INFLUENCE OF DIFFERENT COMBINATIONS OF ORGANIC AND INORGANIC FERTILIZERS ON GROWTH AND YIELD OF BLACKGRAM

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*This is to certify that the thesis entitled "**INFLUENCE OF DIFFERENT COMBINATIONS OF ORGANIC AND INORGANIC FERTILIZER ON GROWTH AND YIELD OF BLACKGRAM**" submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE (M.S.)** in **AGRONOMY**, embodies the results of a piece of bona fide research work carried out by **NOOR-E-ZANNAT**, Registration. No. **11-04505** 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 source of information as has been availed of during the course of this investigation has duly been acknowledged.

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INFLUENCE OF DIFFERENT COMBINATIONS OF ORGANIC AND INORGANIC FERTILIZERS ON GROWTH AND YIELD OF BLACKGRAM

ABSTRACT

A field experiment was conducted to study the influence of different combinations of organic and inorganic fertilizer on growth and yield of blackgram at the central experimental farm, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh during March to June, 2017. Treatments consisted of two combined organic and inorganic varieties viz. V_1= BARI Mash-2, V_2= BARI Mash-3, eight levels of fertilizers viz. F_0 = Control, F_1 = RDF, F_2 = 25% less than RDF + Vermicompost, F_3 = 50% less than RDF + Vermicompost, F_4 = 25% less than RDF + Poultry litter, F_5 = 50% less than RDF + Poultry litter, F_6 = 25% less than RDF + Mixed fertilizer, and F_7 = 50% less than RDF + Mixed fertilize. The experiment was conducted following Randomize Complete Block Design (RCBD) with 3 replications. Results revealed that the growth and yield of blackgram were significantly influenced by organic fertilizer where variety V_2 and fertilizers F_2, F_1 and F_3 gave the highest seed yield (1.83 t ha^{-1}, 1.84 t ha^{-1}, 1.82 t ha^{-1} and 1.79 t ha^{-1}, respectively). The highest seed yield of the interaction treatment was attributed to V_2F_2 followed by V_2F_1 (1.90 t ha^{-1} and 1.87 t ha^{-1}). It can be concluded that the application of organic and inorganic fertilizer had a positive effect on BARI Mash-3 and 25% less than recommended dose of fertilizer + vermicompost or recommended dose of fertilizer can be suggested to cultivate this crop.

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LIST OF ACRONYMS

AEZ	Agro-Ecological Zone
BARI	Bangladesh Agricultural Research Institute
BAU	Bangladesh Agricultural University
BBS	Bangladesh Bureau of Statistics
Co	Cobalt
CV%	Percentage of coefficient of variance
cv.	Cultivar
DAE	Department of Agricultural Extension
DAS	Days after sowing
^0C	Degree Celsius
et al	And others
FAO	Food and Agriculture Organization
g	gram(s)
ha^{-1}	Per hectare
HI	Harvest Index
kg	Kilogram
Max	Maximum
mg	Milligram
Min	Minimum
MP	Muriate of Potash
N	Nitrogen
No.	Number
NS	Not significant
%	Percent
SAU	Sher-e-Bangla Agricultural University
SRDI	Soil Resources and Development Institute
TSP	Triple Super Phosphate
UPOV	Union for the Protection of Plant Varieties
Wt.	Weight

CHAPTAR I

INTRODUCTION

Pulses are important crops in Bangladesh. They occupy an area of about 240 hectares with an annual production of 220 metric tons (BBS, 2010). Pulses are mainly the Rabi seasons crop but they are losing their area of cultivation each year due to increase in cultivation of wheat, vegetables and high yielding Boro rice with increasing facilities of irrigation. Black gram (*Vigna mungo* L.) is an important pulse. It (Black gram) contain a remarkable amount of proteins, minerals, vitamins and carbohydrates. Among the various pulses, Black gram is one of important pulse which contains approximately 25-28% protein, 4.5-5.5% ash, 0.5-1.5% oil, 3.5-4.5% fiber and 62.65% carbohydrate on dry weight basis (Kaul, 1982). It contains Sulphur, amino acids, methionine and cysteine and also lysine which are excellent components of balanced human nutrition. Phosphorus is an important mineral element for grain legumes as it helps in root development, participates in synthesis of phosphate and phosphoproteins and takes part in energy fixing and releasing process in plants. Significant response of legumes to phosphate nutrition has been reported by several workers (Singh and Yadav 2008). Pulses are suitable for cropping process as it needs less time or less term, less input and aridity tolerant quality.

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, biochemical as well as inherent factors associated with the crop. Apart from the genetic makeup, the physiological factor viz., insufficient partitioning of assimilates, poor pod setting due to the flower abscission and lack of nutrients during 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 micro-nutrients through enhanced biological processes, increase 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 (Kannan *et al.*, 2005). Vermiculture biotechnology promises to user in the second green revolution' by completely replacing the destructive agro-chemicals which did more harm than good to both the farmers and their farmlands during the 'first green revolution' of the 1950-60's. Earthwormsrestore and improve soil fertility and boost cropproductivity by the use of their excreta-'vermicast' (Arancon *et al*., 2004). Except on vermicompost, several research works on bacterial, mineral and organic fertilizers from various sources have already been done in Nepal (Maskey and Bhattarai, 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). 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 (Watts *et al*., 2010); thereby improving soil quality and productivity (Kingery *et al*., 1994). The supply of phosphorus to legumes is more important than of nitrogen because, nitrogen is being fixed by symbiosis with *Rhizobium* bacteria. The beneficial effects of phosphorus on nodulation, growth, yield and general behavior of legume crop have been well established because it plays an important role in root development. Phosphorus application to legumes plays a key role in the formation of energy rich phosphate bonds, phospholipids and for development of root system (Tisdale *et al*., 1985). It also improves the crop quality and resistance to diseases. Reddy and Swamy (2000) reported that the Interaction of phosphorus with farmyard manure was significant with respect to seed yield of black gram. Economic analysis of the different treatments showed that the highest additional seed yield and net returns (Rs 3528 ha^{-1}) were associated with 26.2 kg P ha^{-1} + PSB inoculation + no farmyard manure. This treatment also gave a benefit: cost ratio of 2.69.

Therefore, the present experiment was conducted to find out the actual combinations of organic and inorganic fertilizer on growth and yield of black gram. The objectives are as follows:

1. To find out the better variety between the two varieties of black gram in respect of yield,
2. To select suitable combination of organic and inorganic fertilizers for achieving higher yield and
3. To find out the interaction effect of variety and organic and inorganic fertilizer combination for higher yield of black gram.

CHAPTER 2

REVIEW OF LITERATURE

A field experiment was conducted at the Sher-e-Bangla Agricultural University farm to study the influence of different combinations of organic and inorganic fertilizer on growth and yield of blackgram. Some related research findings of different researchers of home and abroad have been cited below:

2.1. Blackgram

Pulses are important crops in Bangladesh. They occupy an area of about 240 hectares with an annual production of 220 metric tons (BBS, 2010). Pulses mainly being the Rabi seasons crop which are losing area under cultivation each year due to increase in cultivation of wheat, vegetables and high yielding Boro rice with increasing facilities of irrigation.

Kaul (1982) noticed that blackgram (*Vigna mungo* L.) is an important pulse. Average yield of black gram is about 347 kg per acre. Pulses contain a remarkable amount of proteins, minerals, vitamins and carbohydrates. Among the various pulses, Black gram is important one of which contains approximately 25-28% protein, 4.5-5.5% ash, 0.5-1.5% oil, 3.5-4.5% fiber and 62.65% carbohydrate on dry weight basis.

Elias, *et al*. (1986) stated that pulse is the great source of protein of diet for the largest population in Bangladesh. Pulse comprises much protein as about twice other than cereals and at the same time it also contains amino acid lysine which is in general shortage in food grains.

Anon. (2011) stated that blackgram (*Vigna mungo*) is a short duration pulse crop with wider adaptability. It is a good source of high quality protein and being a pulse crop it fixes atmospheric nitrogen thereby enriches soil fertility.

Black gram (*Vigna mungo* L.) belongs to family Fabaceae sub family papilionaceae, is being grown as one of the principal pulse crop (Anonymous 2013).

Anon. (2011) reported that blackgram (*Vigna mungo* L.) is one of the major rainy season pulse crops also known as urd or mash grown throughout India. It is consumed in the form of “dal”.

An essential element of agricultural sustainability is the effective management of N in the environment (Rao *et al.*, 2005). Nitrogen deficiency constrains leaf area expansion, enhances leaf senescence after canopy structure and subsequently reduces crop yield (Wolfe *et al*., 1988). Blackgram is one of the main edible pulse crops of Bangladesh. It ranks fourth among the pulses with an area of about 70,000 ha (BBS, 2000). As an excellent source of plant protein it is cultivated extensively in the tropics and subtropics. Soils of Bangladesh are mostly deficient in nitrogen. Nitrogen increases the dry matter and protein percentage of grain as well as methionine and triptophen contents in seed with increases of levels of applied nitrogen (Vidhate *et al*., 1986). The yield of blackgram is very poor as compared to many other legume crops (Rahman, 1991).

2.2. Effect of organic and inorganic fertilizer on legume

Crop yield, soil nutrient content, amount of agricultural production and their environmental effects are all influenced by fertilizer use. Decreased soil fertility and increased mineral fertilizer prices made legumes a popular option as organic fertilizers. Organic fertilizers have an important role in improving soil fertility.

Olesen *et al*. (2009) observed that manures are most often not sufficiently available in organic arable farming, and this necessitates the use of other sources of N for fully fertilizing high yielding cereals under organic farming in Northern Europe.

Guldan *et al*. (1997) noticed that correctly managed, green manures can replace some or all of the N required for non-leguminous succeeding crops. The average amounts of N accumulated by green manures can entirely substitute for mineral fertilizer N at current average application rates. It was often observed that legumes, in contrast to cereals, have a beneficial effect on grain yield of subsequent cereal crops (Olesen *et al*., 2007).

Askegaard and Eriksen (2008) reported that soil fertility is especially affected by soil organic matter, which depends on biomass input to compensate mineralization. Higher biomass return to the soil can increase soil organic carbon and soil total N. N is the most studied nutrient, but P and K levels are also important. They also observed that in organic farming, K deficiency may become a significant problem. Perennial legumes such as lucerne, with their deep root systems, import additional nutrients (P, K, Ca) (Teit, 1990) to the soil that are accessible to succeeding crops (Witter and Johansson, 2001).

A number of researchers consider that plant residues and green manure are not rich in K and especially P (Maiksteniene and Arlauskiene, 2004), but they improve the physical characteristics and stimulate microbial activity of the soils. After decomposition, the organic P and K bound in the green manure crop may provide an easily accessible form of P and K to succeeding crops (Askegaard and Eriksen, 2008; Eichler-Löbermann *et al*., 2009).

2.3. Effect of organic fertilizer on 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, biochemical as well as inherent factors associated with the crop. Apart from the genetic makeup, the physiological factor viz., insufficient portioning of assimilates, poor pod setting due to the flower abscission and lack of nutrients during critical stages of crop growth, coupled with a number of diseases and pests (Mahala *et al*., 2001) were the reasons for the poor yield.

Alabadan *et al*. (2009) stated that 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 micro-nutrients through enhanced biological processes, increase nutrient solubility, alter soil salinity, sodicity and pH.

Kannan *et al. (*2005) though, organic fertilizer contain relatively low concentrations of nutrients and handling is labor intensive, there has been large increase in their use over inorganic fertilizers as nutrient source.
Gaur (1991) reported that therefore, the soil must be 'fed' in a way that the beneficial soil organisms necessary for recycling nutrients and producing humus are not inhibited. The long term manurial studies conducted at many places have revealed the superiority of integrated nutrient supply system in sustaining crop productivity in comparison to chemical fertilizer alone.

Several strategies have been initiated to boost the productivity of blackgram. One among them is foliar application of organic and inorganic sources of nutrients for exploiting genetic potential of the crop. This is considered to be an efficient and economic method of supplementing part of the nutrient requirements at critical stages. Nutrients play a pivotal role in increasing the seed yield in pulses (Chandrasekhar and Bangarusamy, 2003).

2.4. Effect of vermicompost on Blackgram

Vermiculture biotechnology promises to user in the second green revolution' by completely replacing the destructive agro-chemicals which did more harm than good to both the farmers and their farmlands during the 'first green revolution' of the 1950-60's. Arancon *et al. (*2004) stated that earthwormsrestore and improve soil fertility and boost crop productivity by the use of their excreta-'vermicast'.

Rajkhowa *et al*. (2003) reported that application of phosphorus is must incentive coupled with increased use of phosphorus with organic manure (Vermicompost) and bio fertilizers PSB. To compensate the short supply and price hike of chemical fertilizers, use of indigenous sources like vermicompost has to be encouraged as it supplies essential plant nutrients and improves physical, chemical and biological conditions of the soil, soil microbial activities, soil structure, water holding capacity and thereby increase the fertility and productivity of soil. Vermicompost is a potential source due to the presence of available plant nutrients, growth enhancing substances like nitrogen fixing, phosphorus solubilising and cellulose decomposing organism. They also stated that vermicompost alone or in combination with fertilizer improve the N, P and K status of soil and its application resulted in the highest number (24.33) of nodules / plant.

Maskey and Bhattarai (1994) conducted several research works on except on vermicompost on bacterial, mineral and organic fertilizers from various sources have already been done in Nepal). They found that compost produced by traditional processes is generally low in plant nutrient content and the process itself is also slow and time consuming. On the other hand, certain special type of earthworm (Eisenia foitida) has the capacity to convert the biodegradable organic waste into higher quality compost at comparatively faster rate (Bhattarai, 2003) than that of the traditional method. Such a compost usually known as "vermicompost" is rich in plant nutrients and contains higher number of microorganisms, which are responsible for decomposition process (Yami *et al.*, 2003).

