PERFORMANCE OF MUNGBEAN VARIETIES UNDER ORGANIC AND INORGANIC FERTILIZER MANAGEMENTS

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CERTIFICATE

This is to certify that thesis entitled, "**PERFORMANCE OF MUNGBEAN VARIETIES UNDER ORGANIC AND INORGANIC FERTILIZER MANAGEMENTS"** 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 (MS)** IN **AGRONOMY**, embodies the result of a piece of bona fide research work carried out by **BIBI.AMENA,** Registration No. **16-07567** under my supervision and guidance. No part of the 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.

……………………………..
(Prof. Dr. Md. Fazlul Karim)
Supervisor

Dated:
Place: Dhaka, Bangladesh

Dedicated To

My Beloved Parents

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PERFORMANCE OF MUNGBEAN VARIETIES UNDER ORGANIC AND INORGANIC FERTILIZER MANAGEMENTS

ABSTRACT

An experiment was carried out at Sher-e-Bangla Agricultural University farm, Dhaka to investigate the performance of mungbean varieties under organic or inorganic fertilizer managements during the period from April to June, 2017. The field experiment consisted of two factors, factor A: Variety (2); V_1= BARI mung 6, V_2= Binamoog 8. factor B : Fertilizer management (5); F_1 = NPKBS (RDF), F_2= Cowdung (10 t/ ha), F_3= Vermicompost (7 t/ ha), F_4 = Poultry manure (5 t/ha) and F_5= *Rhizobium sp* (80 g/ Kg seed). The experiment was arranged in RCBD (Factorial) with three replications. Results revealed that, BARI mung 6 gave the highest seed yield (0.93 t/ha) which may be attributed to higher number of pods plant^{-1} (12.17), seeds pod^{-1} (11.8) and 1000 seed weight (42.36 g). Among different organic and inorganic fertilizer managements F_1 (NPKSB) treatment affected the growth and yield attributes giving the highest seed yield (1.02 t/ha), pods plant^{-1} (13.60), seeds pod $^{-1}$(13.06), pod length (9.51 cm) which was similar with F_4 (Poultry manure) treatment. Combined treatment of BARI mung 6 and fertilizer, V_1F_1 gave the highest seed yield (1.09 t/ha), pods plant^{-1}(14.03) and seeds pod^{-1} (14.49). Combination of Binamoog 8 and poultry manure treatment (V_2F_4) had greater seed yield (1.01 t/ha), pods plant^{-1} (13.5) and seeds pod^{-1} (14.27), which was statistically similar with BARI mung 6 along with recommended fertilizers. So application of chemical fertilizer can be reduced by the application of organic fertilizer (poultry manure) without sacrificing yield.

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ABBREVIATIONS AND ACRONYMS

AEZ	=	Agro-Ecological Zone
BBS	=	Bangladesh Bureau of Statistics
cm	=	Centimeter
CV %	=	Percent Coefficient of Variation
DAS	=	Days After Sowing
et al.,	=	And others
e.g.	=	exempli gratia (L), for example
etc.	=	Etcetera
FAO	=	Food and Agricultural Organization
g	=	Gram (s)
i.e.	=	id est (L), that is
Kg	=	Kilogram (s)
LSD	=	Least Significant Difference
m^2	=	Meter squares
ml	=	MiliLitre
M.S.	=	Master of Science
No.	=	Number
SAU	=	Sher-e-Bangla Agricultural University
var.	=	Variety
^oC	=	Degree Celceous
%	=	Percentage
NaOH	=	Sodium hydroxide
GM	=	Geometric mean
mg	=	Miligram
P	=	Phosphorus
K	=	Potassium
Ca	=	Calcium
L	=	Litre
µg	=	Microgram
USA	=	United States of America
WHO	=	World Health Organization

