enhance crop growth (yield and nutrient uptake) depends upon its nutrient availability. Application of Poultry Litter to cropland can also increase soil organic matter thereby improving soil quality and productivity (Kingery *et al.*, 1994. Poultry litter contains all the nutrients essential for plant growth and has an approximate 3-3- 2 (N-P_2O_5-K_2O) fertilizer grade equivalent (Mitchell and Donald, 1995). Thus, poultry litter may be a valuable nutrient source for row crop production systems. Numerous studies have proven that poultry litter can be used as an effective fertility source (Hirzel *et al*., 2007; Mitchell and Tu, 2005; Reddy *et al*., 2004; Tewolde *et al*., 2009a; Watts and Torbert, 2011; Wiatrak *et al*., 2004). However, poultry litter may produce yields different to that of commercial fertilizer sources. Mitchell and Tu (2005) reported that no differences in relative yields were observed when broiler litter was applied at the same total N rate as ammonium nitrate. Hirzel *et al*. (2007) found similar results with corn silage; yield averages obtained from PL additions were comparable to that of urea.

Watts and Torbert (2011) also reported that soybean yields were increased 8 out of 9 years when PL was used as a nutrient source. In contrast, a 2.5-year bermudagrass field study showed that forage yield with broiler litter was 64, 48, and 67 % of yield with ammonium nitrate applied at the same N level in these three years, respectively (Woodard and Sollenberger, 2011). Another pasture study indicated that land application of PL provided essential nutrients for hybrid bermudagrass production with no differences in dry matter yield and N uptake compared to that of ammonium nitrate, whereas greater P and K uptake were observed with PL application (Read *et al.,* 2006).

The efficacy of poultry litter applications to enhance crop growth (yield and nutrient uptake) depends upon its nutrient availability. Application of PL to cropland can also increase soil organic matter (Watts *et al*., 2010); thereby improving soil quality and productivity (Kingery *et al.,* 1994). Continuous application of litter or manure can increase the levels of C, N, P, K, Ca and Mg in the soil (Ginting *et al.*, 2003; Wallingford *et al.,* 1975; Watts *et al*., 2010;), thus creating a reservoir of soil nutrients for several years after application. Agbede and Ojeniyi (2009) found similar results with sorghum production in southwestern Nigeria; no-till with or without mulch in combination with 7.5 Mg ha^{-1} of PL improved soil organic C, total N, available P, exchangeable K, Ca and Mg concentration and grain yield.

Blair *et al.* (2014) evaluated soil nutrient availability under both greenhouse and field conditions following surface incorporation of composted and formulated pelletized PL for edamame production in Arkansas. They reported that dissolved organic C and inorganic N was increased under field conditions following pelletized PL application, but not following application of composted PL. There are conflicting results as to the beneficial effects of PL on crop productivity and its influence on increasing the availability of soil nutrients. As a result, there is a need for a comprehensive quantitative review. A few reviews have combined independent studies using quantitative methods to relate the impact of management strategies and environmental effects on crop production.

2.2 Effect of P+K fertilizers

Phogat (2016) concluded that the combined application of P and S showed synergistic effect on seed and stover yields of blackgram with increasing levels of P and S upto highest level. The seed and stover yields were 955.50 and 2398.30 kg ha^{-1} with combined application of 60 and 30 kg ha^{-1}, P and S respectively, indicating synergistic effect of P and S on each other as both the nutrients mutually help absorption and utilization by blackgram probably due to balanced nutrition. The various growth parameters and yield attributes of blackgram viz. plant height, number of pods $plant^{-1}$, 100-seed weight, number of nodules plant1 also increased significantly with increasing levels of P and S up to highest level and the optimum values were recorded with combined application of 60 kg P ha1 and 30 kg S ha^{-1}. However non-significant response of P and S application has been observed in case of plant population (m^{-2}), while it slightly increased with each successive application of P and S up to 60 kg P ha^{-1} and 30 kg S ha^{-1}.

Niraj and Ved (2014) conducted an experiment at the instructional farm of Narendra Deva University of Agriculture and Technology, Narendra Nagar, Kumarganj, Faizabad (U.P.) during Kharif season, 2007. Sixteen treatments were replicated thrice in Randomized Block Design. Blackgram variety Pant Urd-35 was taken as test crop. The data revealed that 45 kg ha^{-1} P and 30 kg ha1 S significantly increased growth parameters such as plant height, number of branches and dry matter accumulation. The same treatment combination proved most effective in improving the yield and yield attributing characters viz., number of pods, number of grains per pod, grains wt. per plant, test weight, grain 16 and straw yield. Application of 60 kg P and 45 kg S ha^{-1} produced highest grain and straw yield along with nutrients content and uptake of nitrogen, phosphorus, potassium and sulphur over rest of the treatments. However, this treatment was at par with the application of 45 kg P and 30 kg S ha^{-1}. A considerable buildup of soil fertility was also noted in this treatment. However, benefit: cost ratio was maximum with P45S30 treatments combination. Thus, recommendation of 40 kg sulphur and 10 kg zinc ha^{-1} can be made to the farmer's of eastern Uttar Pradesh for obtaining good yield, net rerun and fertility build up of soil.

Kadam *et al*. (2014) were conducted a field experiment to study the effect of phosphorus, vermicompost and PSB inoculation on growth, yield and quality of blackgram during Kharif 2011 on the farm of Agronomy department, at college of Agriculture, Latur. The research showed that the application of 75 kg P_2O_5 ha1 recorded highest seed yield (1194 kg ha^{-1}) and yield attributes as well as high economic returns but it was found at par with 50 kg P_2O_5 ha^{-1}. The higher B:C ratio (1.58) was recorded at 50 kg P_2O_5 ha^{-1}. Therefore, it is recommended to apply 50 kg phosphorus ha^{-1} to blackgram crop. The superior development and yield parameters were recorded by the combine application of vermicompost and PSB inoculation. It was also found superior in respect of gross monetary return but higher net monetary return (18377 kg ha^{-1}) and B:C ratio

(1.74) was obtained by the application of PSB inoculation. Hence it is recommended to apply PSB inoculation to blackgram.

Mir *et al*. (2014) were conducted a field experiment at Allahabad Agricultural Institute Deemed University, Allahabad to study the effect of levels of phosphorus, sulphur and Phosphorus Solubilizing Bacteria (PSB) on growth, yield and nutrient content of blackgram for consecutive two years 2004 and 2005. The crop growth parameters viz., plant height, number of nodules and number of leaves per plant, yield and nutrient content increased significantly with the application of high levels of phosphorus, sulphur with or without biofertilizer inoculation.Application of 60 kg P_2O_5 ha^{-1} recorded maximum plant height (49.9 cm), number of leaves plant^{-1} (50.8), number of nodules plant^{-1} (27.8), haulm yield (28.9 q ha^{-1}), grain yield (8 q ha^{-1}) and phosphorus, sulphur and protein content of grain (0.356 %, 0.253% and 22.64%, respectively) as compared to lower levels. Application of Sulphur @ 40 kg ha^{-1} recorded maximum plant height (47.31 cm), number of leaves plant^{-1} (49.80), number of nodules plant^{-1} (25.58), haulm yield (28.80 q ha^{-1}), grain yield (7.92 q ha^{-1}) and phosphorus, sulphur and protein content (0.295, 0.281 and 21.79%, respectively). Inoculation of blackgram seeds with phosphorus solubilizing bacteria recorded slightly higher grain yield (7.49 q ha^{-1}) as compared to no inoculation (7.39 q ha^{-1}).

Singh and Singh (2013) conducted a field experiment during kharif season at the agriculture research farm of Raja Balwant Singh College Bichpuri, Agra (Uttar Pradesh) to find out the effect of phosphorus, sulphur and zinc on nutrient composition in Blackgram. The results revealed that nutrient Nitrogen, phosphorus, protein and sulphur also improved in seed composition by the application of 60 kg phosphorus ha^{-1} and sulphur 40 kg ha^{-1}. The present experiment was conducted in spilt plot design with three replication, three levels of phosphorus 0 kg, 30 kg, 60 kg ha^{-1}, three levels of sulphur 0 kg, 20 kg, 40 kg ha^{-1}, three levels of zinc 0 kg, 5 kg, 10 kg ha^{-1} 27 treatments combination and 81 plots were used to conduct this study.

Yadav (2011) carried out a pot experiment to study the phosphrous-sulphur interaction at Department of Agricultural Chemistry and Soil Science, Rajasthan College of Agriculture, Udaipur on a sandy loam soil (Typic Haplustept) medium in P and deficient in S with clusterbean. Number and weight of nodules, grain and straw yield, content of P and S were increased with increase in level of P and S individually as well as in various combinations. Applied P and S increased grain nitrogen and protein contents. Available P in soil was increased with increasing levels of phosphorus. Similarly, available S in soil was increased with increasing levels of sulphur. The synergistic effect of phosphorus and sulphur was reported on number and weight of nodules plant^{-1}, N, P, S and protein content of clusterbean .

Yadahalli *et al.* (2010) stated that, the seed yield and haulm yield of blackgram were not much influenced by the phosphorus levels (50 kg and 75 kg P_2O_5 ha^{-1}) tried. However, the maximum seed yield (784.77 kg ha^{-1}) was obtained by the application of 75 kg P_2O_5 ha^{-1}. The lack of response of blackgram to higher phosphorus level at 75 kg P_2O_5 ha-1 could be attributed to available soil phosphorus (32.4 kg ha^{-1}). All the values of growth components and yield attributing characters were also on par between 50 kg and 75 kg P_2O_5 ha^{-1}.

Singh *et al*. (2008) reported that, in two years study on the response of blackgram (Vigna mungo L. Hepper) cv JU 2, the optimum level of phosphorus through different sources was determined with or without application of PSB [Phosphorus solubilizing bacteria]. Significantly highest seed yield of 651 kg ha1 was recorded due to application of 40 kg P_2O_5 ha^{-1} through DAP with PSB. The increase in seed yield was attributed mainly due to increase in nodulation, plant height, branches per plant, leaves per plant and pods per plant. A net return of Rs. 2624/- ha^{-1} was also recorded highest in this treatment. It is therefore, recommended for general adoption in medium black soils of Madhya Pradesh.

Agnihotri (2005) conducted an experiment to study the effect of rhizobium phosphorus and sulphur on yield and quality of blackgram *Vigna Mungo* L. Results revealed that vegetative growth, yield and quality of blackgram increased due to rhizobium phosphorus and sulphur application.

Singh (2004) was conducted an experiment to find out the role of sulphur and phosphorus in blackgram production. Result indicated that, with the supplementation of phosphorus, vegetative growth, yield and quality of blackgram increased.

Tanwar *et al.* (2003) carried out a field experiment at Udaipur during kharif, 1996 to study the effect of phosphorus and biofertilizers on yield, nutrient content and uptake by blackgram. The crop yield, N and P content and uptake by grain and straw both, significantly increased upto 60 kg P_2O_5 ha^{-1}. Dual inoculation of seeds with phosphate solubilizing bacteria (Bacillus megaterium var. Phosphaticuir.) and Rhizobium caused a significant increase in yield, N and 20 P content and uptake in grain and straw over alone inoculation and control. However, single inoculation with PSB or Rhizobium were found at par. Maqsood *et al.* (2001) reported that a study in a sandy clay loam field to investigate the effect of phosphorus rates on the agronomic traits of two mashbean genotypes (Mash97 and Mash88). Mashbean genotypes did not differ significantly regarding number of plants m^{-2}, plant height, number of seeds podI , total number of seeds $plant^{-I}$, 1000 seeds weight, seed yield and harvest index. However, Mash-97 gave significantly more seeds per plant than that of the Mash88. Phosphorus application @ 75 kg ha^{-1} gave significantly the highest seed yield of 1832 kg ha^{-I} against the minimum of 1390 kg ha^{-1} without phosphorus. Thiyageshwari and Perumal (2000) conducted a pot experiment with a Vertic Ustropept to test the changes in soil phosphorus fonns, uptake and grain yield due to integrated nutrient management of blackgram through conjuctive use of imported tunisia rock phosphate, vermicompost and phosphobacteria. Growth of blackgram and P uptake was slow in vegetative phase but rapid during reproductive phase. Vermicompost application significantly enhanced grain yield followed by phosphobacteria over 100 per cent P as tunisia rock phosphate. P uptake by blackgram was higher in the combined application of rock phosphate with vermicompost and phosphobacteria. Available phosphorus was higher in the vegetative stage and later decreased at harvest due to P utilisation by blackgram.

Gopala Rao *et al.* (1985) conducted an experiment to study the effect of phosphorus on yield of blackgram (*Vigna mung*). They found that, with the 21 application of phosphorous, along with vegetative growth the yield of blackgram increases gradually.

Dhage *et al.* (1984) stated that fertilization of blackgram with nitrogen (20 kg N ha^{-1}) in the form of urea produced a 32% increase in yield over control, and significantly improved nutritional quality of seeds by increasing crude protein, crude fat, methionine, calcium, phosphorus and iron contents without increasing polyphenols. The highest yield of blackgram was obtained when plants were supplied with phosphorus at a rate of 40 kg P_2O_5 ha^{-1}. Crude protein, crude fats, phosphorus and iron contents increased whereas calcium content decreased significantly at 40 kg P_2O_5 ha^{-1}. A continuous increase in polyphenol content was observed with increasing levels of phosphorus but it was significantly increased at P rates above 40 kg ha^{-1}. Fertilization with N and P in a 1:2 ratio at 20 kg N ha^{-1} and 40 kg P_2O_5 ha^{-1} produced a 32% seed yield increase and improved the nutritional value of blackgram seeds.

Kurhade *et al.* (2015) conducted a field experiment to study the effect of potassium on yield, quality, available nutrient status and its uptake of blackgram and showed that yield quality, nutrient status and its uptake of blackgram were significantly increased due to increased level of potassium fertilizer. Biswash *et al*. (2014) conducted a field experiment to study the effect of potassium fertilizer and vermicompost on growth, yield and nutrient contents of mungbean (BARI Mung 5). They showed that increasing potassium levels have significant effect on plant height, number of leaves and branches $plant^{-1}$, average dry weight $plant^{-1}$, number of pods $plant^{-1}$, number of seeds pod^{-1}, number of seeds $plant^{-1}$, 1000 seed weight, seed yield and stover yield of mungbea.

Ganga *et al.* (2014) conducted a field experiment to study the effect of potassium levels and foliar application of nutrients on growth and yield of late sown chickpea and observed that application of 60 kg K_2O ha^{-1} at sowing and combined foliar spraying of 2% urea and 0.25% multiplex at pre-flowering stage of chickpea resulted in maximum grain yield and ancillary characters.

Thesiya *et al*. (2013) conducted an experiment during the kharif season to study the effect of potassium and sulphur on growth and yield of black gram (Vigna mungo L. Hepper) under rainfed condition. There was a significant effect of potash and sulphur levels on plant height, number of branches per plant, number of pods per plant, length of pod, 100-grain weight, straw yield and grain yield. Significantly the highest grain yield (9.17 q ha^{-1}) and straw (18.28 q ha^{-1}) yield was recorded under 20 kg K_2O ha^{-1}, which was at par with 40 kg K_2O ha^{-1} in case of grain yield.