2.5. Effect of poultry litter on blackgram

Adeleye (2007) reported that application of poultry manure increases soil organic matter content, total-N, available-P, exchangeable cations (Ca, Mg and K), CEC and percent base saturation.

Ewulo *et al*. (2008) reported from an experiment that poultry manure additions up to 50 t ha^{-1} improved soil organic matter total N and available P as well as improved soil physical properties as indicated by reduction in soil bulk density and increased in soil moisture content.

Mitchell and Donald (1995) found that 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. 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; Watts and Torbert, 2011; Wiatrak *et al*., 2004).

Watts *et al*. (2010) observed that 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; thereby improving soil quality and productivity (Kingery *et al*., 1994).
Ginting *et al*. (2003) and Watts *et al*. (2010) stated that continuous application of litter or manure can increase the levels of C, N, P, K, Ca and Mg in the soil, 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.

2.6. Effect of inorganic fertilizer on Blackgram

Tisdale *et al*. (1985) reported that the supply of phosphorus to legumes is more important than of nitrogen because, nitrogen is being fixed by symbiosis with Rhizobium bacteria. The beneficial effects of phosphorus on nodulation, growth, yield and general behavior of legume crop have been well established because it plays an important role in root development. Phosphorus application to legumes plays a key role in the formation of energy rich phosphate bonds, phospholipids and for development of root system. It also improves the crop quality and resistance to diseases.

Nagar *et al*. (2016) reported that the favorable effects of phosphorus with vermicompost and biofertilizers, on soil properties may also be due to increased microbial activities which in turn release organic acids to bring down to soil pH to a range where the activities of plant nutrients are maximum. The increase in microbial activity due to the addition of organic manure and biofertilizer, which enhance activity of enzymes that play a key role in transformation, recycling and availability of plant nutrients in soil. Thus, improvement in nutritional status of plant might have resulted in greater synthesis of amino acids and protein and other growth promoting substances. Similar results were reported by; Mohammad *et al*., (2017) and Jangir *et al*., (2017).

Witham *et.al*. (1971) observed that the integrated plant nutrient system helps in improving and maintenance of soil fertility for sustaining crop productivity. Cultivation of pulses benefit the succeeding crop to the extent of 40 kg N/ha.

Gawai and Pawar (2006) stated that organic manures contain both macro and micronutrients whose application into soil, results in improved soil condition by significantly increasing the level of N fixation. Use of organic manures alone, as a substitute to chemical fertilizers is not profitable and will not be enough to maintain the present levels of crop productivity of high yielding varieties. Use of organic manures along with inorganic fertilizers leads to increase in productivity and also sustain the soil health for a longer period.

Sharma and Vyas (2001) reported that about less than 30% of N and small fraction of P and K in organic manures may become available to immediate crop and rest to subsequent crops.

Vasanthi and Kumaraswamy (1996) observed that fertilizers play vital role in maintaining/improving soil fertility as the source of readily available nutrients to plants. Use of organic manures alone or in combination with chemical fertilizers will help to improve physico-chemical properties of the soil, efficient utilization of applied fertilizers for improving seed quality and quantity. Organic manures provide a good substrate for the growth of microorganisms and maintain a favourable nutritional balance and soil physical properties. It is recognized that combined source of organic matter and chemical fertilizers play a key role in increasing the productivity of soil.

2.7. Combined effect of organic and inorganic fertilizer on growth and yield of Blackgram

Singh and Yadav (2008) stated that organic fertilizer contains Sulphur, amino acids, methionine and cysteine and also lysine which are excellent components of balanced human nutrition. Phosphorus is an important mineral element for grain legumes as it helps in root development, participates in synthesis of phosphate and phosphoproteins and takes part in energy fixing and releasing process in plants. Significant response of legumes to phosphate nutrition has been reported by several workers.

Pattanayak *et al*. (2009) reported that iron is critical for chlorophyll formation and photosynthesis. Iron is also used by enzymes to regulate transpiration in plants. Addition of FYM and vermincompost to these soils not only supplies the additional nutrients to the growing plants but also affects the availability of native nutrients from soil and chemical fertilizers due to release of organic acids and other microbial products during the decomposition. Production of organic acids during decomposition of FYM lowers the pH due to which stable complexes with cations like Ca^{2+}, Mg^{2+}, Fe^{2+} and Al^{3+} of greater stability and releases water soluble phosphates. Due to this chelating effect, the organic acid solubilizes more P than inorganic acids at the same pH.

Parthasarathi *et al.* (2008) observed that besides, FYM also maintains a congenial hydro-thermal regime for optimum crop production. Since vermicompost helps in enhancing the activity of microorganisms in soils which further enhances solubility of nutrients and their consequent availability to plants is known to be altered by microorganism by reducing soil pH at micro sites, chelating action of organic acids produced by them and intraphyl mobility in the fungal filaments. In addition to nitrogen, which is fixed in the soil from the atmosphere, farmyard manure and vermicompost are another source of nutrients which enhance the nitrogen fixation capacity of the crop. In addition to biologically fixed nitrogen, crop also requires nitrogen through fertilization to meet its initial requirement.

Reddy and Swamy (2000) reported that the interaction of phosphorus with farmyard manure was significant with respect to seed yield of black gram. Economic analysis of the different treatments showed that the highest additional seed yield and net returns (Rs 3528 ha^{-1}) were associated with 26.2 kg P ha^{-1} + PSB inoculation + no farmyard manure. This treatment also gave a benefit: cost ratio of 2.69.

Patil (2002) noticed higher germination (94.50%), root length (16.60 em), shoot length (14.00 em), viguor index (2889), seedling dry weight (59.84 mg), protein content (23.15%) and lowest electrical conductivity (0.731 dSm^{-1}) in seeds of greengram (Cv. chinamung cultivar) treated with RDF + FYM @ 2.5 t ha^{-1} compared to RDF and organic manures alone.

Rajkhowa *et al*. (2002) reported that the application of 100 per cent RDF along with vermicompost @ 2.5 t ha^{-1} in green gram recorded significantly higher plant height (52.7 em), number of pods $plant^{-1}$ (12.67), seeds pod^{-1} (12.00), 100 seed weight (4.6 g), seed yield (5.35 q/ha) over control and it was on par with the application of 75% or 50% RDF + vermicompost (2.5 t ha^{-1}) over control in green gram.

Tanwar *et al*. (2003) reported that the crop yield of black gram, N and P contents, and N and P uptake increased with increasing P dose up to 80 kg ha^{-1} .Inoculation with the combination of the biofertilizers (*Rhizobium* sp. And *Bacillus megaterium* var. phosphaticum) resulted in higher yield, N and P content, N and P uptake by the grain and straw compared to no inoculation and individual inoculation.

Abraham and Lal (2004) studied the effect of fertilizer levels, organic manures and biofertilizer along with organic spray on the yield 8 of black gram under black gram-wheat-green gram system. Biofertilizer and organic spray helped in significant increase of the dry matter production and test weight.

Vasanthi and Subramaniam (2004) evaluted the effect of organic manures with NPK fertilizer on the nutrient uptake and crude protein content in black gram. The combined application of vermicompost @ 2 t ha^{-1} with 100% NPK resulted the highest crude protein content, N, P, K contents and uptake.

Gupta *et al*. (2006) reported that seed inoculation with phosphorus- solubilising bacteria showed a significant increase in seed yield of *Vigna mungo* and its attributes as well as protein content and N and P uptake over uninoculated treatment. Response of crop to phosphorus fertilization was significant up to 60 kg P20s ha^{-1} for seed and straw yields.

Das *et al*. (2007) reported that rabbit manure at 5 t/ha + 50% NPK (N:P:K kg 30:60:40 ha^{-1}) produced higher growth, yield attributes and seed yield (17.67 q ha^{-1}) of black gram compared to the control (7.69 q ha^{-1})." This treatment was produced equivalent results to that of NPK + FYM or pig manure. All organic manures applied alone produced superior pod and seed yields compared to the control. The manures alone, or in combination with NPK, improved or maintained the NPK status of the soil.

Pannu *et al*. (2007) reported that the application of FYM as well as PM (pressmud) at 2.50 t/ha along with one fourth of the recommended dose of NP fertilizer (12 kg N and 40 kg P ha^{-1}) 9 recorded the highest yield (6.90 and 6.60 q ha^{-1} respectively) of black gram and similar trend was observed for the various growth attributes, such as number of pods $plant^{-1}$, plant height and 1000-grain weight.

Babou *et al*. (2009) revealed that incorporation of cotton stalks @ 5 t ha^{-1} with *Trichoderma viride* to preceding rice crop significantly improved yield attributes (number of pods $plant^{-1}$, number of seeds pod^{-1} and 1000 seeds weight) yield of black gram and soil available nutrient status.

CHAPTER 3

MATERIALS AND METHODS

The experiment was conducted at the Agronomy field, Sher-e-Bangla Agricultural University, Dhaka-1207 during the period from March to June, 2017. Detailed of the experimental materials and methods followed in the study are presented in this chapter. The experiment was conducted to study the influence of different combinations of organic and inorganic fertilizer on growth and yield of blackgram.

3.1 Site description

3.1.1 Geographical location

The experimental area was situated at 23°77′N latitude and 90°33′E longitude at an altitude of 8.6 meter above the sea level (Anon., 2004).

3.1.2 Agro-ecological region

The experimental site was medium high land belonging of old Madhupur tract (AEZ-28) and the soil series was Tejgaon (FAO, 1988). This was a region of complex relief and soils developed over the Modhupur clay, where flood plain sediments buried the dissected edges of the Modhupur Tract leaving small hillocks of red soils as ‘islands’ surrounded by floodplain (Anon., 1988b).

3.1.3 Climate

The area has sub-tropical climate, characterized by high temperature, high relative humidity and heavy rainfall with occasional gusty winds in Kharif season (April-September) and scanty rainfall associated with moderately low temperature during the Rabi season (October-March). Weather information regarding temperature, relative humidity and rainfall prevailed at the experimental site during the study period were presented in Appendix I.

3.1.4 Soil

The soil of the experimental site 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. Soil pH ranged from 5.6-6.5 and had organic matter 1.10-1.99%. The experimental area was flat having available irrigation and drainage system and above flood level. Soil samples from 0-15 cm depths were collected from experimental field. The analyses were done by Soil Resource and Development Institute (SRDI), Dhaka. The physical and chemical properties of the soil were presented in Appendix II.

3.2 Details of the experiment

3.2.1 Treatments

The experiment consisted of 2 factors:

Factors A: Variety

There were two varieties of black gram. There were-

(a) V_1 = BARI mash-2

(b) V_2 = BARI mash-3

Factors B: Organic and inorganic fertilizer combinations

There were eight levels of fertilizer combinations. There were-

(a) F_0 = 0 (Control)

(b) F_1 = Recommended dose of fertilizer (RDF)

(c) F_2 = 25% less than Recommended dose of fertilizer (RDF) + Vermicompost

(d) F_3 = 50% less than Recommended dose of fertilizer (RDF) + Vermicompost

(e) F_4 = 25% less than Recommended dose of fertilizer (RDF) + Poultry litter

(f) F_5 = 50% less than Recommended dose of fertilizer (RDF) + Poultry litter

(g) F_6 = 25% less than Recommended dose of fertilizer (RDF) + Mixed fertilizer

(h) F_7 = 50% less than Recommended dose of fertilizer (RDF) + Mixed fertilizer

There were sixteen treatment combinations which are as follows:

V_1F_0, V_1F_1, V_1F_2, V_1F_3, V_1F_4, V_1F_5, V_1F_6, V_1F_7, V_2F_0, V_2F_1, V_2F_2, V_2F_3, V_2F_4, V_2F_5, V_2F_6, V_2F_7

3.2.2 Experimental design and layout

The experiment was laid out in Randomize Complete Block Design (RCBD) with three replications. There were 16 treatment combinations. The total numbers of unit plots were 48. The size of unit plot was 2.4 m × 1.6 m. The distances between plot to plot and replication to replication were 0.50 m and 1.0 m, respectively.

3.3 Crop/Planting Material

BARI mash-2 and BARI mash-3 were used as plant material.

3.3.1 Description of crop: Variety

BARI mash-2:

BARI mash-2 was developed by crossing between the lines BMA-2141 and BMA-2140. This variety has been released in 1996. The height of the plant is medium (33-35 cm). The fruit color is red, having awn on its body. The seeds are black in color. The size of the seed larger than local variety. Thousand seed weight 32-36 gm. The protein content is 21-24%. Plant life cycle last for 65-70 days. Yield is 1400-1600 kg/ha.

BARI mash-3:

BARI mash-3 was developed by crossing between BMA-2140 and BMA-2038. This variety has been released in 1996. The height of the plant is medium (35-38 cm). The fruit color is black when ripe, having awn on its body. The seeds are black in color. The size of the seed larger than local variety. Thousand seed weight 40-45 gm. The protein content is 21-24%. Plant life cycle last for 65-70 days. Yield is 1500-1600 kg/ha.

3.3.2 Description of recommended chemical fertilizer

The recommended chemical fertilizer dose was 45 kg ha^{-1}, 100 kg ha^{-1}, 58 kg ha^{-1}, 2.6 ton ha^{-1}, 2.5 ton ha^{-1} and 375 kg $ha^{-1}$of Urea, TSP, MOP, vermicompost, poultry litter and mixed fertilizer, respectively. All the organic and inorganic fertilizers were applied during final land preparation.

3.4 Crop management

3.4.1 Seed collection

Seeds of BARI mash-2 and BARI mash-3 were collected from Pulse Seed Section, BARI, Joydebpur, Gazipur, Bangladesh.

3.4.2 Seed sowing

The seeds of black gram having more than 80% germination were sown by hand in 30 cm apart from lines and plant to plant distance was maintained 10 cm. The sowing depth was 3 cm and sown on 25 March, 2017.