CHAPTER I

INTRODUCTION

Mungbean (*Vigna radiata* L.) is an important pulse crop in Bangladesh that is grown mostly in rotation with cereal crops such as rice, wheat etc. The agroecological circumstance of Bangladesh is more auspicious for growing this crop. Mungbean retains first in market values, the 3rd in protein content and 5th in both acreage and production (BBS, 2008). It maintains 2nd ranking to drought resistance after soybean (Ali *et al.,* 2001). Mungbean is predominantly cultivated for human consumption for its edible seeds which is discriminated by good digestibility, flavor, high protein content and nonappearance of any flatulence properties (Ahmed *et al.,* 2001). The people of Bangladesh take pulse knowingly or unknowingly as the supplement of animal protein. Mungbean seed contains 24.7% protein, 0.6% fat, 0.9% fiber and 3.7% ash (Potter and Hotchkis, 1997) as well as sufficient amounts of calcium, phosphorus and influential vitamins. It comprises exalted quality of lysine (4600 mg/g N) and tryptophan (60 mg/g N). Mungbean can be used as manure, cover crop and forage or intercropped in cereal crops, sugarcane or jute. On an average, it fixes aerial N @ 300 kg /ha annually (Sharar *et al*., 2001). On the nutritional point of view, this legume is one of the best among pulses (Khan, 1981 and Kaul, 1982).

According to FAO (2013) recommendation, per capita intake of pulse should be 80 g day^{-1},where as it is 10.92 g/day in Bangladesh.In Bangladesh almost 291 thousands Mt pulses was imported, in 2006-2007 fiscal year by virtue of deficit of production (BBS, 2010). Mungbean is cultivated on an area of 261.4 thousand hectares including entire grain production of 134.4 thousand tons and approximate yield of 482.63 kg/ha (Anonymous, 2003).

Mungbean is extremely reactive to chemical fertilizers or organic manures. Mungbean needs less nitrogen because of it leguminous in character but require optimum doses of other leading plant nutrients as recommended. With the impetuous growth in population worldwide, the demand of food and agricultural yield has been rising tremendously. Soil and fertilizer management is very intricate and dynamic in nature. High population rate in developing countries has produced stress on agricultural land that forced to meet up growing food requirements by improving yield from existing or even shrinking land areas. As a consequence, the agricultural technique are moving away from the traditional and rather static "soil dependent" agriculture to dynamic "fertilizer dependent" agriculture (BARC, 2005).

Imbalanced application of fertilizers innovate the fertility of the soil by increasing the acid levels in soil that has hostilely influenced agricultural productivity and causes soil degradation. Due to excessive use of chemical fertilizer without sufficient organic recycling originates environmental pollution with multinutrient deficiencies in soil plant system and collapse soil health (Anonymous, 2007). Environmental degradation is a principle threat facing with the world, and the excessive use of chemical fertilizers contributes immensely to the deterioration of the environment through depletion of fossil fuels, formation of carbon dioxide (CO_2) and contamination of water resources. Moreover, chemical fertilizers are becoming costly components in agriculture. Therefore, to face with the current situation it is urgent to expand the production through varietal development and accurate fertilizer management practices. Fitting them with appropriate organic farming system by applying organic manures and use of seed inoculation with effective *Rhizobium* strains will provide better nodulation, nitrogen fixation, growth and higher yield.

Recently, the application of organic materials as fertilizers for crop cultivation has obtained more consideration for sustainable crop productivity (Tejada *et al*., 2009). The adjuvent effects of animal manure on soil physical properties and the ease with which they decompose inside soil are highly advantage over inorganic fertilizers (Adeoye*et al*. 2011). Organic fertilizers covers manures prepared from animal waste like cattledung, poultry manures, excreta of other animals, rural and urban waste, composts, crop residues and green manure (Nwaiwu *et al.*, 2010). Growth enhancing substance, number of salutary microorganism like N fixing, P solubilizing and cellulose decomposing organism are obtainable of these organic manures which improving the availability of essential nutrients to the leguminous crops.