Hussain *et al*. (2011) conducted an experiment to study the growth and yield response of two cultivars of mungbean (Vigna radiata L.) to different potassium levels and showed that the different potassium levels significantly affected the seed yield and yield contributing parameters except number of plants per plot. Chanda *et al*. (2003) reported that the potassium application had significant effect on plant height, yield attributes and grain yield of mungbean. Tariq *et al.* (2001) reported that the number of pods bearing branches plant was significantly increased by potassium application in mungbean. Ali *et al.* (1996) studied the effect of different potassium levels (0, 25, 75,100 and 125 Kg/ha) on yield and quality of mungbean and reported that no. of pods/plant, no. of seeds per pod was influenced significantly by potassium application. Khokar and Warsi (1987) reported that addition of potash from 20 to 60 kg K_2O ha^{-1} raised the grain production.

2.3 Combined effect effect of organic manure and different doses of P+K fertilizers on yield and seed quality of blackgram

Meena (2013) conducted a field experiment to find out the effects of organic and inorganic sources of nutrient on growth attributes and dry matter partitioning of green gram in arid western Rajasthan during summer season of 2004. He observed that inorganic source of nutrients as NPK 100% of RDF and organic sources of nutrients like, FYM at 10 tha^{-1} and vermicompost at 5 t ha-1 significantly enhanced the growth attributes viz., plant height at harvest, dry matter accumulation and its partitioning (g $plant^{-1}$) into leaf, stem and pod at 25, 50, 75 DAS and at harvest, dry weight of root nodules (mg $plant^{-1}$) at flower initiation and peak flowering stages of green gram over control and other treatments. He further quoted that increased level of inorganic and organic sources of nutrients viz., NPK at 125% recommended dose, FYM at 10, 15 and 20 t ha-1 and vermicompost at 5, 7.5 and 10 t ha^{-1} remained at par each other.

Naeem *et al.* (2006) studied the effect of organic manures and inorganic fertilizers on growth and yield of green gram (*Vigna radiata* L.) and reported that grain yield was recorded highest (1104 kg ha^{-1}) with the application of the inorganic fertilizers @ 25:50:50 kg NPK ha^{-1}. Among organic sources, poultry manure @ 3.5 t ha^{-1} was found the best followed by FYM @ 5 t ha^{-1}. The economic analysis revealed maximum net benefit from the treatment, where poultry manure was applied.

Rautaray *et al.* (2003) reported that high dependency on the increased use of chemical fertilizers and associated hazards put back attention on organic sources, which are effective in promoting health and productivity of the soil. Combined use of chemical fertilizer with organic fertilizer may be an important strategy for sustainable production of crops. This may not only improve the efficiency of chemical fertilizers along with their minimal use in crop production besides increasing crop yield and improving available major and minor nutrients Improvement in yield due to combined application of inorganic fertilizer and organic manure might be attributed to control release of nutrients in the soil through mineralization of organic manure which might have facilitated better crop growth and yield (Verma *et al*., 2017

Bending *et al*. (2002) reported that crop residues and soil organic matter both could affect the diversity of soil microbial community and increase the crop growth and yield. Combined use of nutrient may be one of the solutions to increase blackgram production as well as reducing cost of production and make the best use of locally available resources like animal dung, urine, crop residues etc. The use of organic matter as a low cost supplement to the artificial fertilizers may help decreasing the cost of production.

Gaur *et al.*, (1992) reported that on an average well decomposed FYM contains 0.5 percent N, 0.2 percent P_2O_5 and 0.5 percent K_2O. It has been estimated that a ton of FYM would supply 3.6 kg nitrogen + 1.9 kg phosphorus + 1.8 kg potassium. FYM promotes seed germination and root growth of the crop plants by improving the water holding capacity and aeration of the soil.

From the above discussion, it can be assume that there is a wide scope in this aspect for producing quality seed of blackgram.

CHAPTER III

MATERIALS AND METHODS

A pot experiment was conducted in the net house of the Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka-1207 during the period from April 2019 to August 2019. This chapter deals with a brief description on experimental site, climate, soil, land preparation, layout, experimental design, intercultural operations, data recording and their analyses.

3.1 Experimental site

The experiment was conducted in the net house of the department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka-1207, under the Agro-Ecological Zone of Madhupur Tract (AEZ-28). The land area is situated at 23°41′N latitude and 90°22′E longitude at an altitude of 8.6 meter above sea level. The experimental site is shown in the AEZ Map of Bangladesh in Appendix I.

3.2 Climate

The experimental area is under the sub-tropical climate that is characterized by high temperature, high humidity and heavy rainfall with occasional gusty winds in kharif season (April-September) and less rainfall associated with moderately low temperature during the rabi season (October-March). The weather conditions during experimentation such as monthly total rainfall (mm), mean temperature (^{0}C), sunshine hours and humidity (%) collected from the Bangladesh Meteorological Department, Agargoan. The details are presented in Appendix II.

3.3 Soil

Soil of the experimental area belongs to the general soil type, Shallow Red Brown Terrace Soils under Tejgaon Series. Top soils were clay loam in texture, olive-gray with common fine to medium distinct dark yellow brownish mottles. The experimental area was flat having available irrigation and drainage system. The land was above flood level and sufficient sunshine was available during the experimental period. Soil samples from 0-15 cm depths were collected from experimental field. The analyses were done by Soil Resources and Development Institute (SRDI), Dhaka. The physicochemical properties of the soil are presented in Appendix III.

3.4 Planting material

The variety of blackgram used for the present study was BARI mash-1. The required seeds for the experiment were collected from the Pulse Research Centre of Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur. The seeds were healthy, well matured and free from mixture of other seeds, weed seeds and extraneous materials. Before sowing, the seeds were tested for germination in the laboratory and the percentage of germination was found to be over 90%. The important characteristic of this variety is mentioned below:

BARI mash-1 is a medium statured (45-50cm), semi erect cultivar with basal primary branches. Stem pigmentation is absent at the seedling stage, but it becomes light green at the late vegetative stage. Leaves are dark green with slightly pubescence. Leave size is medium with dark green color, short petiole and rachis that form no tendrils. Its flowers are white, and the pods and leaves turn to straw. Its seed coat is ash and testa pattern is dotted with smooth seed surface, and cotyledon is yellow. The variety is resistant to Cercospora leaf spot and yellow mosaic virus. The life cycle of this variety is 65-70 days. It has a 1000 seed weight of 39.2 g compared to 21.5 g or less for the local cultivars. Maximum seed yield is 1.4-1.5 t ha^{-1}. Seeds contain 25.5% protein and 47.3% carbohydrate.

3.5 Details of the experiment

3.6 Treatments

The following treatments were included in this experiment:

Factor A:Effect of organic manure - 3 levels

i. Control (without organic manure)= OM_0

ii. Cowdung= OM_1

iii. Poulty litter= OM_2

B: Phosphorus+Potassium (P+K) levels-4

i. Control (without inorganic fertilizer = F_0

ii. Recommended dose of P + K with recommended other fertilizer= F_1

iii. 25% higher of recommended dose of P + K with recommened other fertilizer= F_2

iv. 50% higher of recommended dose of P + K with recommened other fertilizer =F_3

N.B. The recommened dose of organic manure and inorganic fertilizer used in this experient are presented in section 3.8.3

Treatment combination

OM_0F_0, OM_0F_1, OM_0F_2, OM_0F_3, OM_1F_0, OM_1F_1, OM_1F_2, OM_1F_3, OM_2F_0, OM_2F_1, OM_2F_2 and OM_2F_3

3.7 Experimental design and lay out

The experiment was laid out in a completely Randomized Design (CRD) with four replications. Four extra replications were sown in the experiment from where growth data were taken. There were 48× 2 pots all together in the experiment.

3.8 Conduction of the experiment

3.8.1 Seed collection

Seeds of BARI Mash-1 were collected from Bangladesh Agricultural Research Institution (BARI) Joydebpur, Gazipur, Bangladesh.

3.8.2 Preparation of pot

The soil was collected from the experimental field of SAU. The collected soil was sun dried, crushed and sieved properly. The soil and organic manure were mixed well before placing the soils into the pots. For blackgram, amounts of fertilizers were mixed with the soil as per treatment of the experiment. Each pot was filled up with 20 kg soil. The size of the individual pot was 22 cm in diameter and 25 cm in height.

3.8.3 Fertilizer dose and method of application

The fertilizer N, P and K were applied in the form of Urea, Triple super phosphate (TSP) and Muriate of potash. The rate of Urea, TSP and Mop were 40, 70 and 35 kg ha^{-1}, respectively. The rate of cowdung and poultry litter were 10 and 5 t ha^{-1}, respectively. All the organic and inorganic fertilizers were mixed with with soil in full dose as per the treatment and then fill up into the pots.

3.8.4 Seed sowing

Seeds were sown in the pot on 09 April, 2019. Ten seeds were used in each pot

3.9 Intercultural operation

3.9.1 Gap filling and thinning

After seed sowing, continuous observation was done to observe the condition of the pot and seedlings. Strong observation and monitoring was made for thinning to maintain seedlings spacing requirement. Thinning was done to maintain spacing of the plants. No gap filling was needed. After 10 days after sowing 3 healthy seedlings were kept in each pot and others were thinned out from the experimental pots. But growth data were taken from the plants of the extra pots.

3.9.2 Weeding

Weeding was done as as when necessary to keep the pot weed free.

3.9.3 Irrigation

There was huge rainfall during the whole period of growth and till final harvest.
However, irrigation was done as when necessary to keep the pot moister.

3.9.4 Plant protection measure

Just after sowing, some ants attacked the crop. Sevin powder was used in this regard. At early stage of growth few virus vectors (jassid) infested the young plants and at later stage of growth pod borer (*Maruca testulalis*) attacked the plant. They were effectively controlled by the application of Diazinon 50 EC and Ripcord @ 1 L ha^{-1}.

3.9.5 General observation of the experimental pots

Regular monitoring and evaluation was done for the observing of weed infestation, insect and pest attack and disease infestation. When weed infestation, insect and pest attack and disease infestation were found, an immediate remedy was taken to solve the problem.

3.9.6 Harvesting and processing

On different dates based on pods maturity the crop (pods) were harvested by hand picking. Harvesting of pods were done in three steps-first at 50% maturity, second at 25% maturity and third at rest of the pod maturity. The crop was finally harvested at maturity on 8th August, 2019. Seeds of the pods were separated and dried in the sun and then weighted. The seed weight was converted as seed yield plant^{-1} and seed yield kg ha^{-1}. After collecting of pods, the plants were cut down at the ground level and then the plants of each pot was bundled separately with tag mark indicating the respective treatment and brought to the threshing floor for drying. The bundles were dried in sunshine for 3–4 days and weighted in an electric balance. Then the stover weight was converted into kg ha^{-1}.

3.10 Data collection

Data collections from the experiment of crop were done under the following heads:

A. Plant and growth data

i) Plant height (cm) (at 25, 50, 75 DAS)

ii) Branches plant-1 (at 25, 50, 75 DAS)

iii) Dry weight of plant (g) (at 25, 50, and at harvest)

B. Yield contributing characters data

iv) Pod diameter(mm)

v) Pod length(cm)

vi) Pods plant^{-1} (no.)

vii) Seeds pod^{-1} (no.)

viii) 1000 seed weight (g)

ix) Seed weight plant^{-1}(g)

C. Yield parameters data

x) Seed yield (kg ha^{-1})

xi) Stover yield (kg ha^{-1})

xii) Biological yield (kg ha^{-1})

xiii) Harvest index (%)

D. Seed quality parameter

The pot wise sun-dried seeds were used for quality assessment. The seeds were set for standard germination test in laboratory and the following data were recorded

xiv) Germination percentage (%)

xv) Seedlings length (cm)

xvi) Dry weight of seedlings (g)

xvii) Electric conductivity (EC) test

3.11 Procedures of recording data

A brief outline of the data recording procedure is given below:

3.11.1 Plant height

Plant height was measured at 25 days interval starting from 25 days after sowing (DAS) and continued up to harvest. Three plants were used for collecting plant height data from each pot. The height of the plants were measured from the ground level to the tip of the plant at 25, 50 and 75 days after sowing (DAS). The collected data were finally averaged.

3.11.2 Branches of plant

Branches plant^{-1} was taken at 25 days interval starting from 25 days after sowing (DAS) and continued up to 75DAS. three plants were used for collecting branches plant^{-1} data from each pot. Only primary branches were counted for taking branches plant^{-1} at 25, 50, 75 days after sowing (DAS). The collected data were finally averaged.

3.11.3 Dry weight of plant

The dry weight of plant was measured at 25 days interval starting from 25 days after sowing (DAS) and continued up to harvest. Two plants were selected randomly from each pot from the extra replicated pots. The dry weight of the plants was measured at 25, 50, days after sowing (DAS) and at harvest. The selected two plants of each pot were dried by oven and weight data were taken by electric balance every time. The collecter data were finally arranged and expressed as dry weight per plant.

3.11.4 Pod diameter

The pod diameter (mm) was measured with a centimeter scale from the randomly selected 10 pods of each pot and the average value was recorded as pod diameter pod^{-1}

3.11.5 Pod length

The pod length (cm) was measured with a meter scale from the randomly selected 10 pods of each pot and the average value was recorded as pod length pod^{-1}

3.11.6 Pods plant^{-1}

The number of pods were counted from the three plants of each pot and the average value was recorded as pods plant^{-1}

3.11.7 Seeds per pod

The number of seeds were counted from each randomly selected 10 pods and averaged them and then expressed as number of seeds pod^{-1}

3.11.8 Seed weight plant^{-1} (g)

Seeds from each pot were randomly selected and weighed by an electric balance after sun dried.

3.11.9 1000 seed weight (g)

One hundred (100) seeds from each pot were randomly selected and weighed by an electric balance after sun dried and then the weight was multiplied with 10 to convert as 1000 seed weight (g).

3.11.10 Seed yield

Seeds harvested from all the three plants of each pot was sun dried and weighed carefully. The dry weight of the sun dried grain of the respective pot was recorded, and then divided by 3 for yield plant^{-1}. Then from the ideal spacing of BARI Mash-1, number of plants of 1 ha was counted. Number of plants of 1 ha was multiplied by the yield per plant for obtaining the yield of 1 ha area and then calculated yield was converted into kg/ha for each pot. The weight of seed was adjusted at 14% moisture content.

3.11.8 Stover yield

After separation of seeds from plant, the stover obtained from three plants of each pot was sun dried and weighed carefully. The dry weight of stover of the respective pot was recorded, and then divided by 3 for stover yield plant^{-1}. Then from the ideal spacing of BARI Mash-1, number of plants of 1 ha was counted. Number of plants of 1 ha was multiplied by the stover yield plant^{-1} for obtaining the stover yield of 1 ha area and then calculated stover yield was converted into kg ha^{-1} for each pot

3.11.10 Biological yield

Grain yield and straw yield were all together regarded as biological yield and calculated with the following formula:

Biological yield (kg/ha) = Grain yield (t/ha) + Stover yield (kg/ha)

3.11.11 Harvest index (%): Harvest index was calculated by using the following formula-

$$\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$

3.11.12 Germination percentage (%)

Seeds obtained from each treatment were placed in petridish with sand media. There were 25 seeds in each petridish where replicated thrice. The number of sprouted and germinated seeds were counted daily commencing. Germination was recorded at 24 hrs interval and continued upto 6 days. The germination rate was calculated using the following formula

$$\text{Germination percentage (\%)} = \frac{\text{Number of germinated seeds}}{\text{Number of total seeds set for germination}} \times 100$$

3.11.13 Seedling length (cm)

Randomly selected 10 seedlings of 10 days from each treatment were collected and length was measured with a meter scale and the average value was recorded as shoot length per seedling.

3.11.14 Dry weight of seedling (g)

10 seedlings were selected randomly from each treatment. After drying by oven, the dry weight of the seedlings were measured by an electric balance. The collected data were finally averaged and expressed as dry weight per seedling in g.