3.4.3 Collection and preparation of initial soil sample

The soil sample of the experimental field was collected before fertilizer application. The initial soil samples were collected before land preparation from a 0-15 cm soil depth. The samples were collected by an auger from different location covering the whole experimental plot and mixed thoroughly to make a composite sample. After collection of soil samples, the plant roots, leaves etc. were removed. Then the samples were air-dried and sieved through a 10-mesh sieve and stored in a clean plastic container for physical and chemical analysis.

3.4.4 Preparation of experimental land

A pre- sowing irrigation was given on 18 March, 2017. The land was open with the help of a tractor drawn disc harrow on 22 March, 2017, then ploughed with rotary plough twice followed by laddering to achieve a medium tilth required for the crop under consideration. All weeds and other plant residues of previous crop were removed from the field. Immediately after final land preparation, the field layout was made on March 25, 2017 according to experimental specification. Individual plots were cleaned and finally prepared the plot.

3.4.5 Fertilizer application

The specific plots area was fertilized @ 45 kg ha^{-1}, 80-90 kg ha^{-1}, 58 kg ha^{-1}, 2.6 ton ha^{-1}, 2.5 ton ha^{-1} and 375 kg ha^{-1} of Urea, TSP, MOP, vermicompost, poultry litter and mixed fertilizer respectively. The entire amounts of Urea, TSP, and MOP, vermicompost, poultry litter and mixed fertilizer were applied in different combinations according to treatment as basal dose at final land preparation.

3.4.6 Intercultural operations

3.4.6.1 Re-sowing and gap filling

The plots were re-sowing and gap filling were done on 10 days after sowing.

3.4.6.2 Thinning

The plots were thinned out on 20 days after sowing to maintain a uniform plant stand.

3.4.6.3 Weeding

The crop was infested with some weeds during the early stage of crop establishment. Two hand weeding were done, first weeding was done at 10 days after sowing followed by second weeding at 15 days after first weeding.

3.4.6.4 Application of irrigation water

Irrigation water was added to each plot, first irrigation was done as pre- sowing and other two were given 2-3 days before weeding.

3.4.6.5 Drainage

There was a heavy rainfall during the experimental period. Drainage channel were properly prepared to easy and quick drained out of excess water.

3.4.6.6 Plant protection measures

The crop was infested by insects and diseases, those were effectively and timely controlled by applying recommended insecticides and fungicides. Savin was sprayed 4 days after sowing to control ants. Spraying of Austin to control fungus after 10 days of sowing and insecticide marshal was applied 30 days after sowing.

3.4.7 Harvesting and post-harvest operation

Maturity of crop was determined when 80-90% of the pods become blackish in color. The harvesting of black gram was done from 20 June to 04 July, 2017. Three pickings were done. Five pre-selected plants per plot was collected from which different yield attributing data were recorded and $1m^2$ area from middle portion of each plot was separately harvested and bundled, properly tagged and then brought to the threshing floor for recording grain and straw yield. The grains were cleaned and sun dried to a moisture content of 12%. Straw was also sun dried properly. Finally grain and straw yields $plot^{-1}$ were determined and converted to kg ha^{-1}.

3.4.8 Recording of data

Experimental data were determined from 15 days of growth duration and continued until harvest. Dry weights of plant were collected by harvesting respective number of plants at different specific dates from the inner rows leaving border rows and harvest area for grain. The following data were recorded during the experimentation.

A. Crop growth characters

i. Plant height (cm) (25, 50 and 75 DAS)
ii. Number of branch plant^{-1} (40, 55 and 70 DAS)
iii. Dry weight of plant (25, 50 DAS and at harvest)

B. Yield and other crop characters

i. Length of pod (cm)
ii. Number of Pods plant^{-1}
iii. Number of seeds pod^{-1}
iv. Seed weight plant^{-1}
v. Weight of 1000 seeds (g)
vi. Seed yield (t ha^{-1})
vii. Stover yield (t ha^{-1}) at harvest
viii. Biological yield (t ha^{-1})
ix. Harvest index (%)

3.4.9 Detailed procedures of recording data

A brief outline of the data recording procedure followed during the study given below:

A. Crop growth characters

3.4.9.1 Plant height (cm)

Plant height of 5 selected plants from each plot was measured at 25, 50 and 75 days after sowing (DAS). The height of the plant was determined by measuring the distance from the soil surface to the tip of the leaf of main shoot.

3.4.9.2 Number of branch plant^{-1}

Leaves plant^{-1} of 5 selected plants from each plot was measured at 40, 55, and 70 days after sowing (DAS). The number of branch plant^{-1} was determined and average together.

3.4.9.3 Dry weight of plant

The sub-samples of 5 plant plot^{-1} uprooted from second line were oven dried until a constant leveled, from which the weights of above ground dry matter were recorded at 25 days intervals and at harvest.

B. Yield and other crop characters

3.4.9.4 Number of pods plant^{-1}

Pods of ten selected plants were counted and the average pods for each plant was determined.

3.4.9.5 Number of seeds pod^{-1}

Pods from each of ten plants plot^{-1} were separated from which ten pods were selected randomly. The number of seeds pod^{-1} was counted and average number of seeds pod^{-1} was determined.

3.4.9.6 Seed weight plant^{-1}

Seed weight per plant was taken carefully after harvesting from each plot and then averaged.

3.4.9.7 Pods length (cm)

The 10 pods were selected to measure the pod length and then averaged together.

3.4.9.8 Weight of 1000-seeds

One thousand cleaned dried seeds were counted randomly from each sample and weighed by using a digital electric balance at the stage the grain retained 12% moisture and the weight were expressed in gram.

3.4.9.9 Seed yield

Seed yield was determined from the central 1.0 m^2 area of each plot. After separation of seeds, the sub-samples were oven dried to a constant weight and finally converted to kg ha^{-1}.

3.4.9.10 Stover yield (t/ha) at harvest

Total stover yield was calculated after harvest from the central 1.0 m^2 area in each plot and converted into kg ha^{-1}.

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

The biological yield was calculated by using the following formula:

Biological yield = grain yield + stover yield.

3.4.9.12 Harvest index

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

Harvest index denotes the ratio of economic yield (seed yield) to biological yield and was calculated with following formula (Donald, 1963; Gardner *et al*., 1985).

3.4.10 Statistical analysis

All the collected data were analyzed following the analysis of variance (ANOVA) technique using a statistical computer software IBM-SPSS (Version 20.0) and the means were adjusted by Tukey's Test at 0.05% level of significance.

CHAPTER IV
RESULTS AND DISCUSSION

This chapter represent the result and discussions of the present study.

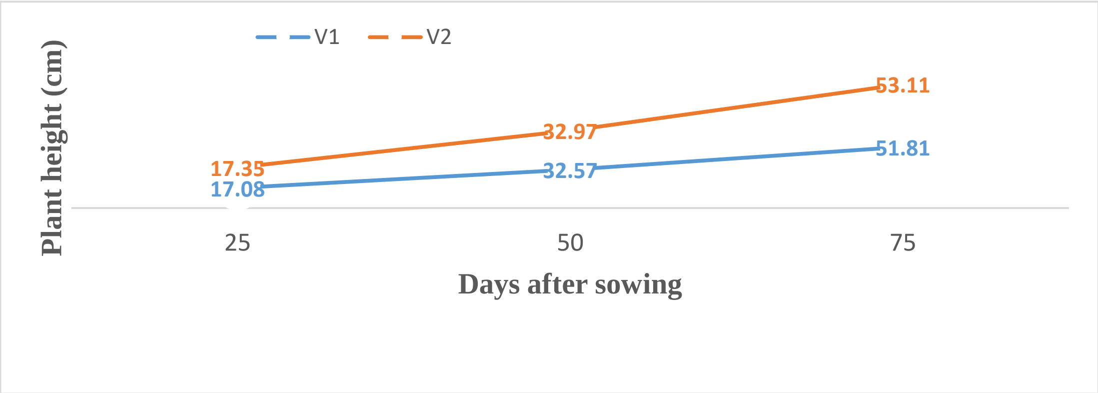
4.1 Effect of organic and inorganic fertilizer on growth of black gram

4.1.1 Plant height

4.1.1.1 Effect of variety

Plant height at 25 DAS gave non-significant result between two black gram varieties. BARI Mash-3(V_2) shown tallest plant height (17.35 cm) where BARI Mash-2(V_1) gave shorter (17.08 cm) than V_2. (Figure 1).

Between two black gram varieties, plant height at 50 DAS showed non-significant result. BARI Mash-3(V_2) shown highest plant height (32.97 cm) where BARI Mash-2(V_1) was shorter (32.57 cm) than V_2. (Figure 1). Non-significant result was found between two black gram varieties, plant height at 75 DAS. BARI Mash-3(V_2) shown highest plant height (53.11 cm) where BARI Mash-2(V_1) was shorter (51.81 cm) than V_2. (Figure 1).



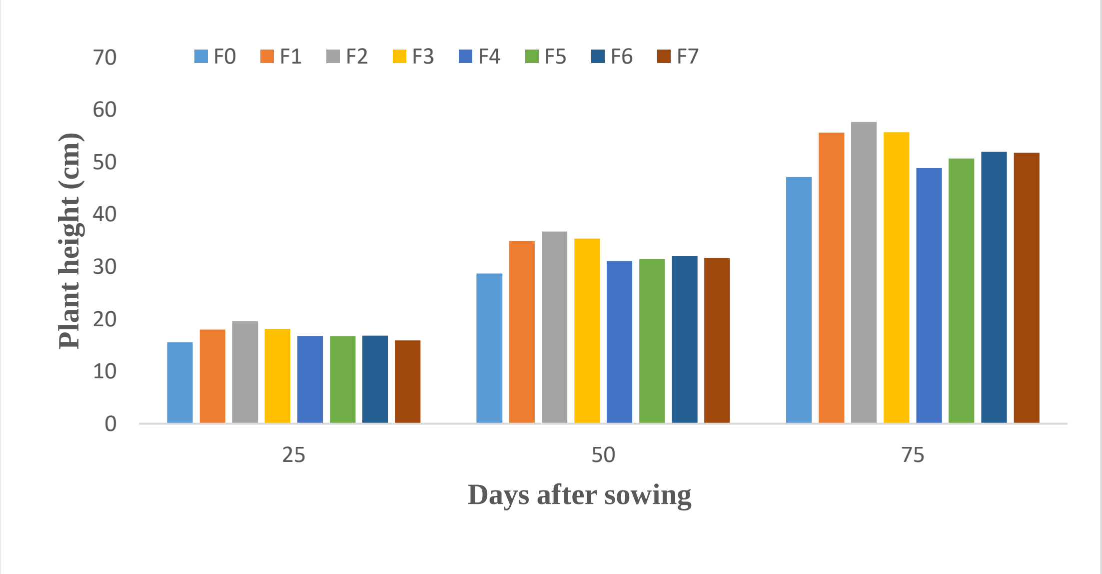
V_1 = BARI Mash-2, V_2 = BARI Mash-3,

Fig 1. Effect of variety on plant height of blackgram at different days after sowing (LSD 0.05=0.62, 1.10 and 1.46 for 25, 50 and 75 DAS respectively)

4.1.1.2 Effect of different combinations of organic and inorganic fertilizer

Different response was found on different combinations of fertilizer in case of plant height. All eight combinations of different organic and inorganic fertilizer combinations are significant where F_2 showed highest plant height at 25 DAS (19.62 cm). F_3, F_1 showed medium plant height at 25 DAS (18.18 cm and 18.03 cm) in comparison to F_2. F_7 and F_0 showed the lowest plant height (15.94 cm and 15.56 cm). This might be due to the different combinations of organic and inorganic fertilizer on plant height at 25 DAS (Figure 2).

Plant height showed different response on different combinations of fertilizer. All eight combinations of different organic and inorganic fertilizer combinations are significant where F_2 showed the highest plant height at 50 DAS (36.77 cm). F_3, F_1 showed medium plant height at 50 DAS (35.40 cm and 34.93 cm) in comparison to F_2. F_0 showed the lowest plant height (28.74 cm). This might be due to the different combinations of organic and inorganic fertilizer on plant height at 50 DAS (Figure 2). Among the eight combinations of different organic and inorganic fertilizer combinations are significant where F_2 showed highest plant height at 75 DAS (57.71 cm). F_3, F_1 showed medium plant height at 75 DAS (55.77 cm and 55.66 cm) in comparison to F_2. F_0 and F_4 showed the lowest plant height (47.15 cm and 48.86 cm). This might be due to the different combinations of organic and inorganic fertilizer on plant height at 75 DAS (Figure 2).



F_0= 0 (Control); F_1= Recommended dose of fertilizer (RDF), F_2= 25% less than RDF + vermicompost; F_3= 50% less than RDF + vermicompost, F_4= 25% less than RDF + poultry litter, F_5= 50% less than RDF + poultry litter, F_6= 25% less than RDF + mixed fertilizer, F_7= 50% less than RDF + mixed fertilizer.

Fig 2. Effect of different combinations of organic and inorganic fertilizer on plant height of blackgram at different days after sowing (LSD 0.05=1.98, 3.52 and 4.68 for 25, 50 and 75 DAS respectively)

4.1.1.3 Interaction effect of variety and fertilizer

Interaction effect of variety and fertilizer showed significant variation on plant height and length at different days after sowing (Table 1).At 25 DAS the tallest plant was found with V_2F_2 combination with which was statistically similar with V_1F_2, V_2F_3 and V_1F_3 combination. The lowest height was recorded from V_2F_0 which was statistically similar with V_1F_0 and V_2F_0. At 50 and 75 DAS V_2F_2 combination showed the tallest plant and V_1F_0 and V_2F_0 combination showed the shortest plant.