Among organic manures, cowdung is highly rich source of organic matter and supports to buffer soils against speedy chemical changes. Cowdung expresses no or little adverse effect on crops and also on human health (Gupta and Gupta, 2011). Poultry manure has been catching up as a very excellent substitute to staying organic source of nutrients in the agroclimatic zone. Its develop soil structure by providing binding effect to soil aggregates and enhances water holding capacity of soils. Vermicompost is a sustainable bio-fertilizer which is regenerated from organic wastage using earthworms. Vermicompost is a strong source of N, P, K and micronutrients. Besides providing a good proportion of exchangeable Ca, Mg, Na, etc. it is also enormous source of growth hormones, vitamins and acts as powerful biocide against diseases and nematodes besides developing physical condition of soil. The use of biological nitrogen fixation (BNF) technology in the form of *Rhizobium* inoculants in grain legumes can also be an substitute of expensive chemical fertilizer, particularly for enhancing the production of food legumes in the country. *Rhizobium* inoculation to seeds of pulse can lead to a saving of about 20 - 40 kg nitrogen. In Bangladesh, inoculation with *Rhizobium*increased 57% effective nodule, 77% dry matter production, 64% grain yieldand 40% hay yield over un inoculated control in mungbean (Chanda *et al*. 1991).

The yield and quality of mungbean can be improved by the balanced use of chemical fertilizers and also by managing the organic manures properly. Organic materials contain great promise as a source of multiple nutrients and ability to develop soil characteristics (Moller, 2009). Proper management either chemical fertilizers or organic manures with high yielding variety of mungbean may be considered as important strategy for sustainable production of mungbean. This may improve the efficiency of chemical fertilizers or organic manures along with their minimal use in crop production besides increasing crop yield and improving available major and minor nutrients.

In view of these points the present study was undertaken with following objectives:

1.To compare between mungbean varieties.

2.To determine the judicial application of either inorganic or organic fertilizer to promote mungbean yield.

3.To study the combined effect of varieties and inorganic or organic fertilizer on the growth and yield of mungbean.

CHAPTER II

REVIEW OF LITERATUR

A number of studies have been conducted in several aspects related to the mungbean production in different countries of the world but research works on the performance of mungbean varieties under organic and inorganic fertilizer management are limited in Bangladesh.

2.1 Effect of Organic Manures

2.1.1 Effect of organic manures on growth and development

Kumar *et al*. (2003) reported that application of vermicompost @ 5 t/ ha substantially exalted plant height of mungbean (*Vigna radiata)* over control.

Choudhary *et al*. (2011) investigated that application of vermicompost @ 0.7 t/ha+50% RDF provided excessive number of braches/plant (7.1) of mungbean crop and remained at par with poultry manure @ 0.85 t/ha + 50% RDF.

Rajkhowa *et al.* (2002) reported that the growth parameters such as plant height, dry matter accumulation etc. of mungbean notably developed with application of vermicompost at 2.5 t/ ha + 100% RDF over control.

Rupa *et al.* (2014) carried out a field trail at Sher-e-Bangla Agricultural University farm during the period February to April 2012 to investigate the effect of organic and inorganic fertilizers on growth and yield of mungbean (BARI Mung 5) where maximum plant height was viewed under the treatment of Vermicompost + 75 % of recommended dose of inorganic fertilizer.

Choudhary *et al.* (2011) conducted a trail and displayed significantly enhanced number and dry weight of nodules in mungbean crop as differentiated to absolute control with all the treatments of combination of both organic manures and chemical fertilizers or singly used organic and inorganic fertilizer whereas application of vermicompost @0.7t/ha + 50%RDF recorded maximum values of nodules numbers and weight of nodules over control.

Karmegam *et al.* (1999) investigated the effect of vermicompost on the grown and yield of green gram and ascertained that under the application of vermicompost greatly improved the growth attributes of mungbean.

Raundal *et al.* (1999) carried out an field trail during kharif season 1997-98 where they ascertained that application of P_2O_5 60 kg/ha through vermicompost meaningfully improved the growth, dry matter accumulation and seed yield of mungbean.