3.11.15 Electric conductivity (EC)

Test assessment of seed vigor has long been an important tool of seed quality control programs and electrical conductivity test is one of the methods for assessment of seed vigor. Electrical conductivity (EC) test was done using EC meter (ModelCM-30-ET) and for this 50 g seed were soaked in 100 ml water for 24h before collecting the data.

3.11.16 Statistical analysis

The data were collceted and tabulated in proper form and were subjected to statistical analysis. Analysis of variance (ANOVA) was done following the computer package Statistix10 program. The mean differences among the treatments were assessed by least significant difference (LSD) test at 5% level of significance (Gomez and Gomez, 1984)

CHAPTER IV

RESULTS AND DISCUSSION

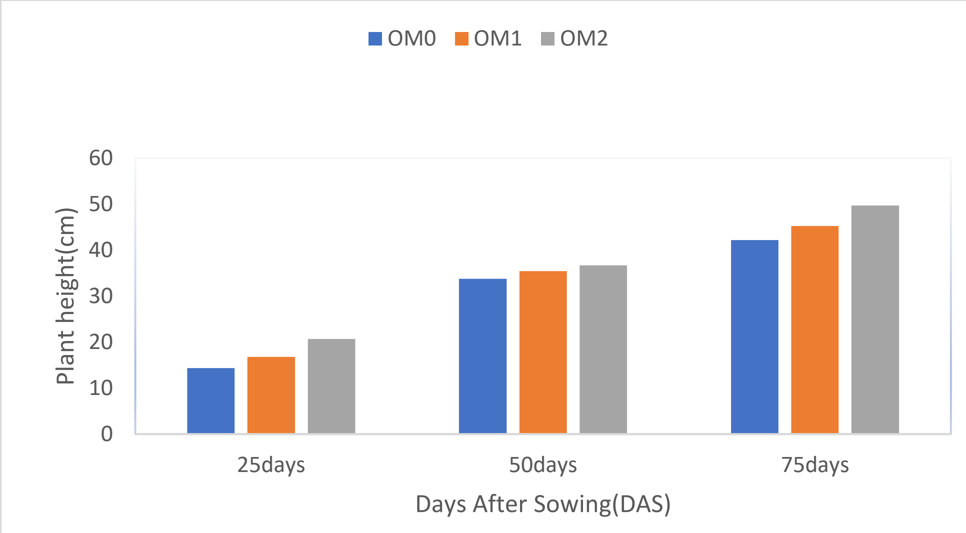
The present experiment was conducted to observe the effect of organic manure with different doses of chemical P+K on the growth, yield and seed quality of blackgram. Data on different growth and yield parameters of blackgram were recorded. All the growth characters, yield attributing characters, yield and seed quality data were statistically analyzed and the results are presented and discussed with the help of either table or graphs. In order to understand the effect of treatments, the data have also been given in appendix tables for reference.

4.1 Growth characters

4.1.1 Plant height

4.1.1.1 Effect of organic manure

The plant heights of blackgram were significantly influenced by the effect of organic manure at 25, 50, and 75 DAS (Fig. 1 and Appendix VI). The figure revealed that plant height showed a gradual increase in trend with the advances of growth stages irrespective organic manure treatment. However, at 25, 50, and 75 DAS and the treatment OM_2 (poultry litter) produced the tallest plant (20.70, 36.67 and 49.68 cm, respectively) and the treatment OM_0 (control) produced the shortest plant (14.39, 33.75 and 42.21 cm, respectively). The reasons behind obtaining higher plant height might be due to the contribution of poultry litter application. Plants that received poultry manure grew taller than that of other plants possibly more concentrated nutrients or minerals were made readily available and easily absorbable by the receiving plants leading to faster growth and development (Enujeke, 2013).

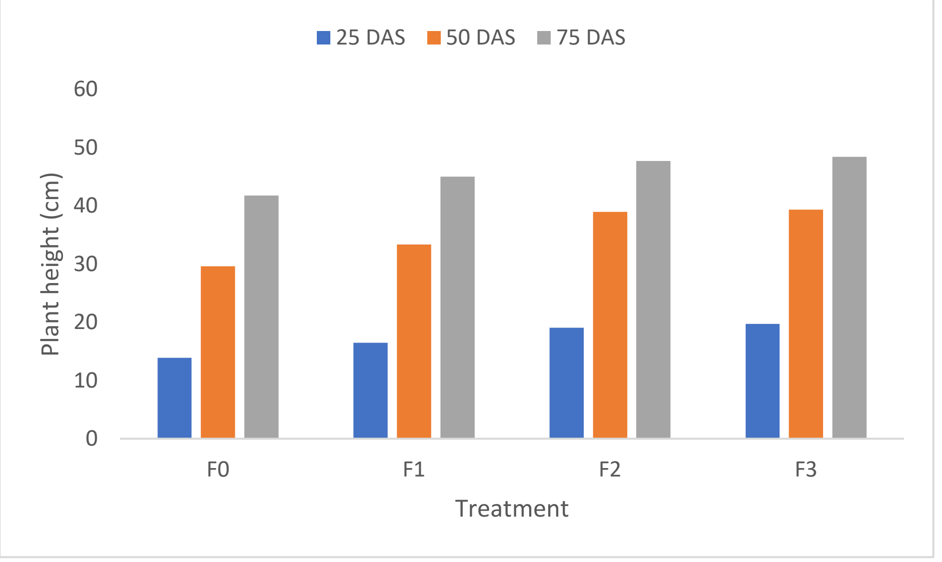


MO_0 = Control, MO_1 = Cowdung, MO_2 = Poultry litter

Fig. 1 Effect of of organic manure on plant height at different days after sowing of Blackgram (LSD $_{(0.05)}$ = 0.56, 2.01, and 1.49 at 25, 50, and 75 DAS and at respectively).

4.1.1.2 Effects of P+K fertilizer dose

A significant variation was observed for plant height of blackgram at 25, 50 and 75 DAS because of different P+K fertilizer doses (Fig. 2 and Appendix VI). It can be inferred from the figure that irrespective fertilizer doses plant height increased gradually with the advancement of growth stages. At 25 DAS, the highest plant height (19.71 cm) was observed from the treatment F_3 which was statistically similar with F_2 (19.06 cm) at 50% higher and 25% higher than the recommended dose of P+K and the lowest plant hight (13.89cm) was observed from the treatment F_0 (control). At 50 DAS the highest plant height (39.32 cm) was observed from the treatment F_3 which was statistically similar with F2 (38.94 cm) at 50% higher and 25% higher than recommended dose of P+K and the shortest plant (29.60 cm) was observed from the treatment F_0. At 75 DAS the tallest plant height (48.92 cm) was observed from the treatment F_3 which was statistically similar with F_2 (47.69 cm) at 50% higher and 25% higher than recommended dose of P+K and the lowest plant height (41.79 cm) was observed from the treatment F_0. The plant height is directly associated with the adequate supply of proper proportion of fertilizers. The finding in close conformity with that of Marsha (2016).



F_0 = Control, F_1 = Recommended dose of (P+K), F_2 = 25% of recommended dose of(P+K) fertilizer, F_3 =50% Recommended dose of (P+K) fertilizer

Fig. 2 Effect of different doses of P+K fertilizer on plant height at different days after sowing of blackgram (LSD $_{(0.05)}$) = 0.71, 2.56, and 1.89 at 25, 50, and 75 DAS, respectively)

4.1.1.3 Combined effects of organic manure with P+K fertilizer dose

Interaction effect of organic manure and different doses of P+K fertilizer showed significant variation on plant height at 25, 50, and 75 DAS (Table 1 and Appendix VI). At 25 DAS, the tallest plant (23.88 cm) was observed from the treatment OM_2F_3 which was statistically similar with OM_2F_2 (23.13 cm) and the shortest plant (11.7 cm) was observed from the treatment OM_0F_0. At 50 DAS, the tallest plant (41.02 cm) was observed from the treatment OM_2F_3 which was statistically similar with OM_2F_2 (40.65cm) and the shortest plant (27.77 cm) was observed from the treatment OM_0F_0. At 75 DAS, the tallest plant (53.62 cm) was observed from the OM_2F_3 treatment and the shortest plant 39.70 cm) was observed from the O_0F_0 treatment which was statistically similar with OM_0F_1 (41.95), and OM_1F_0 (42.40 cm).

Table 1. Interaction of organic fertilizer with different doses of P+K fertilizer on plant height at different days after sowing

Plant height(cm) at			
Treatment	**25 DAS**	**50 DAS**	**75 DAS**
OM_0F_0	11.70 g	27.77 f	39.69 fg
OM_0F_1	13.58 f	32.45 d-f	41.96 fg
OM_0F_2	15.99 d	37.18 a-d	43.22 e-g
OM_0F_3	16.28 d	37.58 a-d	43.95 d-g
OM_1F_0	14.38 ef	30.04 ef	42.39 fg
OM_1F_1	15.66 de	33.38 c-f	44.01 d-f
OM_1F_2	18.10c	38.98 a-c	47.04 c-e
OM_1F_3	18.96 bc	39.37 ab	47.62 cd
OM_2F_0	15.58 de	30.85 ef	43.29 e-g
OM_2F_1	20.21 b	34.16 b-d	49.03 bc
OM_2F_2	23.13 a	40.65 a	52.80 ab
OM_2F_3	23.88 a	41.01 a	53.62 a
$LSD_{(0.05)}$	**1.59**	**5.75**	**4.27**
CV%	**3.71**	**6.57**	**3.76**

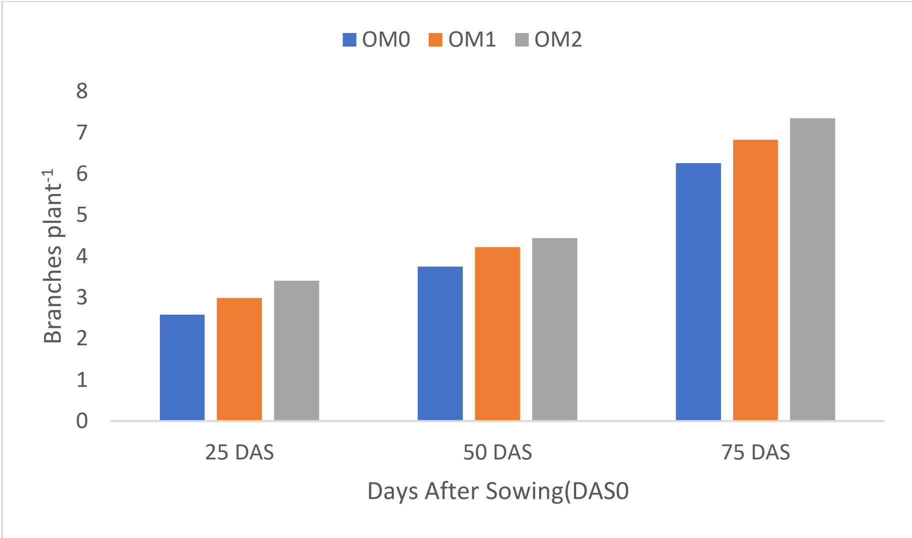
In a column means with having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability.

OM_0 = Control, OM_1 = Cowdung , OM_2 = Poultry litter; F_0 = Control, F_1 = Recommended dose of P+K fertilizer, F_2 = 25% higher than recommended dose of P+K fertilizer, F_3 = 50% higher than recommended dose of P+K fertilizer

4.1.2 branches plant^{-1}

4.1.2.1 Effect of organic manure

The number of branch plant^{-1} of blackgram was statistically significant by organic manure at 25, 50 and 75 DAS Fig. 3 and Appendix VII). The figure revealed that branches plant^{-1} showed a gradual increase in trend with the advances of growth stages irrespective organic manure treatment. However, at 25, 50 and 75 DAS and the treatment OM_2 (poultry litter) produced the maximum branches plant^{-1} (3.40, 4.44 and 7.35, respectively) and the treatment OM_0 (control) produced the minimum branches plant^{-1} (2.58, 3.75 and 6.27, respectively).

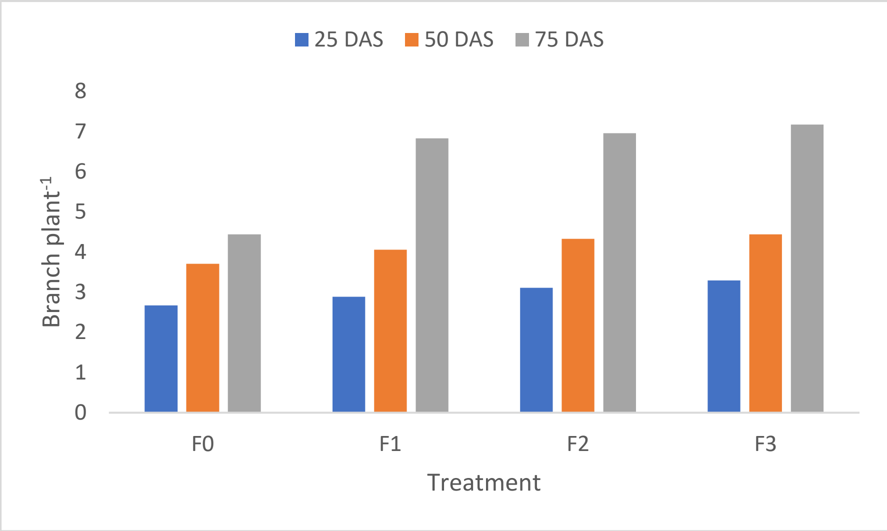


OM_0 = Control, OM_1 = Cowdung, OM_2 = Poultry litter

Fig. 3 Effect of of organic fertilizer on branch plant^{-1} at different days after sowing of Blackgram (LSD $_{(0.05)}$ = 0.15, 0.21, and 0.23 at 25, 50, and 75 DAS and at respectively).

4.1.2.2. Effect of P+K fertilizer dose

Significant variation was observed for branches plant^{-1} of blackgram at 25, 50 and 75 DAS because of different P+K fertilizer doses (Fig. 4 and Appendix VII). It can be inferred from the figure that irrespective of fertilizer doses branches plant^{-1} increased sharply with the advancement of growth stages. At 25 DAS, the highest number of branches plant^{-1} (3.29) was observed from the treatment F_3 which was statistically similar with F_2 (3.11) at 50% higher and 25% higher than recommended dose of P+K and the lowest number branches plant^{-1} (2.67) was observed from the treatment F_0 (control). At 50 DAS the highest plant height (4.45 cm) was observed from the treatment F_3 at 50% higher than recommended dose of P+K the lowest number of branches plant^{-1} (3.71) was observed from the treatment F_0. At 75 DAS the highest number of branches plant^{-1} (7.17) was observed from the treatment F_3 at 50% higher than recommended dose of P+K the lowest number of branches plant^{-1} (4.45) was observed from the treatment $F_{0.}$ The result of this experiment which shows that a vigorously increase in branches plant^{-1} as obtained by application of P+K was more relevant the findings of Teggelli *et al.*, (2016).