Table 1. Interaction effect of variety and different combinations of organic and inorganic fertilizer on plant height of blackgram at different days after sowing (DAS)

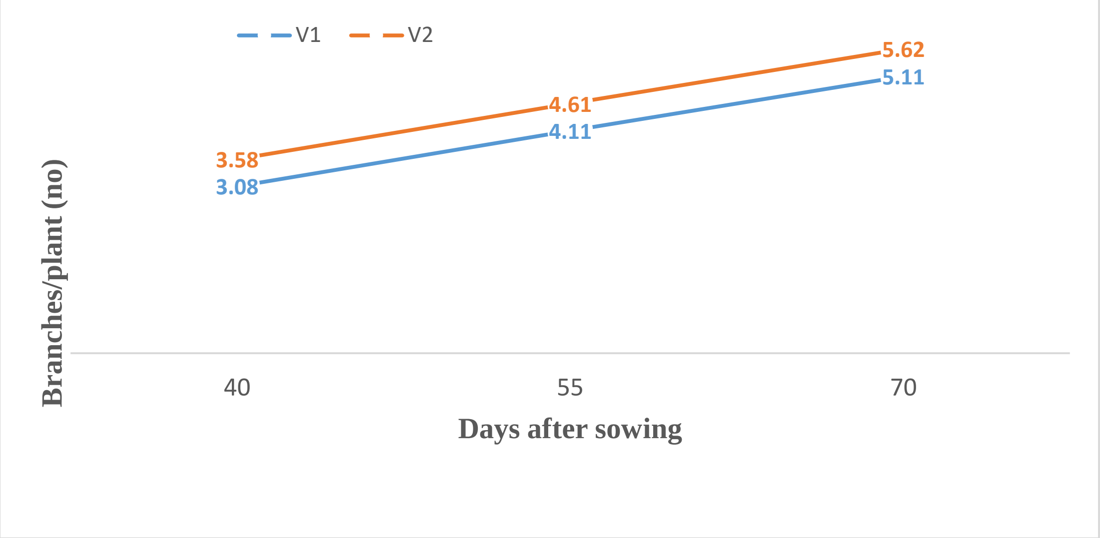
Treatments (variety and fertilizer combinations)	Plant height at (cm)		
	25 DAS	50 DAS	75 DAS
V_1F_0	15.65 e	28.89 g	46.78 e
V_1F_1	18.09 b-d	34.60 b-e	54.59 a-d
V_1F_2	19.31 ab	36.46 a-d	57.20 a
V_1F_3	17.93 a-d	35.49 ab	54.49 a-d
V_1F_4	16.57 b-e	31.12 d-g	49.51 b-e
V_1F_5	16.34 b-e	31.29 d-g	49.40 c-e
V_1F_6	16.55 b-e	31.28 d-g	50.83 a-e
V_1F_7	16.21 b-e	31.44 c-g	51.55 a-e
V_2F_0	15.47 e	28.59 g	47.53 de
V_2F_1	17.98 b-d	35.27 b-e	56.63 a-c
V_2F_2	19.94 a	37.08 a	58.22 a
V_2F_3	18.43 a-c	35.31 b-e	57.05 ab
V_2F_4	17.02 b-e	31.18 d-g	48.21 de
V_2F_5	17.12 b-e	31.65 c-g	51.99 a-e
V_2F_6	17.16 b-e	32.79 b-f	53.20 a-e
V_2F_7	15.67 e	31.93 b-g	52.08 a-e
LSD (.05)	**3.20**	**5.70**	**7.58**
CV (%)	**5.82**	**5.39**	**4.49**

V_1 = BARI Mash-2, V_2 = BARI Mash-3, F_0= 0 (Control); F_1= Recommended dose of fertilizer (RDF), F_2= 25% less than RDF + vermicompost; F_3= 50% less than RDF + vermicompost, F_4= 25% less than RDF + poultry litter, F_5= 50% less than RDF + poultry litter, F_6= 25% less than RDF + mixed fertilizer, F_7= 50% less than RDF + mixed fertilizer

4.1.2 Number of branches plant^{-1}

4.1.2.1 Effect of variety

Number of branch plant^{-1} showed significant effect between the black gram varieties at different sampling dates (40, 55 and 70 DAS) (Figure 3). The figure showed that the trend of number of branches plant^{-1} was increasing with the increase of growth stages and the highest increase was found with 70 DAS for both the varieties. It was also observed from the figure that V_2 variety was superior in producing number of branch plant^{-1} for all sampling dates. This may be due to the genetical characters of varieties.

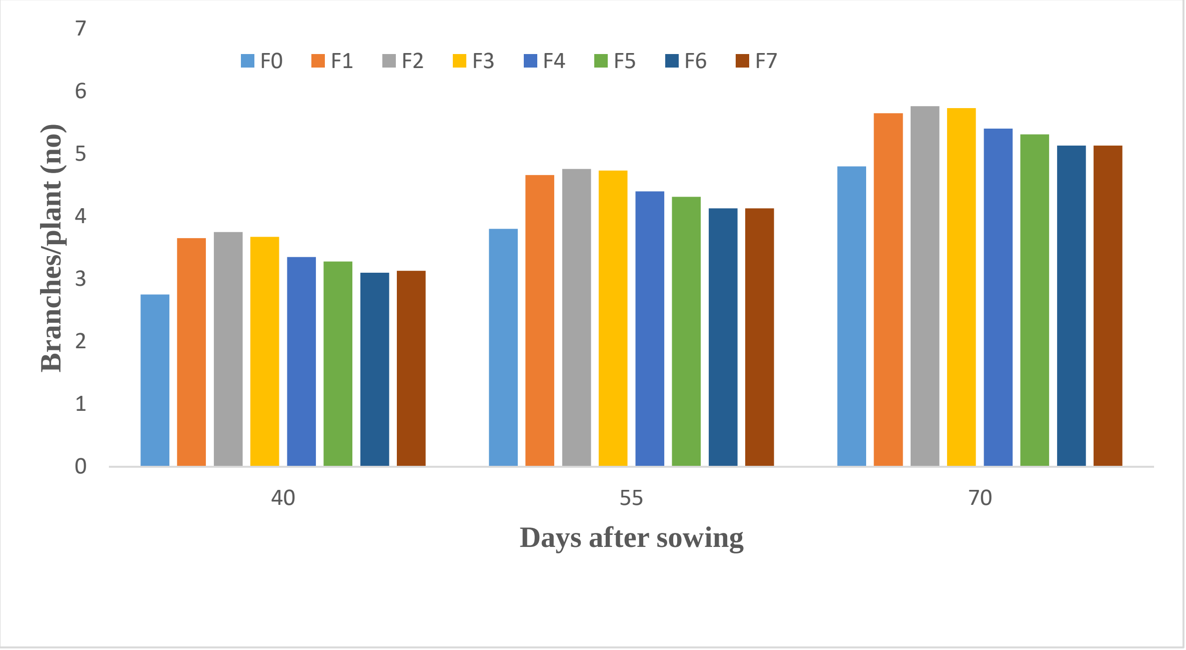


V_1 = BARI Mash-2, V_2 = BARI Mash-3.

Fig 3. Effect of variety on branch plant^{-1} of blackgram at different days after sowing (LSD 0.05=0.12, 0.13 and 0.15 for 40, 55 and 70 DAS respectively)

4.1.2.2 Effect of different combinations of organic and inorganic fertilizer

Number of branch plant^{-1} at 40 DAS showed different response on different combinations of fertilizer. All eight combinations of different organic and inorganic fertilizer combinations are significant where F_2 showed highest Number of branch plant^{-1} (3.75) at 40 DAS. F_3, F_1 showed medium Number of branch plant^{-1} at 40 DAS (3.66 and 3.65) in comparison to F_2. F_0 showed the lowest plant height (2.75). This might be due to the different combinations of organic and inorganic fertilizer on number of branch plant^{-1} at 40 DAS (Figure 4). At 55 DAS among the eight combinations of different organic and inorganic fertilizer combinations are significant where F_2 showed highest number of branch plant^{-1} (4.76). F_3 and F_1 showed medium number of branch plant^{-1} at (4.73and 4.76, respectively) in comparison to F_2. F_0 showed the lowest plant height (3.80). Different response was observed on different combinations of fertilizer, in case of number of branch plant^{-1} at 70 DAS. All eight combinations of different organic and inorganic fertilizer combinations are significant where F_2 showed highest number of branch plant^{-1} (5.77). F_3 and F_1 showed medium Number of branch plant^{-1} at 70 DAS (5.72 and 5.65, respectively) in comparison to F_2. F_0 showed the lowest plant height (4.79). This might be due to the different combinations of organic and inorganic fertilizer on number of branch plant^{-1} at 70 DAS (Figure 4).



F_0= 0 (Control); F_1= Recommended dose of fertilizer (RDF), F_2= 25% less than RDF + vermicompost; F_3= 50% less than RDF + vermicompost, F_4= 25% less than RDF + poultry litter, F_5= 50% less than RDF + poultry litter, F_6= 25% less than RDF + mixed fertilizer, F_7= 50% less than RDF + mixed fertilizer, DAS = Days after sowing

Figure 4. Effect of different combinations of organic and inorganic Fertilizer on branch plant^{-1} of blackgram at different days after sowing (DAS) (LSD 0.05=0.38, 0.42 and 0.43 for 40, 55 and 70 DAS respectively

4.1.2.3 Interaction effect of variety and fertilizer

Significant result was found at the interaction of variety and fertilizer on branch plant^{-1} of blackgram at different sampling dates (Table 2). At 45 DAS V_2F_1 showed highest result (4.04). V_2F_2 and V_2F_3 showed the medium result (3.96 and 3.90). Where V_1F_0 showed the lowest result (2.50).

At 55 DAS interaction of V_2F_3 and V_2F_1 showed the highest result (5.03 and 5.03 which was closely related to V_2F_0. V_2F_4 and V_1F_2 showed the medium result (4.60 and 4.53). Where V_1F_0 showed the lowest result (3.50).

At 70 DAS, highest branch plant^{-1} (6.04) was found with the interaction of V_2F_3 which followed by V_2F_1 (6.01), V_2F_1 (6.03), V_2F_2 (5.99), V_2F_4 (5.61), V_2F_5 (5.50), V_2F_2 (5.53) and V_1F_3 (5.42).

Interaction effect of variety and fertilizer gave non-significant result. On the other hand interaction of V_1F_0 showed the lowest result (4.53).

Table 2. Interaction effect of variety and different combinations of organic and inorganic fertilizer on branch plant^{-1} of blackgram at different days after sowing (DAS)

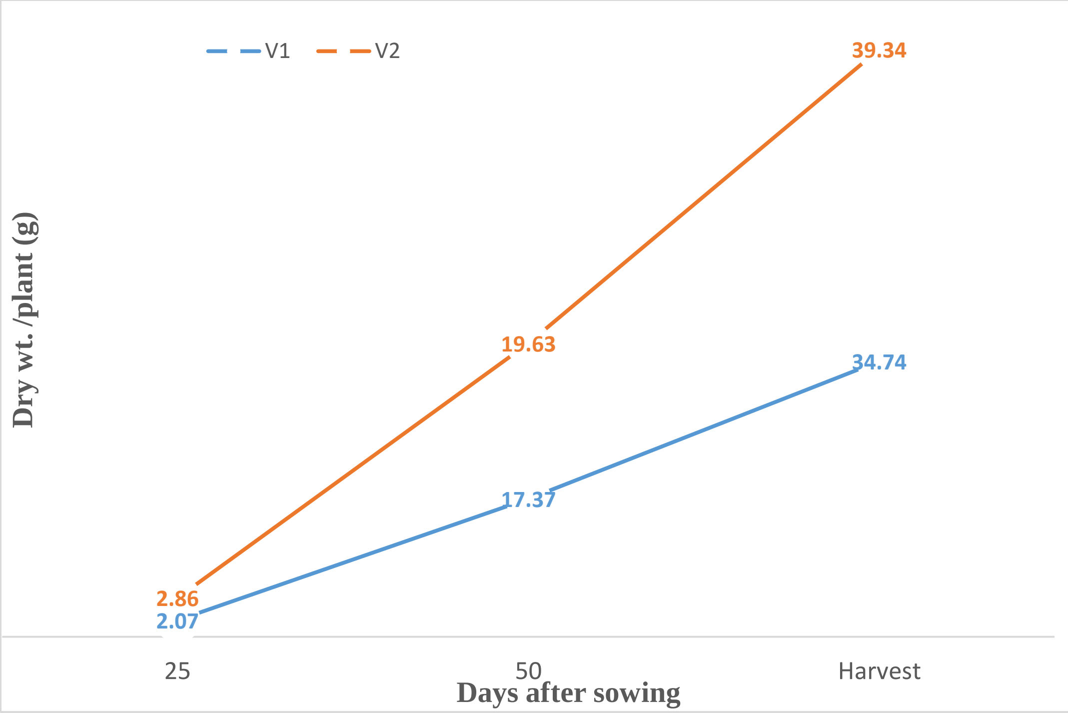
Treatments (variety and fertilizer combinations)	Branches plant^{-1} at (no.)		
	40 DAS	**55 DAS**	**70 DAS**
V_1F_0	2.50 f	3.50 d	4.50 d
V_1F_1	3.26 c-e	4.22 c	5.26 c
V_1F_2	3.53 a-d	4.56 a-c	5.53 a-c
V_1F_3	3.43 a-e	4.45 a-c	5.42 a-c
V_1F_4	3.10 c-f	4.20 c	5.22 c
V_1F_5	3.04 c-f	4.13 cd	5.13 cd
V_1F_6	2.86 ef	3.93 cd	4.91 cd
V_1F_7	2.93 d-f	3.92 cd	4.89 cd
V_2F_0	3.02 c-f	4.10 cd	5.11 cd
V_2F_1	4.04 a	5.03 a	6.03 a
V_2F_2	3.86 ab	5.00 ab	5.99 ab
V_2F_3	3.92 ab	5.03 a	6.04 a
V_2F_4	3.61 a-c	4.60 a-c	5.61 a-c
V_2F_5	3.52 a-d	4.50 a-c	5.50 a-c
V_2F_6	3.43 a-e	4.33 bc	5.31 bc
V_2F_7	3.33 b-e	4.31 bc	5.30 bc
LSD (.05)	**0.619**	**0.69**	**0.69**
CV (%)	**5.80**	**5.00**	**4.07**

V_1 = BARI Mash-2, V_2 = BARI Mash-3, F_0= 0 (Control); F_1= Recommended dose of fertilizer (RDF), F_2= 25% less than RDF + vermicompost; F_3= 50% less than RDF + vermicompost, F_4= 25% less than RDF + poultry litter, F_5= 50% less than RDF + poultry litter, F_6= 25% less than RDF + mixed fertilizer, F_7= 50% less than RDF + mixed fertilizer

4.1.3 Dry weight of plant

4.1.3.1 Effect of variety

Dry weight plant^{-1} blackgram exerted significant effect due to varieties for sampling dates (Figure 5). The figure shows that dry weight plant^{-1} increased with the advanced of growth stages for both the varieties. But the rate of increase was higher in V_2 varieties over V_1 for all sampling dates, but at harvest time V_2 variety showed much higher dry weight than V_1 variety, that was 13.24% higher. The higher dry weight between the varieties may be due to genetic makeup of the varieties.