Das *et al*. (2002) carried out a study and revealed that application of 100 percent recommended dose of fertilizers + vermicompost on greengram cultivation significantly giving taller plants, more leaf area, higher root volume, maximum nodule number, high fresh nodule weight and dry matter yield as compared to control and 100 per cent RDF + FYM.

Singh *et al.* (2008) observed that applying the vermicompost @ 2t/ha substantially improved dry matter collection and growth attributes chickpea.

Mathur (2000) who conducted an experiment on greengram and reported that the application of 20 kg N/ha + vermicompost significantly improved the growth attributes in terms of plant height, dry matter accumulation, LAI, number and dry weight of nodules per plant than rest of other treatments.

Netwal (2003) revealed that more plant height and number of branches per plant of cowpea were observed due to application of vermicompost at 5 t/ha as compared to other treatment (2.5 t vermicompost and 5 t FYM/ha) and control.

Dahama *et al.* (2007) while investigating the effect NPK (20-30-20 Kg/ ha), Zn (25 kg/ha), Fe (5 kg/ha), FYM (10 t/ha) and vermicompost (5 t/ha), applied singly or in combination of both on green gram cv. RMG-62 at Bikaner (Rajasthan) reported that highest plant height was recorded at harvest with the treatment of NPK + vermicompost (43.8 cm) than the other treatments and control.

Yadav (2001) at Jobner also reported that application of nitrogen @ 20 kg/ha + vermicompost or FYM greatly maximized the plant height, number of branches, dry weight of nodules and dry matter accumulation of cowpea over control and other treatment.

Menon *et al.* (2010) reported that growth viz. plant height, dry matter, number of leaves of cowpea production were highest under the treatment including poultry manure and cow dung.

Ramesh *et al.* (2006) conducted a field experiment on pigeon pea with different treatments of organic manures (cattle dung @ 4 t/ ha, vermicompost @ 3 t/ ha and poultry manure @ 2 t/ ha) and noted that among cattle dung given the maximum plant height, number of branches per plant and biomass accumulation where vermicompost remained intermediate while poultry manure recorded lower values of above parameters but was superior to control.

Amanullah *et al.* (2007) reported that the organic manure treatments, i.e. FYM @ 25 t/ha, poultry manure @ 10 t/ha, composted poultry manure @ 10 t/ha, FYM @ 12.5 t/ ha +poultry manure @ 5 t/ha, FYM @ 12.5 t/ ha+ composted poultry manure @ 5 t/ ha provided better growth and yield of pulses crop over control.

Choudhary *et al.* (2011) stated that integration of 50% RDN through poultry manure to supplement the nitrogen to fenugreek recorded maximum growth attributes, viz. plant height, branches/plant, dry matter accumulation/m, nodules/plant and weight of nodules/plant of fenugreek crop over control.

Bhattarai *et al.* (2003) conducted a study at research farm of the Central Agricultural University, Imphal on field pea and reported that application of full recommended nutrient + 5 tons per hectare poultry manure provided the highest plant height and dry matter accumulation per plant over the rest of treatment.

Choudhary *et al.* (2014) conducted an effective experiment for two year on loamy sand soil at Jobner (Rajasthan) and results revealed that under application of vermicompost @ 2.5 t/ha, the effective nodules, total nodules per plant, nitrogen fixing percentage at flowering stage and nodule index of mungbean increased significantly over to other organic manures and control.

Panda *et al.* (2012) reported significant effects of use of the organic amendments viz. groundnut cake, Pongamia cake, neem cake, mustard cake, cowdung, vermicompost, and poultry manure used individually or in combinations on growth, nodulation, yield, and profitability of cowpea, cv. Utkal Manika, grown on sandy loam soil.

Mathur (2000) observed that the application of nirtogen @70 Kg/ha +vermicompost significantly maximized the number and dry weight of nodules per plant of greengram over rest of the treatments.

Rajakhowa *et al.* (2003) reported that the highest number of root nodules per plant of greengram was obtained from the application of vermicompost @ 2.5 t /ha + 75% of recommended dose of chemical fertilizers substantially over control.