F_0 = Control, F_1 = Recommended dose of P+K, F_2 = 25% higher than recommended dose of P+K fertilizer, F_3 =50% higher than recommended dose of P+K fertilizer

Fig. 4 Effect of different doses of P+K fertilizer on branches plant^{-1} at different days after sowing of blackgram (LSD $_{(0.05)}$) = 0.19, 0.27, and 0.29 at 25, 50 and 75 DAS, respectively)

4.1.2.3 Effects of organic manure with P+K fertilizer dose

Interaction effect of organic manure and different doses of P+K fertilizers showed significant variation on branches plant^{-1} of blackgram at 25, 50 and 75 DAS (Table 2 and Appendix VII). At 25 DAS, the maximum number of branches plant^{-1} (3.68) was observed from the treatment OM_2F_3 and the minimum number of branches plant^{-1} (2.33) was observed from the treatment OM_0F_0. At 50 DAS, the highest branches plant^{-1} (4.84) was observed from the treatment OM_2F_3 and the lowest branches plant^{-1} (3.48) was observed from the treatment OM_0F_0. At 75 DAS, the highest branches plant^{-1} (7.75) was observed from the OM_2F_3 treatment and the lowest number of branches plant^{-1} (5.45) was observed from the OM_0F_0 treatment. Reddy *et al.;* (2011) reported that the increased in number of branches could be possible because the application of organic and inorganic fertilizers along with biofertilizers due to 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 Singh *et al.;* (2008; 2011) which support the present findings.

Table 2. Effect of organic manure with different doses of P+K fertilizer on branch plant^{-1} at different days after sowing

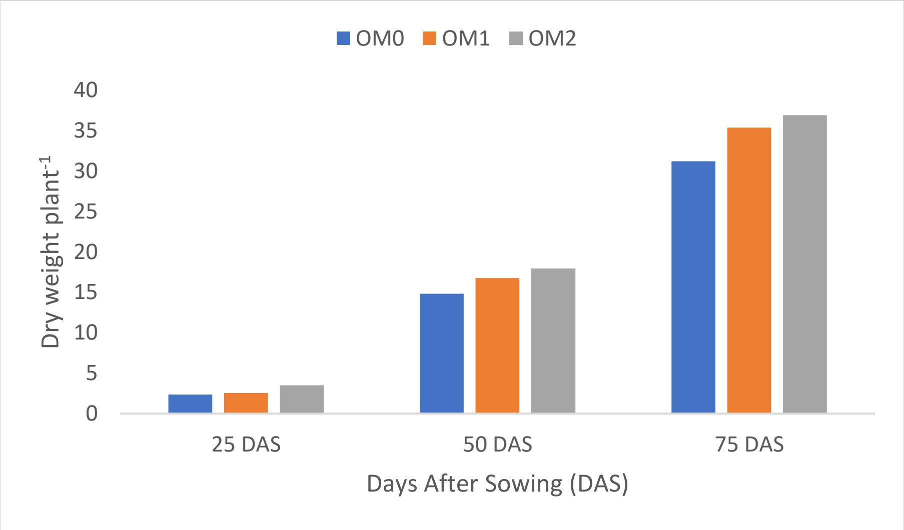
	Branches plant^{-1}(no.) at		
Treatment	**25 DAS**	**50 DAS**	**75 DAS**
OM_0F_0	2.33f	3.48 f	5.45 e
OM_0F_1	2.48 ef	3.69 ef	6.39 d
OM_0F_2	2.61 ef	3.86 c-f	6.49 d
OM_0F_3	2.89 de	3.93 c-f	6.73 cd
OM_1F_0	2.63 ef	3.75 d-f	6.53 d
OM_1F_1	2.88 de	4.15 b-e	6.85 d
OM_1F_2	3.16 b-d	4.44 a-c	6.89 b-d
OM_1F_3	3.29 a-c	4.55 ab	7.04 b-d
OM_2F_0	3.05 cd	3.90 c-f	6.88 b-d
OM_2F_1	3.33 a-c	4.33 a-d	7.25 a-c
OM_2F_2	3.56 ab	4.67 ab	7.50 ab
OM_2F_3	3.68 a	4.84 a	7.78 a
$LSD_{(0.05)}$	0.41	0.59	0.64
CV%	**5.54**	**5.81**	**3.79**

In a column means with having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability.
OM_0 = Control, OM_1 = Cowdung , OM_2 = Poultry litter; F_0 = Control, F1 = Recommended dose of P+K fertilizer, F_2 = 25% higher than recommended dose of P+K fertilizer, F_3 = 50% higher than Recommended dose of P+K fertilizer

4.1.3 Dry weight

4.1.3.1 Effect of organic manure

Dry weight of plant in blackgram varied significantly due to different organic manure have been presented in Fig. 5 (Appendix VIII). The figure shows a steady increasing trend with the advances of growth stages and the maximum increase was recorded at harvest stage, irrespective of organic manure treatments. Poultry litter treatment (OM_2) showed the maximum dry weight for all sampling dates followed by cowdung (OM_1) and the lowest dry weight was found with OM_0 (control) treatment. At 25, 50 DAS and at harvest the treatment OM_2 produced the highest dry weight of plant (3.50, 17.95 and 36.94 g, respectively). In case of 25, 50 DAS and at harvest, the lowest dry weight of plant are produced by the treatment OM_0 (2.356, 14.84 and 31.23 g, respectively).

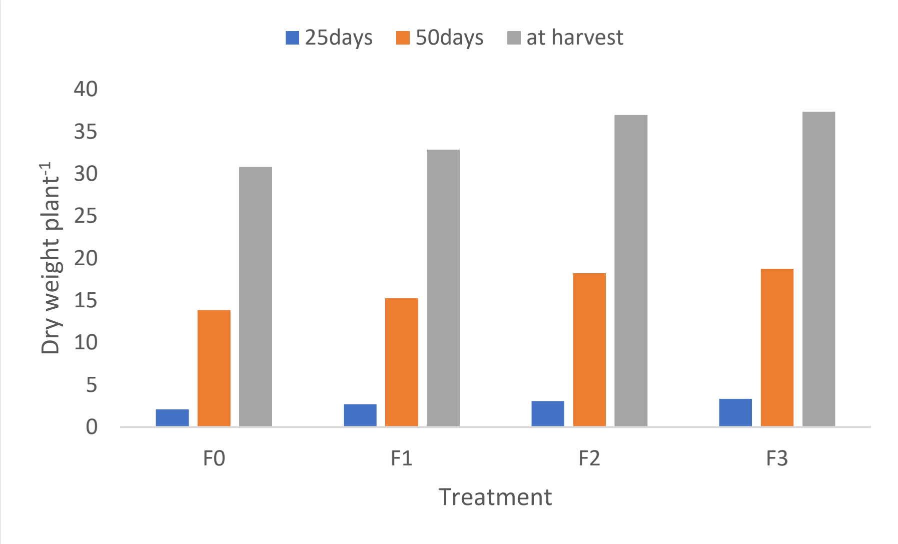


OM_0 = Control, OM_1 = Cowdung , OM_2 = Poultry litter

Fig. 5 Effect of organic manure on plant dry weight at different days after sowing of blackgram (LSD $_{(0.05)}$ = 0.21, 0.66 and 1.52 at 25, 50 DAS and at harvest, respectively).

4.1.3.2 Effects of P+K fertilizer dose

Results of dry weight plant^{-1} due to different doses of P+K fertilizers have been presented in (Fig. 6 and Appendix VIII). It can be inferred from the figure that irrespective fertilizer doses, dry weight plant^{-1} increased gradually with the advances of growth stages. It can be inferred that F_3 and F_2 treatment were found superior than other doses for all sampling dates in producing dry weight plant^{-1}. Laltlanmawia *et al.*, (2004) reported that the plant dry weight of black gram influenced significantly due to different levels of potash which support the present findings.



F_0 = Control, F_1 = Recommended dose of P+K fertilizer, F_2 = 25% of recommended dose of P+K fertilizer, F_3 =50 % Recommended dose of P+K fertilizer

Fig. 6 Effect of P+K fertilizer on plant dry weight at different days after sowing of blackgram (LSD $_{(0.05)}$ = 0.27, 0.84, 0.35 and 0.61 at 25, 50, DAS and at harvest, respectively).

4.1.3.3 Effects of organic manure with P+K fertilizer dose

Significant variation was found in combined effect of organic manure and different doses of P+K fertilizer on plant dry weight plant^{-1} at 25, 50, DAS and at harvest (Table 3 and Appendix VIII). At 25 DAS, the highest plant dry weight (3.92 g) was observed from the treatment OM_2F_3 and the lowest plant dry weight (1.56 g) was observed from the treatment OM_0F_0. At 50 DAS, the highest plant dry weight (20.42 g) was observed from the OM_2F_3 treatment and the lowest plant dry weight (12.21 g) was observed from the OM_0F_0 treatment. At harvest stage the highest plant dry weight (40.51g) was observed from the treatment OM_2F_3 which was statistically similar with OM_2F_2 (39.96 g) and the lowest plant dry weight (28.67 g) was observed from the treatment OM_0F_0.

Table 3. Effect of organic manure with different doses of P+K fertilizer on plant dry weight of blackgram at different days after sowing

	Dry weight plant^{-1} (g) at		
Treatment	**25days**	**50days**	**75days**
OM_0F_0	1.56 g	12.21 f	28.67 f
OM_0F_1	2.32 ef	14.25e	30.04 ef
OM_0F_2	2.71 de	16.11 de	32.95 de
OM_0F_3	2.84 c-e	16.79 cd	33.26 de
OM_1F_0	1.82 fg	14.36 e	31.22 d-f
OM_1F_1	2.38 ef	15.29 de	33.92 c-e
OM_1F_2	2.85 c-e	18.46 bc	38.01 a-c
OM_1F_3	3.21 bd	19.04 ab	38.34 ab
OM_2F_0	2.91 c-e	15.01 de	32.59 d-f
OM_2F_1	3.42 a-c	16.28 d	34.65 b-d
OM_2F_2	3.69 ab	20.10ab	39.99 a
OM_2F_3	3.98 a	20.42 a	40.51 a
$LSD_{(0.05)}$	**0.59**	**1.89**	**4.26**
CV%	**8.57**	**4.60**	**4.96**

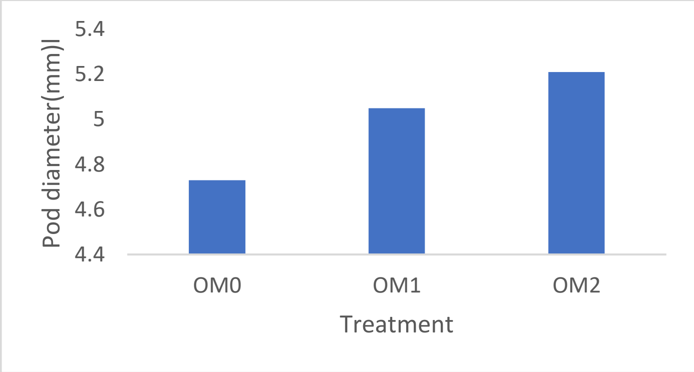
In a column means with having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability. OM_0 = Control, OM_1 = Cowdung, OM_2 = Poultry litter; F_0 = Control, F_1 = Recommended dose of P+K fertilizer, F_2 = 25% higher than recommended dose of P+K fertilizer, F_3 = 50% than recommended dose of P+K fertilizer

4.2 Yield contributing characters

4.2.1 Pod diameter

4.2.1.1 Effect of organic manure

There observed a significant variation on pod diameter of blackgram due to the effect of organic manure (Fig. 7 and Appendix IX). The data expresses that OM_2 (poultry litter) treatment was found superior in producing pod length (5.21 mm) than other treatments and the inferior treatment was OM_0 (control) in producing pod length (4.73 mm) of blackgram.

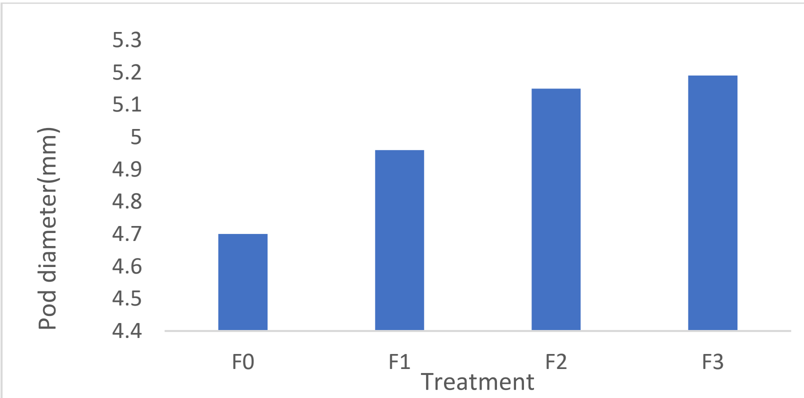


OM_0 = Control, OM_1 = Cowdung , OM_2 = Poultry litter

Fig. 7 Residual effect of organic fertilizer on pod length of blackgram (LSD $_{(0.05)}$ =0.17

4.2.1.2 Effect of P+K fertilizer dose

Significant variation was observed in the diameter of pod of blackgram when different levels of P+K fertilizer were applied (Fig. 8 and Appendix IX). The maximum diameter of pod (5.19 mm) was recorded in F_3 treatment which was statistically at par with F_2 treatment (5.15 mm). On the other hand, the lowest diameter of pod (4.48 cm) was recorded with F_0 (control) treatment. Azadi *et al.* (2013) also reported that the highest pod length was with higher fertilizer dose upto a certain limit which correlates with the present finding.



F_0 = Control, F_1 = Recommended dose of (P+K) fertilizer, F_2 = 25% of recommended dose of (P+K) fertilizer, F_3 = Recommended dose of (P+K) fertilizer

Fig. 8 Effect of P+K fertilizer on pod diameter plant^{-1} of blackgram (LSD $_{(0.05)}$) =0.21)

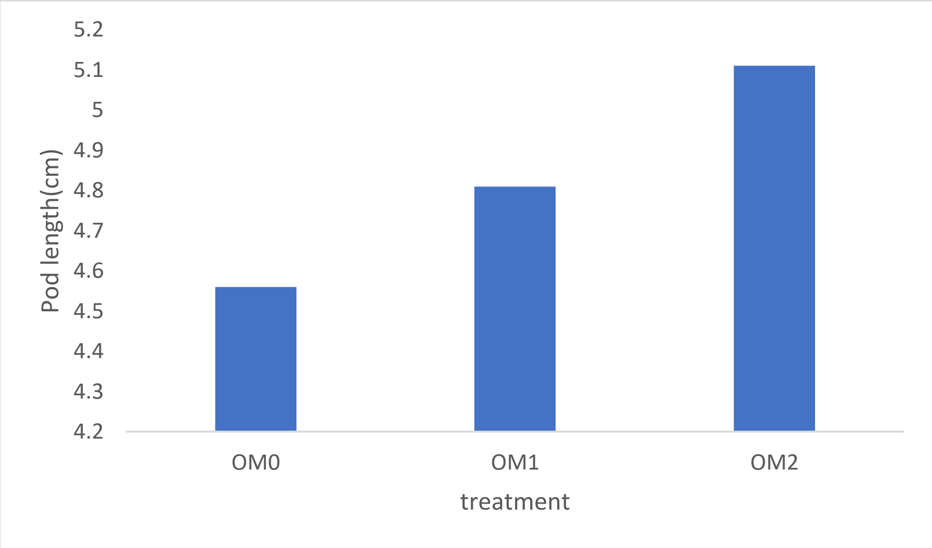
4.2.1.3 Effects of organic manure with P+K fertilizer dose

Effect of organic manure residue and P+K fertilizer exerted significant effect on pod diameter (Table 4 and Appendix IX). The highest diameter of pod (5.43 mm) was observed with OM_2F_3 and the lowest diameter of pod (4.47 mm) was recorded with OM_0F_0 treatment. Similar result also reported by Sharma *et at* (1997) which supports the present findings.