V_1 = BARI Mash-2, V_2 = BARI Mash-3.

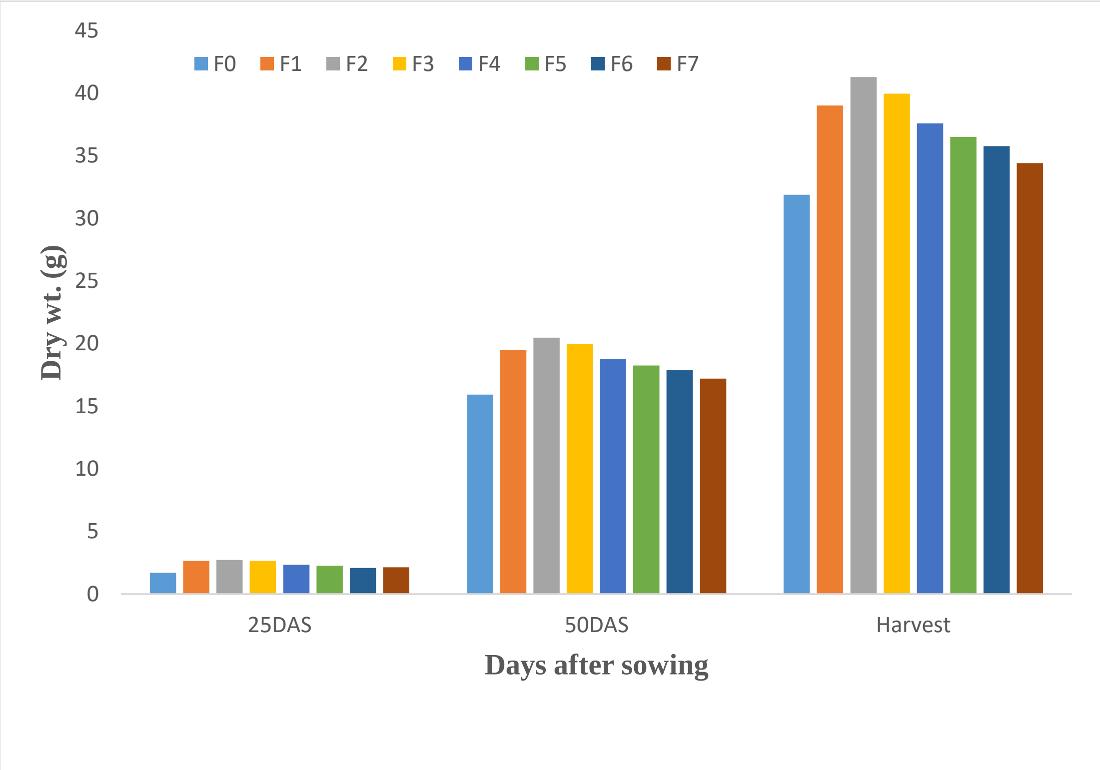
Fig 5. Effect of variety on dry weight of plant of blackgram at different days after sowing (LSD 0.05=0.13, 0.76 and 1.47 for 25 DAS, 50 DAS and at harvest respectively)

4.1.3.2 Effect of different combinations of organic and inorganic fertilizer

Dry weight plant^{-1} of blackgram exhibited significant variation due to combine effect of different organic and inorganic fertilizers for all sampling dates of (25 DAS, 50 DAS and at harvest (Figure 6). At 25 DAS F_2 showed highest dry weight of plant at 25 DAS (2.73 g). F_3, F_1 showed medium dry weight of plant at 25 DAS (2.65 g and 2.65 g, respectively) in comparison to F_2. F_0 showed the lowest dry weight of plant (1.72 g). This might be due to the different combinations of organic and inorganic fertilizer effect on dry weight of plant. Pannu *et al*. (2007) reported that the application of FYM as well as PM (pressmud) at 2.50 t/ha along with one fourth of the recommended dose of NP fertilizer (12 kg N and 40 kg P_2O_5 ha^{-1}) recorded the highest yield (6.90 and 6.60 q ha^{-1}, respectively) of black gram and similar trend was observed for the various growth attributes, such as number of pods plant^{-1}, plant height and 1000-grain weight.

At 50 DAS treatment F_2 showed highest dry weight of plant at 50 DAS (20.47 g). F_3, F_1 showed medium dry weight of plant (19.97 g and 19.50 g, respectively) in comparison to F_2. F_0 showed the lowest dry weight of plant at 50 DAS (15.93 g). This might be due to the positive effect of different combinations of organic and inorganic fertilizer on dry weight of plant at 50 DAS.

At harvest among the eight treatments F_2 showed highest dry weight of plant at harvest (41.28 g). F_3 and F_1 showed medium dry weight of plant at harvest (39.94 g and 39.01 g, respectively) in comparison to F_2. F_0 showed the lowest dry weight of plant (31.87 g). This might be due to the bio fertilizer and organic fertilizer which helped in significant increase of the dry matter production (Abraham and Lal, 2004).



F_0= 0 (Control); F_1= Recommended dose of fertilizer (RDF), F_2= 25% less than RDF + vermicompost; F_3= 50% less than RDF + vermicompost, F_4= 25% less than RDF + poultry litter, F_5= 50% less than RDF + poultry litter, F_6= 25% less than RDF + mixed fertilizer, F_7= 50% less than RDF + mixed fertilizer.

Fig 6. Effect of different combinations of organic and inorganic fertilizer on dry weight of plant of blackgram at different days after sowing (LSD 0.05=0.38, 2.43 and 4.69 for 25 DAS, 50 DAS and at harvest respectively)

4.1.3.3 Interaction effect of variety and fertilizer

Interaction of variety and combination of fertilizer were statistically significant on dry weight plant^{-1} of blackgram for all sampling dates (Table 3). Interaction combination V_2F_2 produced highest dry weight plant^{-1} at 50 DAS and at harvest (21.37 g and 43.39 g, respectively) and V_1F_0 combination produced the lowest dry weight at 25 DAS, 50 DAS and at harvest (1.50 g, 14.60 g and 29.20 g, respectively). At harvest, interaction of V_1F_1, V_1F_2, V_1F_3, V_2F_1 V_2F_3, V_2F_4, V_2F_5, V_2F_6 and V_2F_7 showed statistically similar and the highest dry weight with V_2F_2 interaction.

Table 3. Interaction effect of variety and different combinations of organic and inorganic fertilizer on dry weight plant^{-1} of blackgram at different days after sowing (DAS)

Treatments (variety and fertilizer combinations)	Dry weight at (g)		
	25 DAS	50 DAS	Harvest
V_1F_0	1.50 g	14.60 d	29.20 f
V_1F_1	2.26 c-f	18.47 a-d	36.94 a-e
V_1F_2	2.53 a-e	19.58 a-c	39.17 a-e
V_1F_3	2.43 a-f	18.98 a-c	37.96 a-e
V_1F_4	2.06 d-g	17.61 a-d	35.22 b-f
V_1F_5	2.03 d-g	17.05 b-d	34.10 c-f
V_1F_6	1.83 fg	16.55 cd	33.11 d-f
V_1F_7	1.93 e-g	16.12 cd	32.25 ef
V_2F_0	1.93 e-g	17.27 b-d	34.54 b-f
V_2F_1	3.03 a	20.54 ab	41.08 a-c
V_2F_2	2.93 ab	21.37 a	43.39 a
V_2F_3	2.86 a-c	20.96 ab	41.92 ab
V_2F_4	2.60 a-d	19.95 a-c	39.90 a-d
V_2F_5	2.50 a-e	19.46 a-c	38.92 a-e
V_2F_6	2.33 b-f	19.21 a-c	38.42 a-e
V_2F_7	2.33 b-f	18.28 a-d	36.58 a-f
LSD (.05)	**0.629**	**3.94**	**7.60**
CV (%)	**8.50**	**6.38**	**6.12**

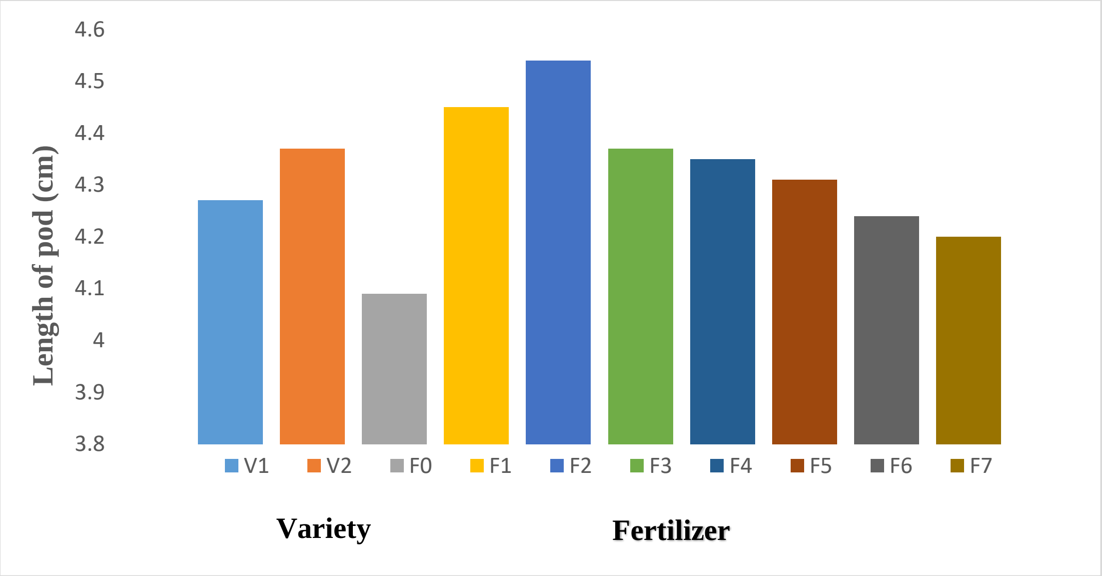
V_1 = BARI Mash-2, V_2 = BARI Mash-3, F_0= 0 (Control); F_1= Recommended dose of fertilizer (RDF), F_2= 25% less than RDF + vermicompost; F_3= 50% less than RDF + vermicompost, F_4= 25% less than RDF + poultry litter, F_5= 50% less than RDF + poultry litter, F_6= 25% less than RDF + mixed fertilizer, F_7= 50% less than RDF + mixed fertilizer

4.2 Effect of organic and inorganic fertilizer on yield attributes and yield of blackgram

4.2.1 Length of pod (cm)

4.2.1.1 Effect of variety

Length of pod (cm) had a significant impact among two black gram varieties. BARI Mash-3(V_2) shown higher length of pod (4.37 cm) where BARI Mash-2(V_1) was lower (4.27 cm) than V_2. (Figure 7).



V_1 = BARI Mash-2, V_2 = BARI Mash-3.

Fig 7. Effect of variety on pod length of blackgram (LSD 0.05=0.06 and 0.19 for variety and fertilizer respectively)

4.2.1.2 Effect of different combinations of organic and inorganic fertilizer

Length of pod (cm) showed significant response on different combinations of fertilizer (Figure 7). Among the F_2 showed highest length of pod (4.54 cm). F_1 showed medium length of pod (4.45 cm) in comparison to F_2. F_0 showed the lowest length of pod (4.09 cm). This might be due to the different combinations of organic and inorganic fertilizer on length of pod. The result correspondents with Das *et al*. (2007) who reported that rabbit manure at 5 t/ha + 50% NPK

(N:P:K kg 30:60:40 ha^{-1}) produced higher growth, yield attributes and seed yield (17.67 t ha^{-1}) of black gram compared to the control (7.69 t ha^{-1}).

4.2.1.3 Interaction effect of variety and fertilizer

Length of pod of blackgram showed significant difference due to interaction effect of variety and fertilizer (Table 4). Data presented in table indicate that V_2F_2 combination showed the longest pod (4.57 cm) which was statistically similar with V_1F_1, V_1F_2, V_1F_3, V_1F_4, V_2F_1, V_2F_3, V_2F_4, V_2F_5 and V_2F_6 interaction. On the other hand the shortest pod (4.03 cm) was found with

V_1F_0 treatment which was statistically similar with V_1F_3, V_1F_4, V_1F_5, V_1F_6, V_1F_7, V_2F_6 and V_2F_7 interactions.