Choudhary (2007) conducted a valuable field trail and stated that using of vermicompost @ 2 t/ha greatly increased the total number of effective of nodules per plant, leghemoglobin content in nodules at pre-flowering stage of greengram than the other treatment.

Ghanshyam and Jat (2010) conducted an experiment for two sequential years where he noted that under the application of vermciompost @ 5 t/ha meaningfully improved the total number of nodules per plant being at par with application of FYM @ 5 t/ ha and both were found superior outcome over control in both the years in green gram.

Madukue *et al.* (2008) observed that organic manure substantially influenced the nodulation of the cowpea and application of poultry manure provided the notable number of nodules (15.9) which was significantly different from the other values of nodules (12.2 and 10.3) recorded from cow dung-treated plots and untreated plots respectively.

2.1.2. Effect of Organic manures on yield attributes and yield

Kumar *et al.* (2003) reported that under the infliction of vermicompost @ 5 t/ ha produced 16.5 and 9.5 per cent higher grain formation of mungbean in comparison to FYM @ 5 t/ ha and vermicompost @ 2.5 t/ha gradually.

Karmegam *et al.* (1999) while working at Gandhigram (Tamil Nadu) conducted a field trail on greengram and reported that maximum seed yield of greengram was recorded under the vermicompost treatment.

Rajkhowa *et al.* (2000) stated that the application of nitrogen (recommend dose) through vermicompost substantially maximized the grain yield of mungbean over control and nitogen as farm yard man

Siag and Yadav (2004) operated an field trail in Rajasthan, India to study the impact of vermicompost (0, 1, 2 and 3 t/ ha) and chemical fertilizer (0, 50% and 100% recommend dose) where consequential enhanced of seed yield, pod per plants of mungbean was recorded by using vermicompost 2 t/ha over control.

Choudhary *et al.* (2014) carried out an experiment for two successive year on loamy sand soil at Jobner (Rajasthan) and maximum outcome recorded under application of vermicompost @ 2.5 t/ ha which increased the symbiotic characters, nitrogen fixing percentage at flowering stage and nodule index of mungbean over the control.

Reddy *et al.* (1998) observed that vermicompost @ 10 t/ha and recommended dose of NPK (27.5: 60: 50 kg/ha) was significantly influenced and improved total grain yield of pea over the other treatments.

Das *et al.* (2002) reported that application of vermicompost created better impact on dry matter accumulation, seed yield and number of pods of greengram compared to other manures or chemical fertilizers used.

Rajkhowa *et al.* (2003) observed that application of vermicompost @ 2.5 t/ha + 2 t/ ha FYM significantly enhanced yield attributes of green gram in the term of number of pods per plant, seeds per pod and 1000 seed weight of green gram over other treatment.

Singh *et al.* (2008) revealed that vermicompost @ 2t/ha significantly improved dry matter accumulation and yield attributes in the term of number of pods/plant, total seed weight/plant seeds yield/ ha and straw yield of chickpea over control.

Ramawatar *et al.* (2013) conducted a field trail where vermicompost @ 2.0 t /ha given substantially higher yield and increased other yield attributes of clusterbean viz: pods /plant, seeds /pods, pod length and seed, straw and biological yield over vermicompost 1.0 t/ha.

Dane *et al.* (1996) operated a field trail in Maharashtra on groundnut cultivar konkan and found that pod yield was considerably higher by using vermicompost @ 1.5 t or FYM @ 5 t/ha with inorganic fertilizer (N:P2O5 -25:50)

Mathur (2000) investigated that associated application of nitrogen @ 70 Kg/ha + vermicompost were greatly higher no. of pods /plant, seed yield/ha, stover yield and total biomass yield of greengram over rest of the treatments.

Mariammal *et al.* (2012) revealed that the application of cowdung and vermicompost, the total number of pods and total yield of blackgram significantly increased and the leaves number, leaf ratio were also higher over the rest of the treatments.