4.2.2 Pod length

4.2.2.1 Effect of organic manure

There observed a significant variation on pod length of blackgram due to application of different organic manure (Fig. 9 and Appendix IX). The data expresses that OM_2 (poultry litter) treatment was found superior in producing pod length (5.11 cm) than other treatments and the inferior treatment was OM_0 (control) in producing pod length (4.56 cm) of blackgram.

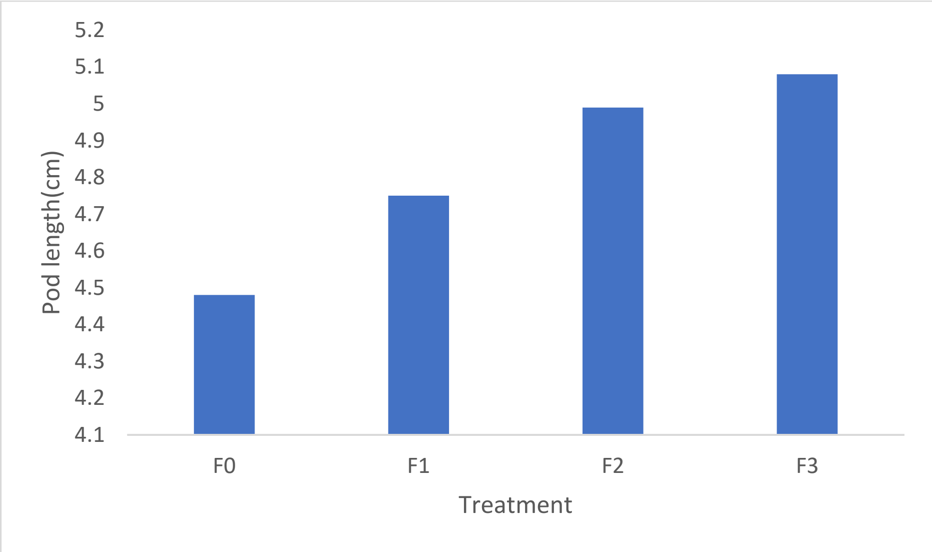


OM_0 = Control, OM_1 = Cowdung , OM_2 = Poultry litter

Fig. 9 Effect of organic manure on pod length of blackgram (LSD $_{(0.05)}$ = 0.18)

4.2.2.2 Effect of P+K fertilizer dose

Significant variation was observed in the length of pod of blackgram when different levels of P+K were applied (Fig. 10 and Appendix IX). The highest length of pod (5.082 cm) was recorded in F_3 treatment which was statistically at par with F_2 treatment (4.99 cm). On the other hand, the lowest length of pod (4.48 cm) was recorded with F_0 (control) treatment. Thesiya *et al*. (2013) also found the similar result of the pod length.



F_0 = Control, F_1 = Recommended dose of (P+K) fertilizer, F_2 = 25% of recommended dose of (P+K) fertilizer, F_3 = Recommended dose of (P+K) fertilizer

Fig. 10 Effect of P+K fertilizer dose on pod length pod^{-1} of blackgram (LSD $_{(0.05)}$ = 0.23)

4.2.2.3 Effects of organic manure with P+K fertilizer dose

Combined effect of organic manure and P+K fertilizer exerted significant effect on pod length of blackgram(Table 4 and Appendix IX). The highest length of pod (5.40 cm) was observed in the treatment combination of OM_2F_3 which was statistically similar with OM_2F_2, OM_2F_1, OM_1F_2, and OM_0F_3. On the other hand, the lowest length of pod (4.35 cm) was recorded with OM_0F_0 treatment which was statistically at par with OM_0F_1, OM_0F_2, OM_0F_3, OM_1F_0, OM_1F_1, and OM_2F_0 combinations. Similar result was also reported by Sharma *et at* (1997) which supports the present findings.

Table 4 Effect of organic manure with different doses of P+K fertilizer on yield contributes of blackgram

Treatment	Pod diameter (mm)	Pod length (cm)	Pods plant^{-1} (no.)	Seed pod^{-1}(no.)	1000 seeds weight (g)	plant Seed weight $^{-1}$(g)
OM_0F_0	4.47 e	4.35 e	14.40 f	4.68 e	32.66 e	2.45 d
OM_0F_1	4.65 de	4.53 c-e	15.78 e	4.78 de	33.39 e	2.53 cd
OM_0F_2	4.89 de	4.65 b-e	19.75 cd	4.93 c-e	33.56 e	2.70 cd
OM_0F_3	4.92 b-e	4.72 b-e	19.99 cd	4.99 c-e	34.62de	2.77 cd
OM_1F_0	4.76 c-e	4.47 de	15.03 ef	4.94 c-e	34.41de	2.62 cd
OM_1F_1	5.03 a-d	4.69 b-e	18.90 d	5.06 b-e	36.38 cd	2.99 cd
OM_1F_2	5.19 a-c	4.98 a-d	25.72 b	5.34 a-d	37.41 c	4.12 b
OM_1F_3	5.21 a-c	5.13 ab	25.99 b	5.57 a-c	39.71 b	4.55 ab
OM_2F_0	4.86 c-e	4.62 b-e	16.04 e	5.16 a-e	32.72 e	2.66 cd
OM_2F_1	5.19 a-c	5.03 a-c	20.58 c	5.41 a-d	37.71bc	3.23 c
OM_2F_2	5.37 ab	5.37 a	28.97 a	5.64 ab	44.72 a	4.72 ab
OM_2F_3	5.44 a	5.40 a	29.65 a	5.76 a	44.14 a	4.95 a
$LSD_{(0.05)}$	**0.47**	**0.52**	**1.23**	**0.65**	**2.09**	**0.74**
CV%	**3.76**	**4.35**	**2.37**	**5.02**	**2.29**	**8.82**

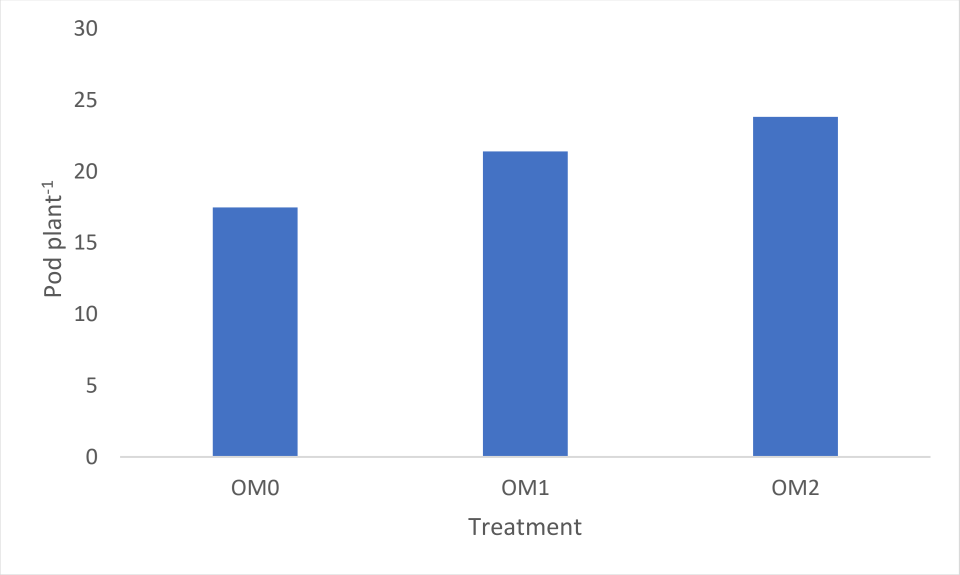
In a column means with having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability.
OM_0 = Control, OM_1 = Cowdung, OM_2 = Poultry litter; F_0 = Control, F_1 = Recommended dose of chemical fertilizer, F_2 = 25% higher than recommended dose of chemical fertilizer, F_3 =50% than recommended dose of P+K fertilizer.

4.2.3 Pods plant^{-1}

4.2.3.1 Effect of organic manure

Statistically significant difference was found for number of pod plant^{-1} of blackgram due to the effect of organic manure (Fig. 11 and Appendix IX). The highest number of pod plant^{-1} (23.81) was recorded from OM_2 treatment, whereas, the lowest (17.48) was observed from OM_0 treatment. It was observed that number of pod plant^{-1} increased with the application of poultry litter and cowdung over control. Reddy *et.al*

41 al. (1998) found that application of vermicompost and chemical fertilizer increased the number of pods plant^{-1} in blackgram which collaborates the present findings.

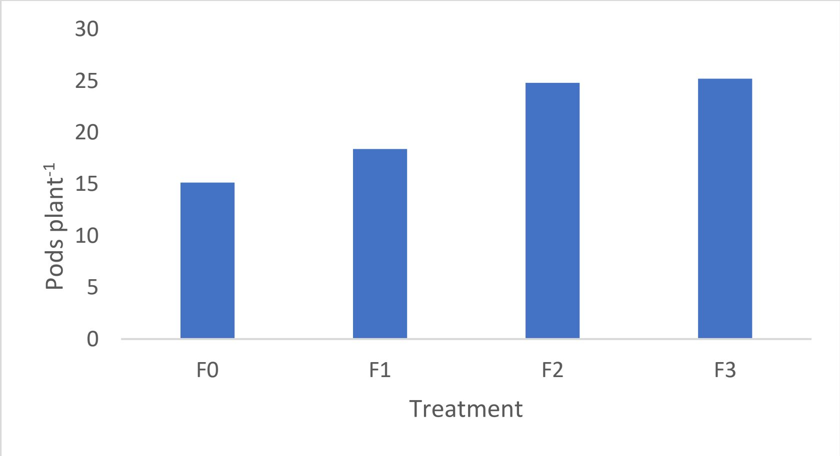


OM_0 = Control, OM_1 = Cowdung , OM_2 = Poultry litter

Fig. 11 Effect of organic manure on pods plant^{-1} of blackgram (LSD $_{(0.05)}$ =0.43)

4.2.3.2 Effect of P+K fertilizer dose

The number of pods plant^{-1} was significantly influenced by different doses of P+K fertilizer (Fig. 12 and Appendix IX). The figure shows that the highest number of pod plant^{-1} (25.22) was obtained from F_3 treatment which was statistically similar with F_2 (24.81). On the other site the lowest number of pod plant^{-1} (15.16) was obtained from F_0 treatment. It was observed that number of pod plant^{-1} increased gradually with the increase of P+K fertilizer doses. This might be due to higher availability of N and P_2O_5 and their uptake that progressively increase photosynthesis and other physiological function of plant resulting in higher pods plant^{-1}. Tank *et al.* (1992) also observed that blackgram fertilized with N along with P_2O_5 significantly increased the number of pods plant $^{-1}$



F_0 = Control, F_1 = Recommended dose of P+K fertilizer, F_2 = 25% higher than recommended dose of P+K fertilizer, F_3 = 50% higher than recommended dose of P+K fertilizer.

Fig. 12 Effect of P+K fertilizer on pod plant^{-1} of blackgram (LSD $_{(0.05)}$) =0.55

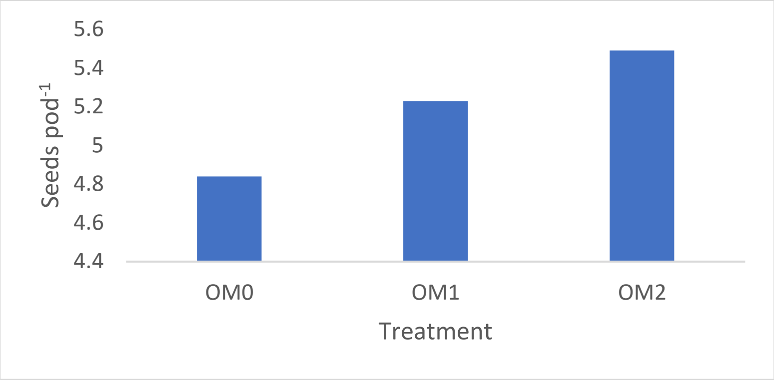
4.2.3.3 Combined effects of organic fertilizer with P+K fertilizer

Number of pods plant^{-1} was significantly affected by the combination of effect of organic manure and P+K fertilizer which is shown in (Table 4 and Appendix IX). Effect of poultry litter with recommended dose of P+K fertilizer (OM_2F_3) scored the maximum number of pods plant^{-1} (29.65) which was statistically at par with OM_2F_2 (28.97) and minimum number of pod plant^{-1} (14.4) was recorded at no organic manure with no use of P+K fertilizer combination (OM_0F_0). It was also similar with the result of Slag and Yadav (1999).

4.2.4 Seed pod^{-1}

4.2.4.1 Effect of organic manure

Number of seeds pod^{-1} of blackgram differed significantly due to residual effect of different organic fertilizer (Fig. 13 and Appendix IX**).** It was observed maximum number of seeds pod^{-1} (5.50) in OM_2 (poultry litter) treatment and the minimum was with the lowest dose OM_0(4.73). It revealed that poultry litter have the greatest effect on seeds per pod of blackgram. Pannu *et al.* (2007) reported that the application of FYM as well as PM gave the higher number of pods plant^{-1} which supports the present result.

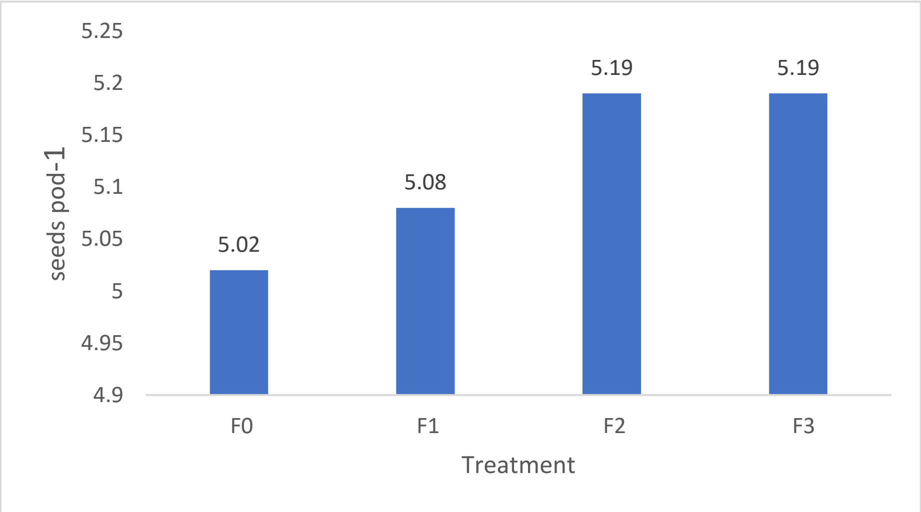


OM_0 = Control, OM_1 = Cowdung , OM_2 = Poultry litter

Fig. 13 Residual effect of organic fertilizer on number of seed per pod of blackgram (LSD $_{(0.05)}$ = 0.23)

4.2.4.2 Effect of P+K fertilizer dose

A critical analysis of mean data (Fig. 14 and Appendix IX) revealed that different doses of P+K fertilizer had significant influence on seed per pod value. Seed per pod value increased with the increase of P+K fertilizer doses. Maximum seed per pod value (5.44) was recorded from F_3 treatment which was statistically at par with F_2 treatment (5.30). Minimum seed per pod value (4.93) was recorded F_0 treatment. Hussain *et al.*, (2011) reported that different potassium levels significantly influenced the number of pods plant^{-1}, number of seeds pod^{-1}, seed yield and yield contributing parameters.



F_0 = Control, F_1 = Recommended dose of P+K fertilizer, F_2 = 25% higher than recommended dose of P+K fertilizer, F_3 = 50% higher recommended dose of P+K fertilizer.