Table 4. Interaction effect of variety and different combinations of organic and inorganic fertilizer on pod length of blackgram

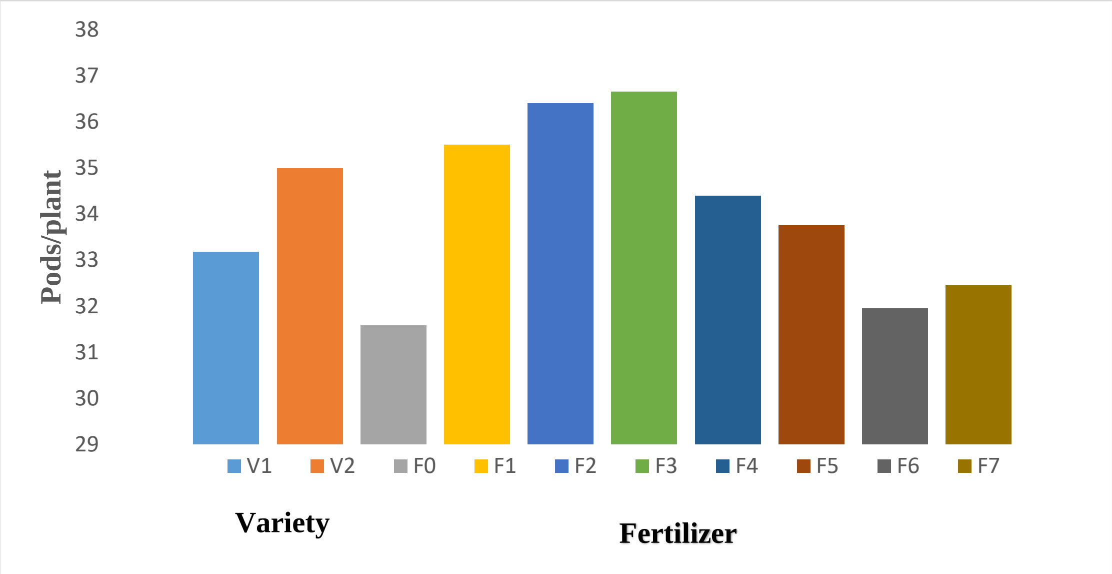
Treatments (variety and fertilizer combinations)	Pods plant^{-1} (no)	Length of pod (cm)	Seeds Pod^{-1} (no)
V_1F_0	30.56 f	4.03 e	6.23
V_1F_1	34.46 a-f	4.39 a-d	6.73
V_1F_2	35.56 a-d	4.51 a-c	7.16
V_1F_3	35.70 a-c	4.35 a-e	6.64
V_1F_4	33.36 a-f	4.32 a-e	6.54
V_1F_5	33.16 b-f	4.22 b-e	6.53
V_1F_6	31.26 ef	4.19 c-e	6.42
V_1F_7	31.36 d-f	4.17 de	6.21
V_2F_0	32.60 c-f	4.15 de	6.41
V_2F_1	36.54 a-c	4.52 ab	6.86
V_2F_2	37.27 ab	4.57 a	7.37
V_2F_3	37.60 a	4.42 a-d	7.24
V_2F_4	35.43 a-e	4.39 a-d	7.40
V_2F_5	34.36 a-f	4.40 a-d	7.55
V_2F_6	32.64 c-f	4.29 a-e	6.64
V_2F_7	33.53 a-f	4.21 b-e	6.97
LSD (.05)	**4.29**	**0.32**	**NS**
CV (%)	**3.77**	**2.26**	**7.29**

V_1 = BARI Mash-2, V_2 = BARI Mash-3, F_0= 0 (Control); F_1= Recommended dose of fertilizer (RDF), F_2= 25% less than RDF + vermicompost; F_3= 50% less than RDF + vermicompost, F_4= 25% less than RDF + poultry litter, F_5= 50% less than RDF + poultry litter, F_6= 25% less than RDF + mixed fertilizer, F_7= 50% less than RDF + mixed fertilizer, NS= non significant

4.2.2 Number of pods plant^{-1}

4.2.2.1 Effect of variety

A significant effect was found in number of pods plant^{-1} between two black gram varieties. BARI Mash-3(V_2) shown higher number of pods plant^{-1} (34.99) where BARI Mash-2(V_1) was lower (33.18) than V_2. (Figure 8).



V_1 = BARI Mash-2, V_2 = BARI Mash-3

Fig 8. Effect of variety on number of pod plant^{-1} of blackgram (LSD 0.05=0.83 and 2.65 for variety and fertilizer respectively)

4.2.2.2 Effect of different combinations of organic and inorganic fertilizer

Combinations of fertilizer had significant effect on pods plant^{-1} of blackgram (Figure 8). Figure shows that the values of pods plant^{-1} increased gradually up to F_3 treatment with the increased doses of fertilizer, further increasing doses reduced the pods plant^{-1} gradually. Howevr, the highest pod (36.65) was found with F_3 treatment and that of lowest (31.50) was recorded with F_0 treatment. The result agrees with the finding of Tisdale *et al*., (1985) who reported that fertilizer had positive effect on yield attributes of blackgram.

4.2.2.3 Interaction effect of variety and fertilizer

Interaction effect of variety and fertilizer gave significant result of pod plant^{-1} of blackgram. Where V_2F_3 and V_2F_2 showed highest result (37.60 and 37.26, respectively). Where V_1F_0 showed lowest result (30.56). (Table 5).

Table 5. Interaction effect of variety and different combinations of organic and inorganic fertilizer on number of pods plant^{-1} of blackgram

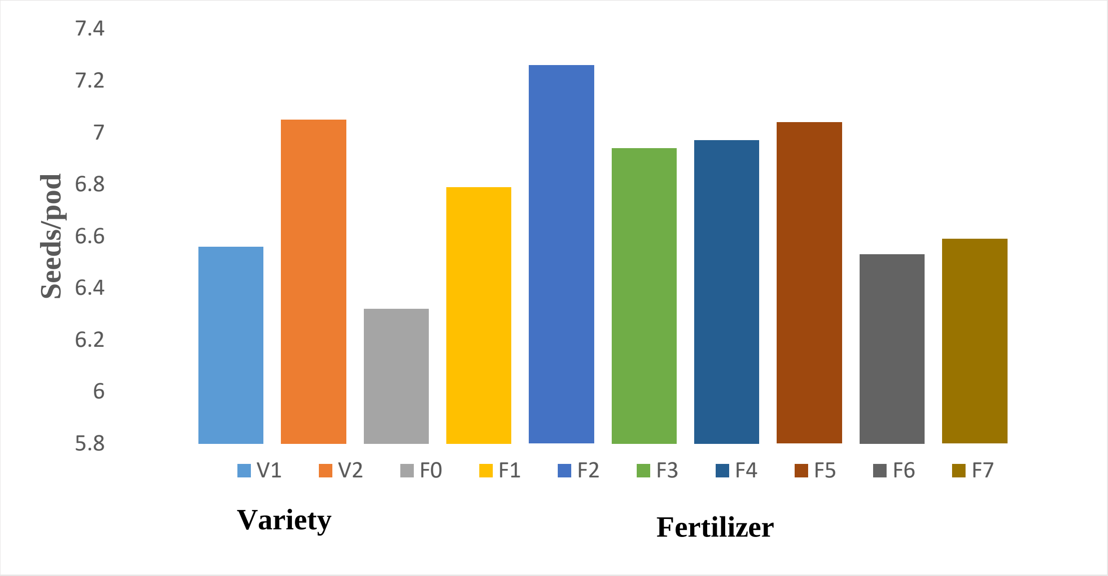
Treatments (variety and fertilizer combinations)	Seed weight plant^{-1} (g)	Thousand seed wt. (g)
V_1F_0	3.07 g	35.44 g
V_1F_1	5.49 a-d	41.91 a-c
V_1F_2	5.84 a-c	40.47 b-f
V_1F_3	5.16 a-f	38.92 c-f
V_1F_4	4.92 a-f	38.59 c-g
V_1F_5	4.29 b-g	37.82 d-g
V_1F_6	3.72 e-g	37.21 fg
V_1F_7	3.83 d-g	37.38 e-g
V_2F_0	3.57 fg	37.44 e-g
V_2F_1	5.98 ab	43.91 a
V_2F_2	6.34 a	42.47 ab
V_2F_3	5.66 a-c	40.92 a-d
V_2F_4	5.40 a-e	40.59 a-e
V_2F_5	4.78 a-f	39.82 b-f
V_2F_6	4.22 c-g	39.21 b-f
V_2F_7	4.32 b-g	39.38 b-f
LSD (.05)	**1.70**	**3.35**
CV (%)	**10.52**	**2.51**

V_1 = BARI Mash-2, V_2 = BARI Mash-3, F_0= 0 (Control); F_1= Recommended dose of fertilizer (RDF), F_2= 25% less than RDF + vermicompost; F_3= 50% less than RDF + vermicompost, F_4= 25% less than RDF + poultry litter, F_5= 50% less than RDF + poultry litter, F_6= 25% less than RDF + mixed fertilizer, F_7= 50% less than RDF + mixed fertilizer

4.2.3 Number of seeds pod^{-1}

4.2.3.1 Effect of variety

Number of seeds pod^{-1} had a significant impact among two black gram varieties. BARI Mash-3(V_2) shown higher number of seeds pod^{-1} (7.05) where BARI Mash-2(V_1) was lower (6.65) than V_2. (Figure 9). The result is supported with thw findings of Gupta et al. (2006) who reported that seed inoculation with phosphorus- solubilising bacteria showed a significant increase in yield attributes and yield of *Vigna mungo*.



V_1 = BARI Mash-2, V_2 = BARI Mash-3

Fig 9. Effect of variety on seeds pod^{-1} of blackgram (LSD 0.05=0.30 and 0.95 for variety and fertilizer respectively)

4.2.3.2 Effect of different combinations of organic and inorganic fertilizer

Different response was found on different combinations of fertilizer in number of seeds pod^{-1}. All eight combinations of different organic and inorganic fertilizer combinations are non-significant where F_2 and F_5 showed highest number of Pods plant^{-1} (7.26and 7.04). F_4, F_3 showed medium number of seeds pod^{-1} (6.97 and 6.94) in comparison to F_2 and F_5. F_0 showed the lowest number of seeds pod^{-1} (6.32). This might be due to the different combinations of organic and inorganic fertilizer on number of seeds pod^{-1} (Figure 9). Use of organic manures alone or in combination with chemical fertilizers will help to improve physico-chemical properties of the soil, efficient utilization of applied fertilizers for improving seed quality and quantity (Vasanthi and Kumaraswamy, 1996).

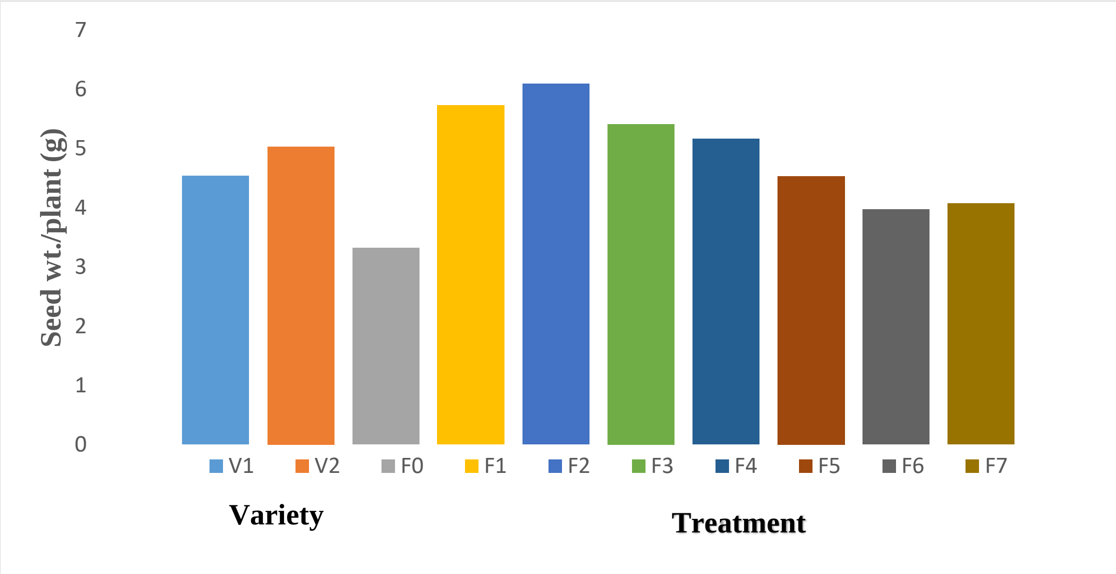
4.2.3.3 Interaction effect of variety and fertilizer

Non-significant result was given at the interaction of variety and fertilizer in blackgram. Where V_2F_5 and V_2F_4 showed highest result (7.55 and 7.40, respectively). Where V_1F_0 showed lowest result (6.23) (Table 5).

4.2.4 Seed weight plant^{-1}

4.2.4.1 Effect of variety

Seed weight plant^{-1} had a significant impact among two black gram varieties. BARI Mash-3(V_2) shown higher seed weight plant^{-1} (5.03 g) where BARI Mash-2(V_1) was lower (4.54 g) than V_2. (Figure 10).



V_1 = BARI Mash-2, V_2 = BARI Mash-3

Fig 10. Effect of variety on the seed weight plant^{-1} (g) of blackgram (LSD 0.05=0.32 and 1.05 for variety and fertilizer respectively)

4.2.4.2 Effect of different combinations of organic and inorganic fertilizer

Seed weight plant^{-1} of blackgram exerted significant effect due to different combination of organic and inorganic fertilizers (Figure 10). It can be inferred from the figure that seed weight plant^{-1} increased sharply with the increased fertilizer level and the highest increased was found with F_2 treatment. Further increases of fertilizer dose reduce the seed weight plant^{-1} gradually and the reduction continued up highest dose (F_7). However, F_2 showed the highest seed weight plant^{-1} (6.09 g). F_0 showed the lowest seed weight plant^{-1} (3.32 g). This might be due to the different combinations of organic and inorganic fertilizer on seed weight plant^{-1}. The result confirms with findings of Gawai and Pawar (2006) who reported that use of organic manures along with inorganic fertilizers leads to increase in productivity and also sustain the soil health for a longer period.