Yadav (2001) based on his study reported that application of nitrogen @ 20 Kg/ ha with vermicompost notably increased the no. of pods per plant, seeds per pod, seed yield and straw yield of cowpea over the identical dose of N applied through FYM.

Salahin *et al.* (2011) was conducted a field trail for three successive years to investigate the effect of integrated nutrient management and tillage on soil properties and yield under tomato-mungbean- T. aman cropping pattern during 2007-08, 2008-09 and 2009-10 at BARI, Gazipur. There were nine treatment combinations comprising three tillage practices i.e. T_1: tillage up to 8 cm depth, T_2 : tillage up to 12 cm depth and T_3 : tillage up to 20 cm depth and three levels of fertilizers i.e. F_1: recommended dose of chemical fertilizers only, F_2: cowdung @ 5 t ha^{-1} + RDF and F_3: control were taken. They were obtained effective improvement on crop yield by different treatment combinations of organic and inorganic fertilization but not by tillage practices.

Singh *et al*. (2008) carried out a field to investigate the effect of different organic manures, viz cattle dung manure, vermicompost and poultry manure application on soybean, [*Glycine max* (L.) Mer.], chickpea (*Cicer arietinum* L.) and wheat (*Triticum durum*) seeds yield quality parameters and their effect on soil biological properties under soybean - durum wheat and soybean - chickpea cropping systems and recorded that the application of cattledung manure + vermicompost reported highest seed yields of chickpea (1 551 kg/ha) distinguished to other organic combinations and control (1185 kg/ha).

Remesh *et al.* (2012) investigated the effect of different combination of organic manures including cowdung , poultry manure and vermicompost with chemical fertilizers (RDF) and control on the yield potential of soybean (*Glycine max*), chickpea (*Cicer arietinum*) and blond psyllium (Plantago ovata) and recorded higher improvement in soil fertility.

Raghav and Kamal (2007) revealed that FYM + biofertilizers produced 9.7% higher green pod yield than the treatment having chemical fertilizers (RDF) of cowpea crop compared to the other treatments.

Shikha *et al*. (2004) studied the effect of 50, 75, 100 or 125% of the recommended dose of chemical fertilizers and RRF 20 kg K_2O and 100 kg K_2O as for soybean and in conjunction with FYM 10 t/ ha and poultry manure 2.5 t /ha or biofertilizers on the performance of soybean-wheat cropping system and revealed that all treatments significantly enhanced the yields of the crops and the highest number of under 125% RRF + FYM, poultry manure or biofertilizers over control and the other treatments.

Madukue *et al*. (2008) revealed that the yield of cowpea was notably improved by applying of poultry manure with a mean yield of 744.7 kg/ha, which was greatly distinguishable from values (571.9kg/ha and 505.0kg/ha) noted under control and cow dung treated plots respectively.

Adeoya *et al*. (2011) stated that these plots ware treated by poultry waste along had highest yield (854 kg/ha) performance of cowpea crop over control and other treatments.

Amanullah *et al*. (2007) revealed that the organic manure treatments, i.e. FYM @ 25 t/ha, poultry manure @ 10 t/ha, composted poultry manure @ 10 t/ha, FYM @ 12.5 t/ha + poultry manure @ 5 t/ha, FYM @ 12.5 t/ha+ composted poultry manure @ 5 t/ha along with the control provided higher nutrient uptake in legumes crop and available nutrients in post harvest soil.

Pramesh *et al.* (2006) reported that the application of poultry manure @ 2 t/ha given substantially higher number of pods/ plant and seed yield of pigeonpea crop over control.

Rao and Shaktawat (2002) reported that the application of poultry manure @ 5 t/ha significantly higher number of pods per plant (18.6 pods /plant) in groundnut crop over control.