Fig. 14 Effect of P+K fertilizer on seeds plant^{-1} of blackgram (LSD $_{(0.05)}$) =0.29)

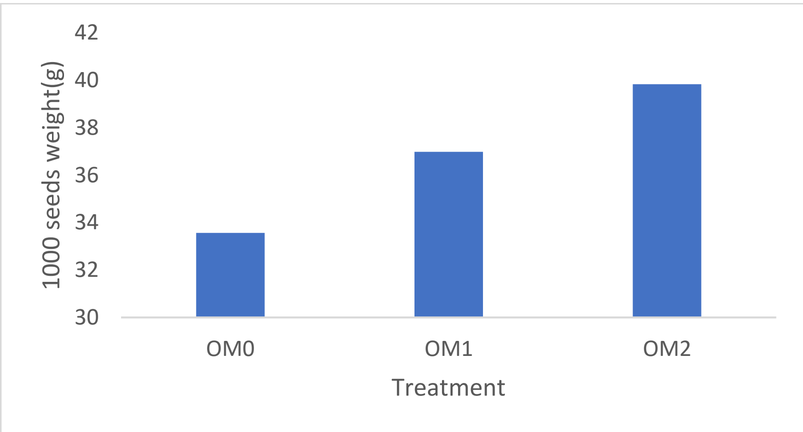
4.2.4.3 Effects of organic manure with P+K fertilizer dose

Interaction effect between the effect of organic manure and different doses of P+K fertilizer exerted significant effect on number of seeds pod^{-1} (Table 4 and Appendix IX). The highest number of seed per pod (5.76) was observed from the OM_2F_3 treatment. The lowest number of seed per pod (4.68) was observed from the OM_0F_0 treatment.

4.2.5 1000 seed weight

4.2.5.1 Effect of organic manure

Significant variation was observed on weight of 1000 seed of blackgram due to the effect of different organic manure (Fig. 15 and Appendix IX). The treatment OM_2 produced the highest weight of 1000 seed (39.83 g) and the OM_0 produced the lowest 1000 seed weight (33.56 g). Abedin *et al.* (1999) and Apostol (1989) reported that the combined application of organic manure increased the 1000-grain weight of rice. Hoque (1999) also recorded that 1000-grain weight were increased by the application of organic manure.

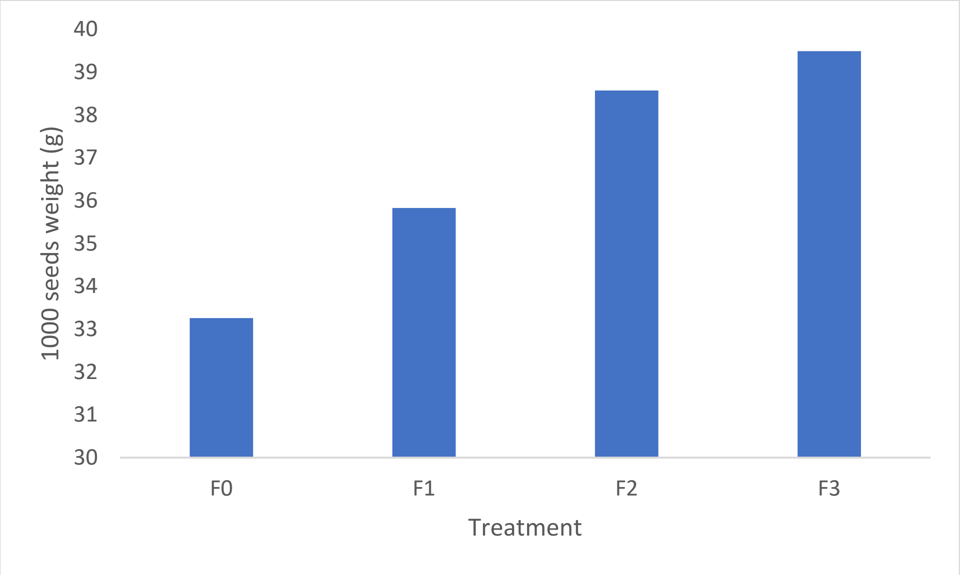


OM_0 = Control, OM_1 = Cowdung , OM_2 = Poultry litter

Fig. 15 Effect of organic manure on 1000 seed weight of blackgram (LSD $_{(0.05)}$ = 0.73)

4.2.5.2 Effect of P+K fertilizer dose

Significant variation was observed in 1000 seed weight of blackgram when different levels of P+K fertilizer were applied (Fig. 16 and Appendix IX). The figure shows that weight of 1000 seed of blackgram showed an increasing trend with the increase of P+K fertilizer level and highest increase was found with highest P+K fertilizer dose (F_3). However, the value maximum weight of 1000 seed of blackgram (39.49 g) was recorded in F_3 treatment which was statistically at par with F_2 (44.15). On the other hand, minimum weight of 1000 seed of blackgram (32.66g) was recorded with F_0 treatment.



F_0 = Control, F_1 = Recommended dose of P+K fertilizer, F_2 = 25% higher than recommended dose of P+K fertilizer, F_3 = 50% higher than recommended dose of P+K fertilizer.

Fig. 16 Effect of P+K fertilizer on 1000 seed weight of blackgram (LSD $_{(0.05)}$) = 0.93)

4.2.5.3 Effects of organic manure with P+K fertilizer dose

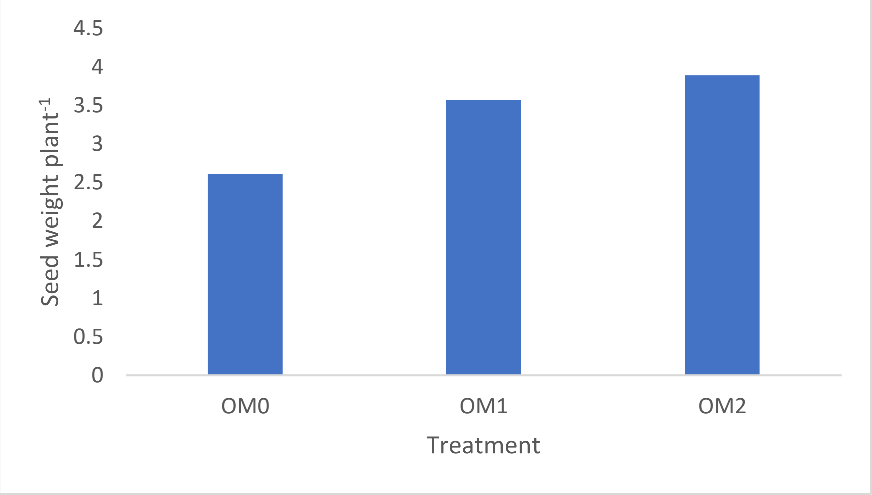
The combined effect of different integration of organic manure and different doses of P+K fertilizer showed statistically significant variation for 1000 seed weight of blackgram (Table 4 and Appendix IX). The result revealed that the highest 1000 seed weight was observed in OM_2F_3 (44.72 g) which was statistically similar with F_2OM_2(44.15gm). The lowest 1000 seed weight (32.66 g) was recorded in OM_0F_0 treatment which was similar with OM_0F_1 (33.40g), OM_0F_2(33.56g) It is clearly observed that the application of poultry litter with different levels of P+K fertilizer showed better performance in producing 1000-seed weight of blackgram.

4.2.6 Seed weight plant^{-1}

4.2.6.1 Effect of organic manure

Significant effect was observed on weight of seed plant^{-1} due to organic manure application in blackgram (fig 17 and appendix IX). The highest weight of seed plant^{-1}

(3.89gm) was achieved from the (OM_2) treatment and the lowest weight of seed plant^{-1}(2.61gm) was found from (OM_0) treatment.

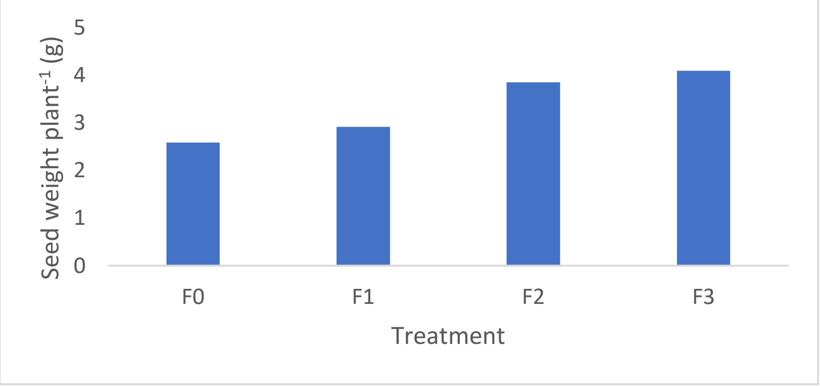


OM_0 = Control, OM_1 = Cowdung , OM_2 = Poultry litter

Fig. 17 Effect of organic manure on seed weight plant^{-1} of blackgram (LSD $_{(0.05)}$ = 0.26).

4.2.6.2 Effect of P+K fertilizer dose

Weight of seed plant^{-1} of blackgram exerted significant variation due K+P fertilization at different levels **(**Figure 18 and appendix IX). The figure indicated that the trend of weight of seed plant^{-1} increased sharply up to F_3 (4.09 gm) treatment which was statistically similar with F_2 (3.84 gm) treatment. However, the lowest weight of seed plant^{-1} (2.58 gm) was found with F_0 treatment.



F_0 = Control, F_1 = Recommended dose of P+K fertilizer, F_2 = 25% higher than recommended dose of P+K fertilizer, F_3 = 50% higher than recommended dose of P+K fertilizer.

Fig. 18 Effect of P+K fertilizer on seed weight plant^{-1} of blackgram (LSD $_{(0.05)}$ = 0.33)

4.2.6.3 Effects of organic manure with P+K fertilizer dose

Interaction effect of organic manure and K+ P level showed significant result. Where OM_2F_3 showed the highest result (4.95g) and OM_0F_0 showed lowest result (2.45 gm). (Table 4 and Appendix IX). Sharma and Sharma (2004) determined the effects of P (0, 20 and 40 kg ha^{-1}), potassium (0 or 20 kg/ha) and Rhizobium inoculation on the growth and yield of lentil cv. L-4147. The mean number of branches, nodules and pods per plant; 1000 seed weight and seed yield were highest with the application of 40 P kg/ha, whereas mean plant height and plant stand row length were highest with the application of 20 P kg ha^{-1}. These findings collaborates the results of the present experiment.

4.3 Yield parameter

4.3.1 Seed yield

4.3.1.1 Residual effect of organic fertilizer

It was noticed that statistically significant differences were found for seed yield of blackgram due to the effect of organic manure (Table 5 and Appendix X). The result revealed that OM_2 treatment showed the highest seed yield (1419.5 kgha^{-1}) which was followed by OM_1(1240.7) on the other hand OM_0 treatment gave the lowest seed yield (1156.5 kg ha^{-1}). The result indicated that OM_2 (poultry litter) applied treatment was highest seed yield from cowdung treatment OM_1

4.3.1.2 Effect of P+K fertilizer dose

It was observed that statistically non-significant differences were found for seed yield of blackgram due to different doses of P+K fertilizer (Table 6 and Appendix X). It can be said from the table that seed yield increased gradually with the increase of P+K doses. The maximum seed yield (1372.6 kg ha^{-1}) was recorded from F_3 treatment which was statistically similar with F_2 (1332.7). On the contrary the minimum seed yield (1118.3 kg ha^{-1}) was recorded from F_0 treatment. The result revealed that F_3 treatment out yielded over F_1 and F_0 by producing 2.99 and 22.74%% higher yield, respectively. The result is in agreement with the findings of Sadeghipour *et al*. (2010), who found that the maximum seed yield was obtained at higher fertilizer level.

4.3.1.3 Effects of organic manure with P+K fertilizer dose

Effect of organic manure and different doses of P+K fertilizer showed significant variation in seed yield of blackgram (Table 7 and Appendix X). The highest seed yield (1529.4 kg ha^{-1}) was recorded from the combination of OM_2F_3 treatment. The lowest yield (1037.5 kg ha^{-1}) was recorded from the combination of OM_0F_0 treatment. Similar trends of results were reported by Raundal *et al*. (1999) and Satish *et al*. (1999). Combination of organic and inorganic fertilizers was found better by Channaveerswami (2005) in groundnut and Rajkhowa *et al*. (2002) in green gram than only inorganic fertilizers.

4.3.2 Stover yield

4.3.2.1 Effect of organic manure

Stover yield was significantly influenced by the residual effect of dfferent organic manure (Table 5 and Appendix X). Treatment OM_2 (poultry litter) gave the highest stover yield of blackgram (1652.8 kg ha^{-1}) and the lowest stover yield (1500.5 kg ha^{-1}) was observed in OM_0 (control) treatment.

4.3.2.2 Effect of P+K fertilizer dose

Stover yield of blackgram varied significantly due to different doses of P+K fertilizer application (Table 6 and Appendix X). Maximum stover yield (1609.2 kgha^{-1}) was observed from F_3 treatment which was statistically similar with F_2 and F_1treatment while minimum stover yield (1442.8kgha^{-1}) from F_0 (control) treatment.

4.3.2.3 Effects of organic manure with P+K fertilizer dose

Effect between residual effects of organic manure and different doses of P+K fertilizer showed significant effect on strover yield of blackgram (Table 7 and Appendix X). The highest strover yield (1759.4 kgha^{-1}) was observed in the OM_2F_3 treatment which was statistically similar with OM_2F_2, OM_2F_1 and OM_1F_3 combinations (1728.3, 1686.4 and 1561.0 kg ha^{-1}, respectively. The lowest strove yield (1421.9 kg/ha) was observed in the OM_0F_0 treatment combination which at par with all the combination except OM_2F_3 OM_1F_0 and OM_2F_1 comniations (1437.2 and 1469.3 kgha^{-1}, respectively). Similar result was observed by Bharne *et al* (2003).

4.3.3 Biological yield

4.3.3.1 Effect of organic manure

Significant variation was observed on biological yield of blackgram due to application of different organic manure (Table 5 and Appendix X). It was observed from the data that biological yield increased over control due to application of organic manure. Among the organic manure, OM_2 (poultry litter) showed the maximum yield (3075.3 kg ha^{-1}. On the other hand, the minimum yield (2638.5 kg ha^{-1}) was observed in the OM_0 (control) treatment.

4.3.3.2 Effect of P+K fertilizer dose

The effect of different doses of P+K fertilizer on biological yield of blackgram was significant (Table 6 and Appendix X). It was found from the table that biological yield increased gradually with the increase of P+K doses. The maximum biological yield (2990.1 kg ha^{-1}) was produced from F_3 (50% higher dose of P+K) treatment which was statistically similar with F_2 (2932.5 kg ha^{-1}) treatment. On the other hand, the minimum yield (2566.8 kg ha^{-1}) was observed in F_0 treatment. Sardana *et al.* (1987) stated that the application of nitrogen, phosphorus and potassium fertilizers in combination resulted in the significant increase in biological yield of blackgram which supports the present findings.

4.3.3.3 Effects of organic manure with P+K fertilizer dose

Effects of organic manure and different doses of P+K fertilizer had significant effect on biological yield of blackgram (table 7, appendix X). The maximum biological yield (3288.8 kg ha^{-1}) was observed in the treatment combination of OM_2F_3 which was statistically similar with OM_2F_2 and OM_2F_1 treatment (3248.0 kg $ha^{-1}$and 3116.9 kg ha^{-1} respectively). On the other hand, the minimum biological yield (2459.9 kg ha^{-1}) was recorded with OM_0F_0 treatment. It can be explained from the table that biological yield increased with the residual effect of organic fertilizers with different doses of chemical fertilizer than contor treatment.