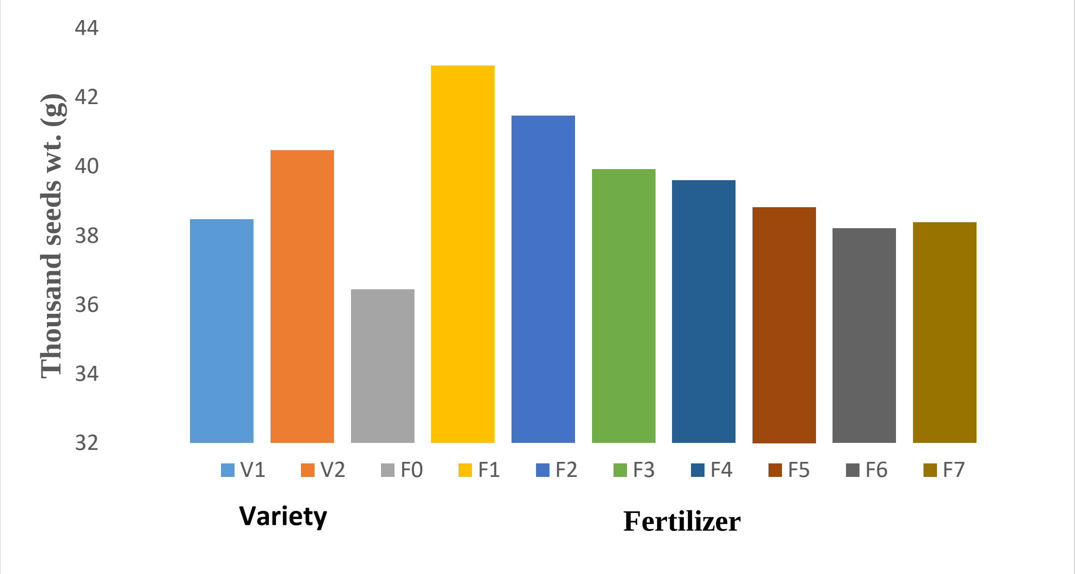
4.2.4.3 Interaction effect of variety and fertilizer

Interaction of variety and fertilizer combination gave significant result on seed weight plant^{-1} of blackgram (Table 5). Where V_2F_2 showed the highest result (6.34 g) which was statistically similar with V_1F_1, V_1F_2, V_1F_3, V_1F_4, V_2F_1, V_2F_3, V_2F_4, and V_2F_5 combinations. Where V_1F_0 showed the lowest result (3.07 g) which was statistically similar with V_1F_5, V_1F_6, V_1F_7, V_2F_0, V_2F_6 and V_2F_7 combinations.

4.2.5 Weight of 1000 seeds (g)

4.2.5.1 Effect of variety

Weight of 1000 seeds (g) showed a significant variation on thousand seed weight between two black gram varieties. BARI Mash-3(V_2) had higher weight of 1000 seeds (40.47 g) than BARI Mash-2(V_1) (38.47 g) (Figure 11)



V_1 = BARI Mash-2, V_2 = BARI Mash-3

Fig 11. **Effect of variety on thousand seed weight (g) of blackgram** (LSD 0.05=0.64 and 2.06 for variety and fertilizer respectively)

4.2.5.2 Effect of different combinations of organic and inorganic fertilizer

Different response was observed in weight of 1000 seeds on different combinations of fertilizer. All eight combinations of different organic and inorganic fertilizer combinations are significant where F_1 and F_2 showed highest weight of 1000 seeds (42.91 g and 41.47 g, respectively). F_3 and F_4 showed medium weight of 1000 seeds (39.92 g and 39.57 g, respectively) in comparison to F_1 and F_2. F_0 showed the lowest weight of 1000 seeds (36.44 g). This might be due to the different combinations of organic and inorganic fertilizer on weight of 1000 seeds (Figure 11)

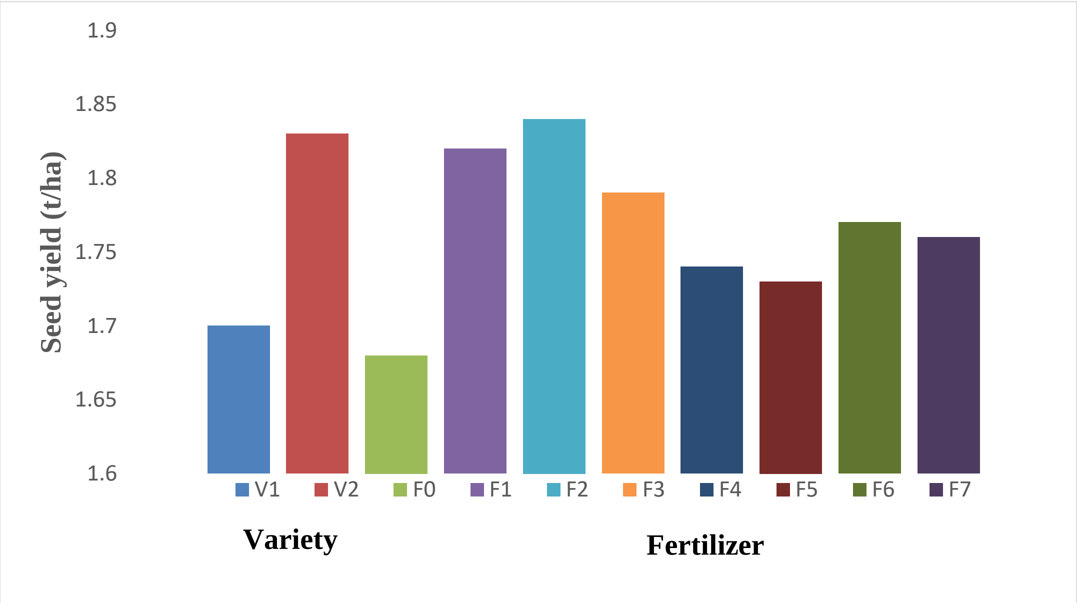
4.2.5.3 Interaction effect of variety and fertilizer

Significant result was found at the interaction of variety and fertilizer. Interaction of V_2F_1 showed the height 1000 sees weight which was statistically similar with V_2F_2, V_1F_1, V_2F_3, and V_2F_4 interactions. On the other hand, V_1F_0 treatment showed the lowest weight of 1000 sees weight which was statistically similar with V_1F_4, V_1F_5, V_1F_6, V_1F_7 and V_2F_0 interactions (Table 5).

4.2.6 Seed yield (t ha^{-1})

4.2.6.1 Effect of variety

Seed yield had a significant effect between two black gram varieties. BARI Mash-3(V_2) shown higher seed yield (1.83 t ha^{-1}) where BARI Mash-2(V_1) was lower (1.71 t ha^{-1}) than V_2. (Figure 12 and appendix VI). 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).



V_1 = BARI Mash-2, V_2 = BARI Mash-3

Fig 12. Effect of variety on seed yield of blackgram (LSD 0.05=0.011 and 0.38 for variety and fertilizer respectively)

4.2.6.2 Effect of different combinations of organic and inorganic fertilizer

Seed yield showed different response on different combinations of fertilizer.

All eight combinations of different organic and inorganic fertilizer combinations are significant where F_2 and F_1 showed highest seed yield (1.84 t ha^{-1} and 1.82 t ha^{-1}). F_3 and F_6 showed medium seed yield (1.79 t ha^{-1} and 1.77 t ha^{-1}) in comparison to F_2 and F_1. F_0 showed the lowest seed yield (1.68 t ha^{-1}). This might be due to the different combinations of organic and inorganic fertilizer on seed yield (Figure 12). Phosphorus is an important mineral element for grain legumes as it helps in root development, participates in synthesis of phosphate and phosphoproteins and takes part in energy fixing and releasing process in plants (Singh and Yadav, 2008).

4.2.6.3 Interaction effect of variety and fertilizer

Interaction of variety and fertilizer exerted significant response in respect of seed yield (Table 6). The value of seed yield was highest (1.9 t ha^{-1}) with V_2F_2 interaction treatment which was statistically similar with V_2F_3 and V_2F_5 (1.85 t ha^{-1} and 1.84 t ha^{-1}, respectively). On the other hand, V_1F_0 interaction showed significantly lowest yield (1.61 t ha^{-1}).

Table 6. Interaction effect of variety and different combinations of organic and inorganic fertilizer on seed yield, stover yield and biological yield of blackgram

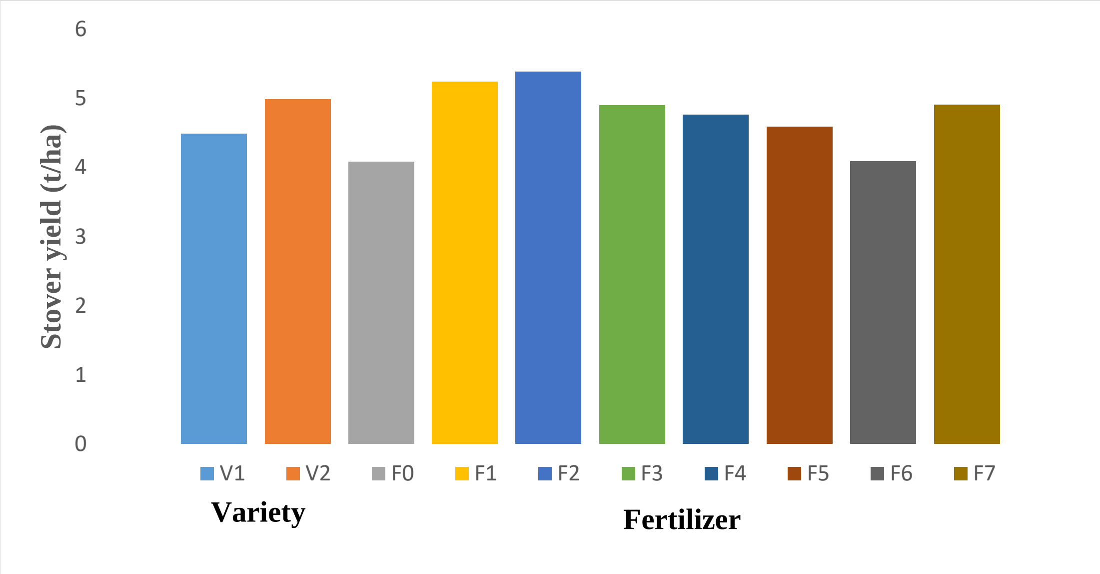
Treatments (variety and fertilizer combinations)	Seed yield (t ha^{-1})	Stover yield (t ha^{-1}) at harvest	Biological yield (t ha^{-1})
V_1F_0	1.61 j	3.77 b	5.38 b
V_1F_1	1.77 d-f	4.98 ab	6.75 ab
V_1F_2	1.78 d-f	5.13 ab	6.91 ab
V_1F_3	1.74 f-h	4.65 ab	6.39 ab
V_1F_4	1.68 hi	4.50 ab	6.18 ab
V_1F_5	1.67 i	4.35 ab	6.02 ab
V_1F_6	1.70 g-i	3.84 b	5.54 b
V_1F_7	1.70 g-i	4.65 ab	6.35 ab
V_2F_0	1.76 e-g	4.42 ab	6.18 ab
V_2F_1	1.87 e-g	5.50 a	7.37 a
V_2F_2	1.90 a	5.64 a	7.54 a
V_2F_3	1.85 a-c	5.16 ab	7.01 ab
V_2F_4	1.81 b-e	5.10 ab	6.91 ab
V_2F_5	1.79 c-f	4.84 ab	6.63 ab
V_2F_6	1.84 a-c	4.35 ab	6.19 ab
V_2F_7	1.83 b-d	5.17 ab	7.00 ab
LSD (.05)	**0.0617**	**1.14**	**1.06**
CV (%)	**4.14**	**7.43**	**5.74**

V_1 = BARI Mash-2, V_2 = BARI Mash-3, F_0= 0 (Control); F_1= Recommended dose of fertilizer (RDF), F_2= 25% less than RDF + vermicompost; F_3= 50% less than RDF + vermicompost, F_4= 25% less than RDF + poultry litter, F_5= 50% less than RDF + poultry litter, F_6= 25% less than RDF + mixed fertilizer, F_7= 50% less than RDF + mixed fertilizer

4.2.7 Stover yield (t ha^{-1})

4.2.7.1 Effect of variety

Significant result was found in stover yield at harvest among two black gram varieties. BARI Mash-3(V_2) shown higher stover yield at harvest (4.99 t ha^{-1}) where BARI Mash-2(V_1) was lower (4.48 t ha^{-1}) than V_2. (Figure 13)



V_1 = BARI Mash-2, V_2 = BARI Mash-3

Fig 13. Effect of variety on stover yield of blackgram (LSD 0.05=0.91 and 2.92 for v_1 and v_2 and fertilizer respectively)

4.2.7.2 Effect of different combinations of organic and inorganic fertilizer

All eight combinations of different organic and inorganic fertilizer combinations are significant where F_2 showed highest stover yield at harvest (5.39 t ha^{-1}). F_1 showed medium stover yield at harvest (5.24 t ha^{-1}) in comparison to F_2 and F_1. F_0 showed the lowest stover yield at harvest (4.03 t ha^{-1}). This might be due to the different combinations of organic and inorganic fertilizer on stover yield at harvest (Figure 13).