2.2. Effect of biofertilizer:

2.2.1. Effect of biofertilizer on growth and development

Muhammad *et al.* (2004) revealed that seeds inoculation with *Rhizobium* and application of P fertilizer both were significantly enhanced the plant height and number of branches per plant. They conducted a field trail on mungbean cv. NM- 92 under the rainfed conditions with various levels of phosphorus (20. 35, 50. 65, and 80 kg/ha) integrated with and without *Rhizobium* inoculation. The maximum plant height (72.6 cm) was recorded in the plot, which received 35 kg P_2O_5/ha + *Rhizobium* inoculum.

Sattar and Ahmed (1995) carried out a field trail on mungbean inoculation with biofertilizer (*Rhizobium)* and recorded meaningful enhancement of plant height by *Rhizobium* inoculation compared to control.

Hasanuzzaman (2001) conducted a field trail on mungbean seed inoculation with *Bradyrhizobium* and reported significantly higher plant height over uninoculated control.

Solaiman (2002) carried out a field trail with *Bradyrhizobium* on seed inoculation of mungbean and recorded that seed inoculation greatly influenced plant height compared with other uninoculated treatment.

Kavathiya and Pandey (2000) carried out a pot experiment with biofertilizer on seed inoculation of mungbean and recorded that seed inoculated resulted in significantly higher plant height compared with uninoculated control.

Mozumder (1998) conducted an experiment on seed inoculation of mungbean with various strains of *Bradyrhizobium* and recorded that plant height and other growth attributes were significantly enhanced over uninoculated control.

Thakur and Panwar (1995) carried out a field trial where *Vigna radiata* cv. Pusa-105 and PS-16 were given seed inoculation with *Bradyrhizobium* with or without combined soil inoculation with VAM fungus. They found that seed inoculation either singly or combinedly with soil inoculation significantly increased plant height compared with no inoculation.

Rahman (1993) conducted a field trail on mungbean (*Vigna radiata) cv.kanti and* reported that seed inoculation of *Rhizobium* to *Vigna radiata* cv. kanti greatly increased plant height.

Sultan (1993) carried out a field trail on lentil seed inoculation with *Rhizobium* inoculum and noticed that *Rhizobium* inoculation recorded in significantly better plant height than obtained in uninoculated control.

Solaiman (1999) conducted an experiment on response of mungbean to *Bradyrhizobium sp* inoculation with and without chemical fertilization and found significantly higher plant height and root length from *Bradyrhizobium* inoculant over control.

Das *et al.* (1997) carried out field trail where local seeds of mungbean (*Vigna radiata)* were inoculated with *Rhizobium* with or without VAM culture. They reported that growth viz. shoot and root lengths were enhanced with dual interaction compared with uninoculated control.

Podder *et al.* (1999) conducted a experiment to evaluate the effect of seed inoculation with eight *bradyrhizobial* strains on shoot length of soybean. They found significantly higher shoot length in the inoculated treatments than the uninoculated control.

Uslu *et al*. (1997) carried out a study of soybean under the inoculation with *Bradyrhizobium japonicum* and reported that plant height was increased due to inoculation.

Sattar and Podder (1994) conducted several field trail on inoculation of groundnut with local single strain of inoculants and multistrain inoculants. They showed that the inoculation with local mixed culture resulted in maximum shoot dry weight at 90 and 120 DAS and pod yield.

Sudhakar *et al*. (1989) carried out an field trail on blackgram and reported that the crop growth was enhanced due to *Rhizobium* inoculation. They stated that inoculation or P application alone enhanced the protein content in blackgram while their integration increased further *Rhizobium* inoculation to 22.06% higher protein content with 40 kg P_5O_5/ha over control.

Solaiman *et al*. (2003) searched the response of mungbean cultivars (BARI Mung- 2, BARI Mung-3, BARI Mung-4, BARI Mung-5, Bina Moog-2 and BU Mung-1) to *Rhizobium sp* strains TALI69 and TAL441. They noticed that the seeds with bacterial inoculation greatly increased dry matter production of various mungbean cultivers. The best characteristics were acquired from BARI Mung-4 which was inoculated with strain TALI 69.