4.3.4 Harvest index

4.3.4.1 Effect of organic manure

Significant difference was observed due to the effect of organic manure on harvest index of blackgram (Table 5 and Appendix X). Numerically, the highest harvest index (45.94%) was found in OM_2 (poultry litter) treatment and lowest harvest index

(43.86%) was obtained from the OM_0 (control) treatment which was statistically at par with OM_1 (cowdung) (45.02%).

Table 5. Effect organic manure on yield and harvest index of blackgram

Treatment	Seed yield kg ha^{-1}	Stover yield kg ha^{-1}	Biological yield kg ha^{-1}	Harvest index%
OM0	1156.5 c	1500.5 b	2638.4 c	43.86 b
OM_1	1240.7 b	1512.5 b	2763.0 b	45.01 ab
OM_2	1419.5 a	1652.8 a	3075. a	45.94 a
$LSD_{(0.05)}$	**33.474**	**70.29**	**75.64**	**1.19**
CV%	**3.03**	**8.66**	**5.18**	**3.08**

In a column means with having similar letter(s) differ significantly by LSD at 0.05 level of probability.
OM_0 = Control, OM_1 = Cowdung, OM_2 = Poultry litter

4.3.4.2 Effect of P+K fertilizer dose

Harvest index was significantly influenced by different doses of P+K fertilizer application (Table 6 and Appendix X). From the present study table showed that the highest harvest index (46.11%) was recorded in F_3 which was statistically at par with F_2 and F1 (45.33% and 44.74%) and the lowest harvest index (43.52%) was achieved by F_0 treatment. There observed that the successive increase in phosphorus levels significantly increased number of pods plant^{-1}, number of grains pod^{-1}, seed weight, grain yield, straw yield and biological yield is close to 40 kg per hectare, which was comparable application of highest level of 60 kg ha^{-1} and no significant effect was observed on harvest index Maya Yadav *et al*.; (2017) [8]

Table 6. Effect P+K fertilizer on yield and harvest index of blackgram

Treatment	Yield kgha^{-1}	Straw yield kg ha^{-1}	Biological yield kg ha^{-1}	Harvest index%
F_0	1118.3 c	1442.8 b	2566.8 c	43.52 b
F_1	1332.7 b	1569.4 ab	2813.1 b	44.79 ab
F_2	1332.7 a	1599.7	2932.5 a	45.33 a
F_3	1372.6 a	1609.2 a	2990.1 a	46.11 a
$LSD_{(0.05)}$	**42.61**	**89.48**	**96.28**	**1.53**
CV%	**3.03**	**5.21**	**3.08**	**3.08**

In a column means with having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability.

F_0 = Control, F_1 = Recommended dose of P+K fertilizer, F_2 = 25% higher than recommended dose of P+K fertilizer, F_3 = 50% higher than recommended dose of P+K fertilizer

4.3.4.3 Effects of organic manure with P+K fertilizer dose

Effect of organic manure and different doses of P+K fertilizer showed significant effect on harvest index of blackgram (Table 7 and Appendix X). The highest harvest index (46.59%) was observed in the OM_2F_3 treatment. The lowest harvest index (42.19%) was observed in OM_0F_0 treatment.

Table 7. Effect of organic manure with different doses of P+K fertilizer on yield and harvest index of blackgram

Treatment	Seed yield kg ha^{-1}	Stover yield kg ha^{-1}	Biological yield kg ha^{-1}	Harvest index%
OM_0F_0	1037.5 h	1421.9 d	2459.9 f	42.19 c
OM_0F_1	1151.7 fg	1532.0 b-d	2609.0 d-f	43.77 a-c
OM_0F_2	1195.5 efg	1541.0 b-d	2736.6 c-e	44.290 a-c
OM_0F_3	1241.2 ef	1507.0 cd	2748.2 c-e	45.175 a-c
OM_1F_0	1119.1 gh	1469.3 d	2592 ef	43.14 bc
OM_1F_1	1213.6 e-g	1489.8 cd	2713.5 de	44.73 a-c
OM_1F_2	1283.0 de	1529.9 bd	2812.9 cd	45.61 ac
OM_1F_3	1347.2 cd	1561.0 a-d	2933.2 bc	46.09 ab
OM_2F_0	1198.4 e-g	1437.2 d	2648.1 d-f	45.25 a-c
OM_2F_1	1430.5 bc	1686.4 a-c	3116.9 ab	45.89 ab
OM_2F_2	1519.7 ab	1728.3 ab	3248.0 a	46.55 ab
OM_2F_3	1529.4 a	1759.4 a	3288.8 a	46.59 a
$LSD_{(0.05)}$	**95.74**	**201.05**	**216.32**	**3.43**
CV%	3.03	5.21	3.08	3.08

In a column means with having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability. OM_0 = Control, OM_1 = Cowdung, OM_2 = Poultry litter; F_0 = Control, F_1 = Recommended dose of P+K fertilizer, F_2 = 25% higher than recommended dose of P+K fertilizer, F_3 = 50% higher than recommended dose of P+K fertilizer

4.4 Seed quality parameter

4.4.1 Germination percentage

4.4.1.1 Effect of organic manure

Seed germination was influenced by different organic manure treatment (Table 8 and appendix XI.**).** It was found that the highest percentage of seed germination (92.07%) was found from the seeds produced from OM_2 treatment and the lowest percentage of seed germination (82.39%) as found with OM_0 (control)treatment

4.4.1.2 Effect of P+K fertilizer dose

Significant difference was observed due to the different doses of P+K fertilizers on germination percentage of blackgram **(**Table 9 and Appendix XI**).** From the present study table showed that the highest seed germination percentage (92.62%) was recorded in F_3 which was statistically at par with F_2 (91.3%) and the lowest harvest index (82.97%) was achieved by F_0 treatment.

4.4.1.3 Effects of organic manure with P+K fertilizer

Effect of residual effect of organic manure and different doses of P+K fertilizer showed significant effect on seed germination percentage of blackgram (Table 10 and Appendix XI). The highest seed germination (96.83) was observed in the OM_2F_3 treatment. The lowest seed germination (79.17%) was observed in OM_0F_0 treatment.

4.2.2 Seedling length

4.4.2.1 Effect of organic manure

There remarked a significant variation on seedling length of blackgram due to diffferent organic fertilizer (Fig. 8 and Appendix XI). The data expresses that OM_2 (poultry litter) treatment was found superior in producing seedling length (21.45 cm) than other treatments and the inferior treatment was OM_0 (control) in producing pod length (18.45 cm) of blackgram

4.4.2.2 Effect of P+K fertilizer dose

The seedling length of black gram is positively affected by the application of P+K and it showed statistically significant variation **(**Figure 9 and Appendix XI). Seedling length showed an increasing trend with an increasing the higher dose of P+K fertilizer. The tallest seedling (21.79 cm) was found in F_3 which was statistically similar with F_2 and shortest seedling length (18.05 cm) was recorded in F_0 treatment.

4.4.2 Effects of organic manure with P+K fertilizer dose

The given data showed that the seedling length was found significant due to combine effect of organic manure and P+K fertilizer level (Table 10 and appendix XI). the highest seedling length was observed in OM_2F_3 (23.06 cm) which was statistically similar with OM_2F_2 (22.73 cm) and OM_1F_3(22.26 cm) treatment. The given data also showed that the lowest seedling length was OM_0F_0 (16.25 cm) treatment.

4.4.3 Dry weight of seedling

4.4.3.1 Effect of organic manure

Significant effect was observed on dry weight of seedling due to organic manure of blackgram (Table 8 appendix XI.) The highest dry weight of seedling (0.035 gm) was achieved from the (OM_2) treatment and the lowest dry weight of seedling (0.030 gm) was found from (OM_0) treatment.

4.4.3.2 Effect of P+K fertilizer dose

Application of potassium+ phosphorus had a positive effect on dry weight of seedling of black gram (table, and Appendix XI).treatment The data indicated that the values of dry weight of seedling had an increasing trend with the increment of P+K dose. The treatment F_3 (50% higher than recommended dose of P & K) produced the highest value of dry weight of seedling (0.036 g) which was statistically at par with F_2 treatment (0.035 gm). Lowest dry weight of seedling (0.029 gm) was recorded F_0 .

3 .4.3.3 Effects of organic manure with P+K fertilizer

Effect of organic manure residue and P+K fertilizer exerted significant effect on dry weight of seedling (Table 10 and Appendix XI). The highest dry weight of seedling (0.038 gm) was observed in the treatment combination of OM_2F_3 which was statistically similar with OM_2F_2, OM_2F_1, OM_1F_3, OM_1F_2 and OM_0F_3 interaction (0.037, 0.035, 0.036,0.033 and 0.034 g, respectively). On the other hand, the lowest length of pod (0.023 gm) was recorded with OM_0F_0 treatment.

4.4.4 Electrical conductivity

4.4.4.1 Effect of organic fertilizer

Effect of organic manure on electrical conductivity on blackgram was observed statistically significant (Table 8 and appendix XI.) The highest electrical conductivity was recorded (2073.8 mS cm^{-1}) from OM_0 treatment while the lowest electrical conductivity (1272.9 mS cm^{-1}) observed with OM_2 treatment.

Table 8. Effect organic manure on seed quality parameters of blackgram

Treatment	Germination (%)	Seedling length (cm)	Seedling dry weight (g)	Electrical conductivity (mS cm^{-1})
O_0	82.39 c	18.45 c	0.03 c	2073.8 a
O_1	90.34 b	20.41 b	0.03 b	1939.7 b
O_2	92.07 a	21.45 a	0.04 a	1722.9 c
$LSD_{(0.05)}$	**1.67**	**0.43**	**1.317E**	**46.76**
CV%	**2.17**	**2..47**	**4.58**	**2.76**

In a column means with having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability.
OM_0 = Control, OM_1 = Cowdung, OM_2 = Poultry litter

4.4.4.2 Effect of P+K fertilizer dose

It was observed that statistically significant differences were found for electrical conductivity of blackgram due to different doses of P+K fertilizer (Table 7 and Appendix XI). It can be said from the table that electrical conductivity increased gradually with the decreases of P+K doses. The highest electrical conductivity (2156.6 mS cm^{-1}) was recorded from F_0 treatment which was statistical similar with F_1 (2103.1 mS cm^{-1}). On the contrary the lower electrical conductivity (1722.9 mS cm^{-1}) was recorded from F_3 treatment.

Table 9. Effect P+K fertilizer on seed quality parameters of blackgram

Treatment	**Germination (%)**	**Seedling length (cm)**	**Seedling dry Weight (g)**	**Electrical conductivity (mS cm^{-1})**
F_0	82.97 c	18.05 c	0.029 c	2156.6 a
F_1	86.45 b	19.19 b	0.033 b	2103.1 a
F_2	91.03 a	21.37 a	0.035 a	1833.6 b
F_3	92.62 a	21.79 a	0.036 a	1722.9 c
$LSD_{(0.05)}$	**2.12**	**0.55**	**1.317E**	**59.52**
CV%	**2.17**	**2.47**	**4.58**	**2.76**

In a column means with having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability.
F_0 = Control, F_1 = Recommended dose of P+K fertilizer, F_2 = 25% higher than recommended dose of P+K fertilizer, F_3 = 50% higher than dose of P+K fertilizer.

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4.4.4.3 Effects of organic manure with P+K fertilizer dose

Effect of residual effect of organic fertilizers and different doses of P+K fertilizer showed significant effect on electrical conductivity of blackgram (Table 10 and Appendix XI). The highest electrical conductivity (2293.4 mS cm^{-1}) was observed in the OM_0F_0 treatment. The lowest electrical conductivity (1621.1 mS cm^{-1}) was observed in OM_2F_3 treatment

Table 10. Effect of residual value of organic manure with different doses of P+K fertilizer on seed quality parameters of blackgram

Treatment	Germination (%)	Seedling length (cm)	Seedling dry weight (g)	Electrical conductivity (mS cm^{-1})
OM_0F_0	79.17 e	16.25 g	0.023 e	2293.4 a
OM_0F_1	80.83 de	17.57 f	0.032 cd	2226.2 ab
OM_0F_2	84.23 c-e	19.89 d	0.034 bc	1946.6 ef
OM_0F_3	85.33 cd	20.06 d	0.034 a-c	1829.2 fg
OM_1F_0	85.33 cd	18.46 ef	0.028 d	2145.3 bc
OM_1F_1	86.69 c	19.44 de	0.033 c	2097.8 b-d
OM_1F_2	94.34 ab	21.48 bc	0.035 a-c	1797.4 g
OM_1F_3	95.68 ab	22.26 ab	0.036 a-c	1718.3 gh
OM_2F_0	86.42 c	19.45 de	0.034 bc	2031.3 c-e
OM_2F_1	91.83 b	20.57 cd	0.035 a-c	1985.2 de
OM_2F_2	94.51 ab	22.73 a	0.037 ab	1756.7 g
OM_2F_3	96.83 a	23.06 a	0.038 a	1621.1 h
$LSD_{(0.05)}$	**5.19**	**1.24**	**3.767E**	**133.74**
CV%	**2.17**	**2.47**	**4.58**	**2.76**

In a column means with having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability. OM_0 = Control, OM_1 = Cowdung, OM_2 = Poultry litter; F_0 = Control, F_1 = Recommended dose of P+K fertilizer, F_2 = 25% higher than recommended dose of P+K fertilizer, F_3 = 50% higher than recommended dose of P+K fertilizer

CONCLUSION

The pot experiment was conducted at the net house of the department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka during the period from April 2019 to July 2019 to study the effect of organic manure and different doses of P+K chemical fertilizer on growth yield and seed quality of blackgram. The experimental area belongs to the Agro-Ecological Zone (AEZ) of "The Modhupur Tract"(AEZ-28). The land area is situated at 23°41′N latitude and 90°22′E longitude at an altitude of 8.6 meter above sea level. The experimental area is under the sub-tropical climate that is characterized by high temperature, high humidity and heavy rainfall with occasional gusty winds in kharif season (April-September) and less rainfall associated with moderately low temperature during the rabi season. Soil of the experimental area belongs to the general soil type, Shallow Red Brown Terrace Soils under Tejgaon Series. Top soils were clay loam in texture, olive-gray with common fine to medium distinct dark yellowish brown mottles. The land was above flood level and sufficient sunshine was available during the experimental period. The experiment consisted of two factors. Factor A: organic manure management (3 levels); OM_0 = Control, OM_1 = Cowdung, OM_2 = Poultry litter. Factor B: chemical fertilizer doses (4 levels); F_0 = Control, F_1 = Recommended dose of (P+K) chemical fertilizer, F_2 = 25% higher recommended dose of P+K fertilizer, F_3= 50% higher recommended dose of P+K fertilizer. The data were compiled and tabulated in proper form and were subjected to statistical analysis. Analysis of variance (ANOVA) was done following the computer package Statistix10 program. The mean differences among the treatments were adjusted by least significant difference (LSD) test at 5% level of significance. The variety BARI Mash-1 was used in this experiment as the test crop. The experiment was laid out in two factors Completely Randomized Design (CRD) with four replications

Different growth characters, yield contributing characters, yield and seed quality parameters were significantly influenced by the effect of different organic manure. The tallest plant (49.68 cm) was obtained from OM_2, while the shortest plant (42.21 cm) was obtained from OM_0 treatment at 75 DAS. On the other hand, some treatment also gave the highest and lowest branches were (7.35) and (6.27) at 75DAS. The maximum and minimum dry weight plant^{-1} (36.94 g) and (31.23 g) was obtained from treatment

OM_2 and OM_0 treatment, respectively at hervast stage. The highest and lowest length of pod (5.11 cm) and (4.56 cm) and pod diameter (5.21 dm and 4.73 dm) was recorded in O_2 and O_0 treatment, respectively. The highest and lowest pods plant^{-1} (23.81 and 17.48), seeds pod^{-1} (5.49 and 4.84), 1000 seed weight (39.83 g and 33.56 g) , seed weight plant^{-1} (3.89 g and 2.61 g), was recorded in OM_2 and OM_0 treatment, respectively. The maximum and minimum seedling dry weight (0.036 g) and (0.031 g) and seedling length (21.45 cm and 18.45 cm) was recorded in OM_2 and OM_0 treatment, respectively. The highest and lowest seed yield (1419.5 kg ha^{-1} and 1156.5 kg ha^{-1}), stover yield (1652.8 kg ha^{-1} and 1500.5kg ha^{-1}), biological yield (3075.4 kg ha^{-1} and 2638.4 kg ha^{-1}), harvest index (45.94% and 43.86%) was recorded in OM_2 and OM_0 treatment, respectively. The highest and lowest germination percent (92.07% and 82.48%), The maximum and minimum seedling dry weight (0.036 g) and (0.031 g) and seedling length (21.45 cm and 18.45 cm) was recorded in OM_2 and OM_0 treatment, respectively. The highest and lowest EC test value (2073.8mS cm^{-1} and 1848.6 mS cm^{-1}) was found in OM_0 and OM_2 treatment, respectively.