Inoculation with the combination of the biofertilizers (*Rhizobium* sp. And *Bacillus megaterium* var. phosphaticum) resulted in higher yield, N and P content, N and P uptake by the grain and straw compared to no inoculation and individual inoculation (Tanwar *et al*., 2003)

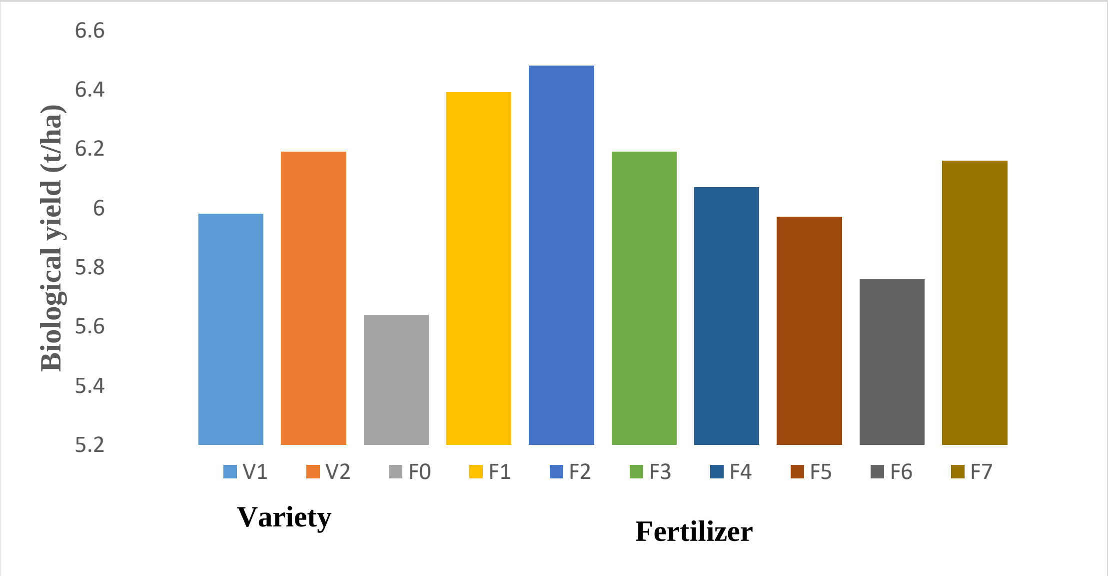
4.2.7.3 Interaction effect of variety and fertilizer

Interaction effect of variety and fertilizer gave significant result on stover yield of blackgram. Where V_2F_2 showed highest result (5.64 t ha^{-1}). Where V_1F_0 showed lowest result (3.77 t ha^{-1}). Which was statistically similar with all the combinations except V_1F_0 and V_1F_6 (Table 6).

4.2.8 Biological yield (t ha^{-1})

4.2.8.1 Effect of variety

Tanwar *et al*. (2003) reported that the crop yield of black gram, N and P contents, and N and P uptake increased with increasing P dose up to 80 kg ha^{-1}. Biological yield at harvest had a significant impact among two black gram varieties. BARI Mash-3(V_2) shown higher biological yield (6.19 t ha^{-1}) where BARI Mash-2(V_1) was lower (5.98 t ha^{-1}) than V_2. (Figure 14).



V_1 = BARI Mash-2, V_2 = BARI Mash-3

Fig 14. Effect of variety on biological yield of blackgram (LSD 0.05=0.20 and 0.65 for variety and fertilizer respectively)

4.2.8.2 Effect of different combinations of organic and inorganic fertilizer

Biological yield showed different response on different combinations of fertilizer. All eight combinations of different organic and inorganic fertilizer combinations are significant where F_2 showed the highest biological yield (6.48

t ha^{-1}). F_1 showed medium biological yield (6.39 t ha^{-1}) in comparison to F_2. F_0 showed the lowest biological yield (5.64 t ha^{-1}). This might be due to the different combinations of organic and inorganic fertilizer on biological yield (Figure 14).

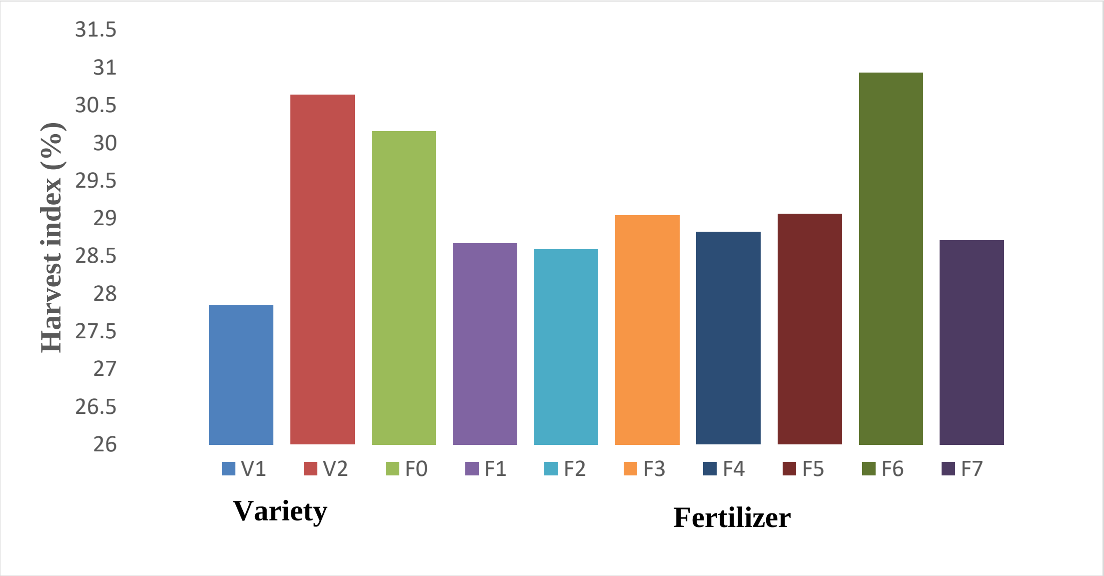
4.2.8.3 Interaction effect of variety and fertilizer

Interaction effect of variety and fertilizer showed non-significant result. Where V_2F_2 showed the highest result (6.91 t ha^{-1}). Where V_1F_0 showed the lowest result (5.38 t ha^{-1}). (Table 6).

4.2.9 Harvest index (%)

4.2.9.1 Effect of variety

Harvest index had a significant impact between two black gram varieties. BARI Mash-3(V_2) shown higher harvest index (30.64 %) where BARI Mash-2(V_1) was lower (27.85 %) than V_2. (Figure 15).



V_1 = BARI Mash-2, V_2 = BARI Mash-3

Fig 15. Effect of variety on harvest index of blackgram (LSD 0.05=0.92 and 2.92 for variety and fertilizer respectively)

4.2.9.2 Effect of different combinations of organic and inorganic fertilizer

On different combinations of fertilizer, harvest index showed different response. All eight combinations of different organic and inorganic fertilizer combinations are non-significant where F_6 and F_0 showed highest harvest index (30.93% and 30.16%). F_5 and F_4 showed medium harvest index (29.06 % and 29.04 %) in comparison to F_2 and F_1. F_2 showed the lowest harvest index (28.59 %). This might be due to the different combinations of organic and inorganic fertilizer on harvest index (Figure 15).

4.2.9.3 Interaction effect of variety and fertilizer

Interaction effect of variety and fertilizer showed significant result. Where V_2F_2 and V_2F_1 showed highest result (31.42% and 31.06%, respectively). Where V_1F_2 showed lowest result (25.76 %). (Table 7).

Table 7. Interaction effect of variety and different combinations of organic and inorganic fertilizer on harvest index of blackgram

Treatments (variety and fertilizer combinations)	Harvest index (%)
V_1F_0	30.51 ab
V_1F_1	26.28 ab
V_1F_2	25.76 b
V_1F_3	26.28 ab
V_1F_4	25.76 ab
V_1F_5	27.24 ab
V_1F_6	27.24 ab
V_1F_7	27.94 ab
V_2F_0	29.81 ab
V_2F_1	31.06 a
V_2F_2	31.42 a
V_2F_3	30.83 ab
V_2F_4	30.40 ab
V_2F_5	30.19 ab
V_2F_6	30.82 ab
V_2F_7	30.60 ab
LSD (.05)	**5.18**
CV (%)	**10.91**

V_1 = BARI Mash-2, V_2 = BARI Mash-3, F_0= 0 (Control); F_1= Recommended dose of fertilizer (RDF), F_2= 25% less than RDF + vermicompost; F_3= 50% less than RDF + vermicompost, F_4= 25% less than RDF + poultry litter, F_5= 50% less than RDF + poultry litter, F_6= 25% less than RDF + mixed fertilizer, F_7= 50% less than RDF + mixed fertilizer.

CHAPTER V
SUMMARY AND CONCLUSION

The experiment was conducted at Sher-e-Bangla Agricultural University research field during March to June, 2017 to find out the different combinations of organic and inorganic fertilizer on growth and yield of blackgram. The experiment comprised with two factors-viz. factor A. variety-2, BARI Mash-1(V_1) and BARI Mash-2(V_2) and factor B. fertilizer combination-7, control (F_0), RDF (F_1), 25% less than RDF+vermicompost (F_2), 50% less than RDF+vermicompost (F_3), 25% less than RDF+poultry litter (F_4), 50% less than RDF+poultry litter (F_5), 25% less than RDF+mixed fertilizer (F_6), 50% less than RDF+mixed fertilizer (F_7).The experiment was conducted following Randomize Complete Block Design (RCBD) with three replications. The result revealed that in case of variety branch plant^{-1}, dry weight of plant, pods plant^{-1}, seeds pod^{-1}, seed weight plant^{-1}, length of pod, thousand seed weight, seed yield, stover yield and biological yield showed significant variations. The plant height and harvest index were non-significant in case of variety. The results indicated that BARI Mash-3 had better performance over BARI Mash-2. In case of BARI Mash-3 branch plant^{-1} (5.61), dry weight of plant (39.34 g), pods plant^{-1} (34.99), seeds pod^{-1}(7.05), seed weight plant^{-1} (5.03), length of pod (4.47 cm), thousand seed weight (40.47 g), seed yield (1.83 t ha^{-1}), stover yield (4.99 t ha^{-1}) and biological yield (6.82 t ha^{-1}) all showed highest values. In case of BARI Mash-2 plant height and harvest index was 51.81 cm and 27.85 %, whereas BARI Mash-3 had 53.11 cm and 30.64 % which were non-significant.

Effects of fertilizer combination treatments results showed that plant height, branch plant^{-1}, dry weight of plant, pods plant^{-1}, seed weight plant^{-1}, length of pod, thousand seed weight, seed yield, stover yield, biological yield and harvest index had significant variations. Where seeds pod^{-1} was non-significant in case of fertilizer. The research work showed F2 (25% less than RDF + vermicompost) and F3 (50% less than RDF + vermicompost) had good performance over other fertilizer treatments. In case of F_2 and F_3 plant height (57.71cm and 55.77 cm), branch plant^{-1} (5.76 and 5.73), dry weight of plant (41.28 g and 39.94 g), pods plant^{-1} (36.41 and 36.65), seed weight plant^{-1} (6.09 g and 5.41 g), length of pod (4.54 cm and 4.38 cm), thousand seed weight (41.47 g and 39.92 g), seed yield (1.84 t ha^{-1} and 1.79 t ha^{-1}), stover yield (5.39 t ha^{-1} and 4.90 t ha^{-1}), biological yield (7.23 t ha^{-1} and 6.69 t ha^{-1}) and harvest index (28.59 % and 29.04%) showed highest result. In case of seeds pod^{-1} fertilizer treatments F_2= 7.26(the highest) and F_0= 6.32(the lowest) was non-significant.

In case interaction of variety and fertilizer all treatments showed non-significant result. Where V_2F_2 was the highest for plant height (58.22 cm), V_2F_3 for branch plant^1 (6.03), V_2F_2 for seeds pod^{-1} (7.37), V_2F_2 for dry weight of plant (43.39 g), V_2F_3 for pods plant^{-1} (37.60), V_2F_2 for seed weight plant^{-1} (6.34 g), V_2F_2 for length of pod (4.57 cm), V_2F_1 for thousand seed weight (43.91 g), V_2F_2 for seed yield (1.90 ton ha^{-1}), V_2F_2 for stover yield (5.64 t ha^{-1}), V_2F_2 for biological yield (7.54 kg ha^{-1}) and V_2F_2 for harvest index (31.42 %).

From the above results it is clear that application of vermicompost and poultry litter with RDF in different combinations increased the vegetative growth and yield. Yield contributing characters like pods plant^{-1}, seeds pod^{-1}, 1000 seed weight, seed yield and biological yield and harvest index greatly influenced by vermicompost with RDF combinations (F2 and F3). The growth contributing characters like plant height and branch plant^{-1} greatly influenced by vermicompost with RDF combinations (F2 and F3) too.

To have a clear idea, this kind of study need to be conducted more by alternating the level of organic and inorganic fertilizer combinations. It is also needs to include other varieties to verify results. Therefore, it can be concluded that the application of organic and inorganic fertilizers had a better positive effect BARI Mash-3 than BARI Mash-2.

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APPENDICES

Appendix I. Monthly record of air temperature, relative humidity and rainfall of the experimental site during the period of March, 2017 to June, 2017

Month	Air temperature (^0C)		Relative humidity (%)		Rainfall (mm) (total)
	Maximum	Minimum	Maximum	Minimum	
March	32.5	20.4	71	62	65.8
April	33.7	23.6	81	73	165.3
May	32.7	22.6	80.2	46.4	202
June	32.4	22.5	69.5	45.3	199

Source: SAU mini weather station, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh

Appendix II. Soil test result of the experimental field.

Element	Levels in the soil plot
pH	5.9
N	0.071%
K	0.31 meq/100g soil
Ca	6.36 meq/100g soil
P	14.04 µg/g soil
S	15.16 µg/g soil
B	0.30 µg/g soil

Source: Soil Resources Development Institute (SRDI), Khamarbari, Farmgate, Dhaka

Plate 1. Sprouting stage of blackgram

Plate 2:.Seedling stage view in field

Plate 3. Field view of experimental plot at growth stage

Plate 4. Flowering view in experiment field

Plate 5. Fruiting view of experimental plot at growth stage