Different growth characters, yield contributing characters, yield and seed quality parameters were significantly influenced by different doses of P+K fertilizer. The tallest plant (48.39 cm) was obtained from F3, while the shortest plant (41.79 cm) was obtained from F_0 treatment at 75 DAS. The highest and lowest branches plant-1 were (7.17 and 4.44) was found F_2 and F_0 treatment. The maximum and minimum dry weight per plant (37.37 g) and (30.82 g) was obtained from treatment F_3 and F_0 treatment, respectively at hervas at stage. The highest and lowest length of pod (5.08 cm and 4.45 cm) and pod diameter (5.19 mm and 4.70 mm) was recorded in F_3 and F_0 treatment, respectively. The highest pods plant^{-1} (25.22) were obtained from F_3 treatment while the lowest pods plant^{-1} (15.16) were obtained from F_0 treatment. The highest and lowest seeds pod-1 (5.44 and 4.93), seed weight plant^{-1} (4.09 and 2.58), 1000 seed weight (39.49 g and 33.26 g) was recorded in F_3 and F0 treatment, respectively. The highest and lowest seed yield (1372.6 kg ha^{-1} and 1118.3 kg ha^{-1}), stover yield (1609.2 kg ha^{-1} and 1442.8 kg ha-1), biological yield (2990.1 kg ha^{-1} and 2566.8 kg ha^{-1}), harvest index (46.11% and 43.53%) was recorded in F_3 and F_0 treatment, respectively. The highest and lowest germination percent (92.62% and 82.97%), seedling length (21.79 cm and 18.05 cm), dry weight of seedling (0.029 g and 0.036 g) was recorded in F_3 and F_0

treatment, respectively. The highest and lowest EC test value (1722.9 mS cm^{-1} and 2156.6 mS cm^{-1}) was found in F_3 and F_0 treatment, respectively.,

Different growth characters, yield contributing characters, yield and seed quality parameters were significantly influenced by different organic manure and different doses of P+K fertilizer. The tallest plant (53.62 cm) was obtained from OM_2F_3, treatment combination while the shortest plant (39.70 cm) was obtained from OM_0F_0 treatment combination at 75 DAS. The highest and lowest branches number were (7.75 and 5.45) The maximum and minimum dry weight $plant^{-1}$(39.995 g) and (28.67 g) was obtained from treatment OM_2F_3 treatment combination and OM_0F_0 treatment combination, respectively at harvest. The highest and lowest length of pod and pod diameter (5.4 cm and 4.34 cm) and (5.43 mm and 4.47 mm) was recorded in OM_2F_3 treatment combination and OM_0F_0 treatment combination, respectively. The highest pods $plant^{-1}$ (29.65) were obtained from OM_2F_3 treatment combination while the lowest pods $plant^{-1}$ (14.68) were obtained from OM_0F_0 treatment combination. The highest and lowest seeds pod^{-1} (5.76 and 4.68), seed weight $plant^{-1}$ (2.45 g and 4.45 g),1000 seed weight (44.15 g and 32.66 g) was recorded in OM_2F_3 and OM_0F_0 treatment combination, respectively. The highest and lowest seed yield (1529.4 kg ha^{-1} and 1037.5 kg ha^{-1}) was recorded in OM_2F_3 and OM_0F_0 treatment, respectively. The highest and lowest stover yield (1421.9 kg ha^{-1} and 1759.4 kg ha^{-1}), biological yield (3288.8 kg ha^{-1} and 2459.9 kg ha^{-1}) was recorded in OM_2F_3 and OM_0F_0 treatment, respectively. The highest and lowest harvest index (46.59% and 42.19%) was recorded in OM_2F_3 and OM_0F_0 treatment, respectively. The highest and lowest germination percent (96.83% and 79.17%), seedling length (16.25 cm and 23.053 cm), dry weight of seedling (0.038 g and 0.023 g) was recorded in OM_2F_3 and OM_0F_0 treatment, respectively. The highest and lowest EC test value (2293.4 mS cm^{-1} and 1621.1 mS cm^{-1}) was found in OM_0F_0 and OM_2F_3 treatment, respectively.

Based on the experimental results, it may be concluded that

i) Poultry litter had a great positive effect on the yield contributing characters, yield and seed quality in blackgram

ii) P+K fertilizers at 50% higher than the recommended dose seems to be suitable for higher yield and quality seed production of blackgram, and

iii) The combine application of poultry litter as organic manure with 50% higher than recommended dose of P+K fertilizers may be recommended for seed production of blackgram

RCOMMENDATION

The study was undertaken at the environment of Sher-e-Bangla Agricultural University which may not be similar to those of the rural farmers field environment. Moreover, the soil condition and nutritional status of the Sher-e-Bangla Agricultural University is different from the farmer's field. So, results obtained from this study may not be applicable in the farmers field. To optimize the obtained technology in this study, the trial must be repeated on-farm in the farmers field at different ecological regions of Bangladesh.

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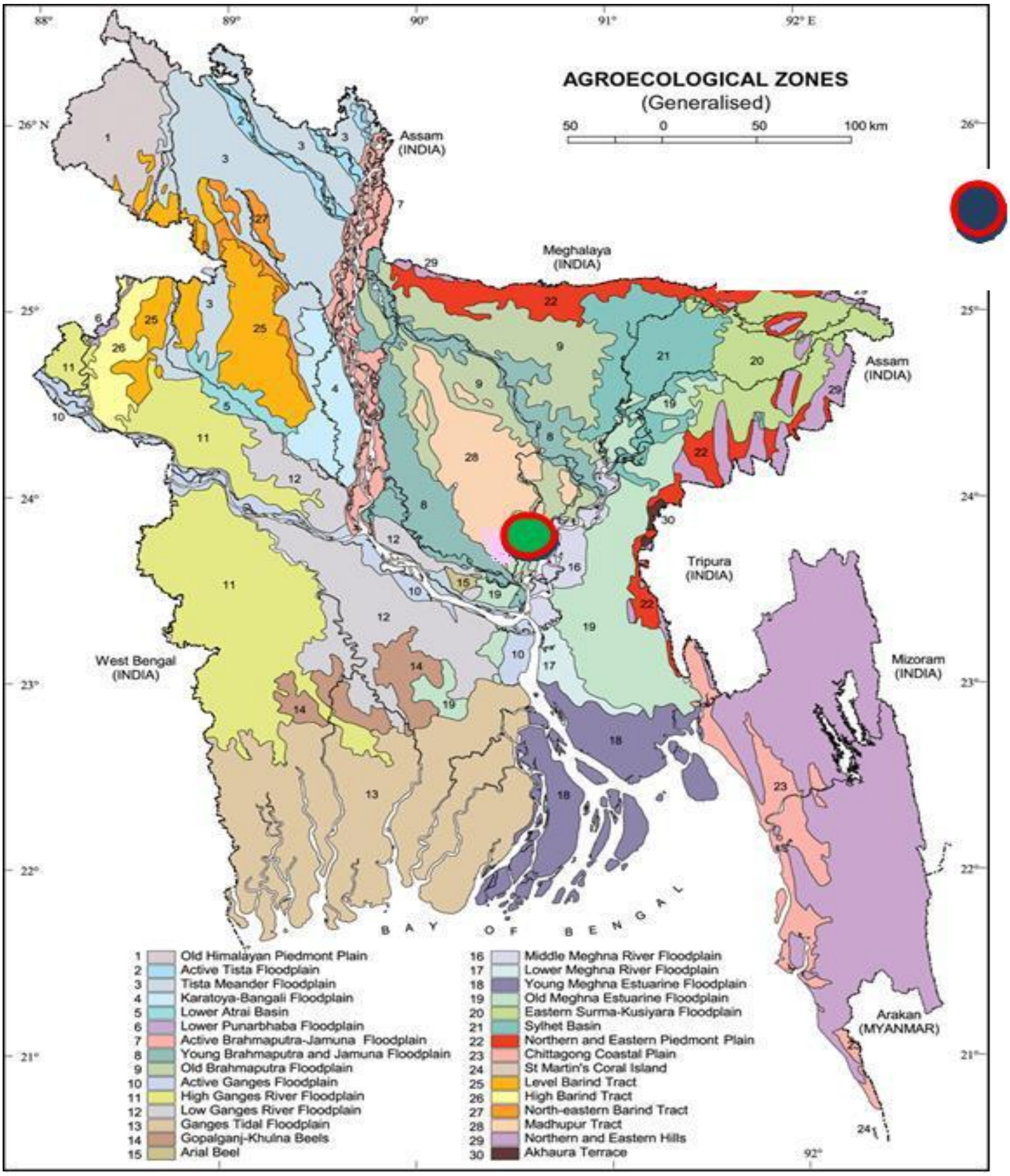
APPENDICES

Appendix I. Map showing the experimental site under study



Appendix II. Monthly meteorological information during the period from April to july, 2019

Year	Month	Air temperature (^{0}C)		Relative Humidity (%)	Total rainfall (mm)
		Maximum	Minimum		
2109	April	35.07	17.94	67.96	49
	May	34.92	18.76	58.43	137
	June	30.91	20.60	64.63	290
	July	33.49	22.80	71.53	298
	August	33.56	22.45	78.25	315.60

Source: Metrological Centre, Agargaon, Dhaka (Climate Division)

Appendix III. Morphological characteristics of the experimental field

Morphology	Characteristics
Location	SAU Farm, Dhaka
Agro-ecological zone	Madhupur Tract (AEZ- 28)
General Soil Type	Deep Red Brown Terrace Soil
Parent material	Madhupur Terrace
Topography	Fairly level
Drainage	Well drained
Flood level	Above flood level

Source: Soil Research and Development Institute, Farmgate, Dhaka

Appendix IV. The physical and chemical characteristics of soil of the experimental site as observed prior to experimentation (0-15 cm depth)

Constituents	Percent
Sand	26
Silt	45
Clay	29
Textural class	Silty clay

Source: Soil Resources Development Institute (SRDI)

Chemical composition:

Soil characters	Value
pH	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.54
Total nitrogen (%)	0.027
Phosphorus	6.3 µg/g soil
Sulphur	8.42 µg/g soil
Magnesium	1.17 meq/100 g soil
Boron	0.88 µg/g soil
Copper	1.64 µg/g soil
Zinc	1.54 µg/g soil
Potassium	0.10 meg/100g soil

Source: Soil Resources Development Institute (SRDI)

Appendix VI. Analysis of variance of the data on plant height at different days after sowing of Blackgram as influenced by organic manure, P+K fertilizer and also their combination

Sources of variation	Degrees of freedom	Mean Square of		
		Plant height at		
		25 DAS	50 DAS	75 DAS
Replication	3	0.24	8.43	1.69
Factor A	2	162.59*	34.49*	226.05*
Factor B	3	84.93*	265.38*	107.81*
A×B	6	4.18	0.84*	9.735*
Error	33	0.41	5.37	2.954

*Significant at 5% level

Appendix VII Analysis of variance of the data on plant branch at different days after sowing of blackgram as influenced by organic manure, P+K fertilizer and also their combination

Sources of variation	Degrees of freedom	Mean Square of		
		Plant Branch at		
		25 DAS	50 DAS	75 DAS
Replication	3	0.0065	0.05	0.13
Factor A	2	2.74*	34.49*	4.62*
Factor B	3	0.86*	2.01*	1.71*
A×B	6	0.014	0.050*	0.15*
Error	33	0.03	0.06	0.07

*Significant at 5% level

Appendix VIII. Analysis of variance of the data on dry weight per plant at different days after sowing of blackgram as influenced by organic manure, P+K fertilizer and also their combination

Source of variation	Degrees of freedom	Mean Square of Dry weight per plant		
		25 DAS	50 DAS	75 DAS
Replication	3	0.09	0.39	9.23
Factor A	2	05.97*	39.39*	135.27*
Factor B	3	3.53*	65.93*	116.26*
A×B	6	0.05	0.88*	3.06*
Error	33	0.06	0.58	2.93

*Significant at 5% level

Appendix IX. Analysis of variance of the data on yield contributing parameters of blackgram as influenced by organic manure, P+K fertilizer and also their combination.

Sources of variation	Degrees of Freedom	Mean square of yield contributing parameters					
		Length of pod	Pods plant^{-1}	Pod diameter	Seeds pod^{-1}	1000 seed weight	Seed weight plant^{-1}
Replication	3	0.021	0.08	0.015	0.09	1.15	0.16
Factor A	2	1.19*	163.31*	0.96*	1.70*	157.44*	7.16
Factor B	3	0.89*	292.16*	0.61*	0.63*	95.28*	6.33
A × B	6	0.047	15.22*	0.006	0.02	28.47	1.05
Error	33	0.044	0.25	0.036	0.07	0.71	0.09

*Significant at 5% level

Appendix X: Analysis of variance of the data on yield parameters of blackgram as influenced by organic manure, P+K fertilizer and also their combination

Sources of variation	Degrees of Freedom	Mean square of yield contributing parameters			
		Seed yield	Stover yield	Biological yield	Harvest index
Replication	3	1215	412907	10128	2.73
Factor A	2	288548*	114777*	810855*	17.49*
Factor B	3	149874*	70924*	422480*	14.11*
A × B	6	6836*	16918*	40163*	0.97
Error	33	1488	6562	7597	1.91

*Significant at 5% level

Appendix XI. Analysis of variance of the data on seed quality parameters of blackgram as influenced by organic manure, P+K fertilizer and also their combination

Sources of variation	Degrees of Freedom	Mean square of yield contributing parameters			
		Germination percentage	Seedling length	Dry weight of seedlings	Electric conductivity (EC) value
Replication	3	1.303	0.13	3.910E-06	1726
Factor A	2	402.61*	37.29*	1095E-04*	205431*
Factor B	3	228.63*	37.95*	1.416E-04*	524811*
A × B	6	15.44	0.10	1.408E-05*	1713
Error	32	3.68	0.25	2.304E-06	2904

*Significant at 5% level

Plate 1. Pictorial presentation of the experiment

Plate 2. Pictorial presentation of the experiment