Khan *el al*. (2002) carried out a pot experiment on the effects of different level of phosphorus (50, 75 and 100 kg P_2O_5/ha) on the growth and yield of inoculated or uninoculated mungbean seeds with *Rhizobium* and narrated that the stover yield enhanced with increasing rates of P_2O_5 in Rhizobium inoculated.

Hoque and Hashem (1993) investigated that using *Rhizobium* as bio-fertilizer was remarkably beneficial on shoot weight and total dry matter accumulation of soybean and groundnut.

Muniruzzaman and Khan (1990) carried out an experiment on lentil and reported that nodulation, plant dry matter accumulation and N uptake substantially increased when inoculated with *Rhizobium*.

Patra and Bhattacharyya (1997) carried out a field study with *Vigna radiata* cv. B-1, *Rhizobium* and urea (25 kg/ha) and recorded that all treatments increased nodulation compared with controls. They also narrated that the highest nodule numbers were received from integrated treatment of *Rhizobium* + urea

Mandal and Ray (1999) conducted a field experiment where mungbean (*Vigna radiata)* cv. 105, B 1 and Hooghly local were untreated; seed inoculated with *Rhizobium* and various levels of urea were used where greatest resulted was recorded with inoculation and N treatment in B 1.

Sangakara and Marambe (1989) stated that inoculation significantly improved nodulation of *Vigna radiata* 21 days after sowing. Seed inoculation and soil inoculation before sowing maximized nodulation number per plant at flowering where no N was applied. Inoculation + applied N (25 kg/ha) gave seed yields 8.1-10.1 g per plant differentiated with 8.3 g with N (25 kg per ha) alone and 5.2-6.5 g with inoculation alone seed inoculation was the most effective method.

Vaishya *et al*. (1983) investigated the seed inoculation with *Rhizobium* strain M1 significantly improved the number of nodules and seed yield of 12 *Vigna radiata* cultivars. The average yield was 42.3% and ranged from 4.3% in cv. Pusa Baishakhi to 162T in cv. J-10.

Podder *et al*. (1989) conducted a field trail of lentil with 6 isolates and reported effective improve in seed and hay yield due to *Rhizobium* inoculation. They noticed 28-42 % increase in grain yield over uninoculated control.

Gill *et al*. (1985) stated that inoculation substantially developed the growth and yield attributes in the term of number of branches/plant, pods/plant, seeds/pod, straw and grain yield and harvest index of mungbean.

Navgire *et al*. (2001) carried out an experiment with seeds of mungbean cultivars these were inoculated with various *Rhizobium* strains (M-11-85, M6-84, GR-4 and M-6-65) before sowing. As a result of experiment, they acquired the highest plant biomass (8.29 q/ha) and grain yield (4.79 q/ha)

Bhuiyan *et al*. (1996) stated that *Rhizobium* inoculant of groundnut in presence of P. K, Mo and B fertilizer resulted significant higher shoot dry weight. They also noticed that shoot weight of groundnut increased due to *Rhizobium* inoculant in association with Mo and B.

Solaiman *et al.* (2003) observed the response of various mungbean cultivers. BARI Mung- 2, BARI Mung-3, BARI Mung-4, BARI Mung-5. Bina Moog-2 and BU Mung-1 to *Rhizobium* sp. strains TALI69 and TAL441 and investigated that bacterial inoculation of the seeds increased nodulation. They found highest inoculation from BARI Mung -4 with strain TALI69.

Chatterjee and Bhattacharjee (2002) studied the effects of inoculation with Rhizobium sp. on the nodulation of mungbean cv. B-l and showed that the plants inoculated with *Rhizobium* strains given higher nodulation and N content.

Navgire *et al*. (2001) conducted an experiment on mungbean (Cultivars BM-4, S-8 and BM-86) seeds inoculated with *Rhizobium* strains (M-l 1- 85, M-6-84, GR-4 and M-6-65). They recorded the maximum mean nodulation (16.66) in S-8, BM-4 and BM-86.

Poi and Ghosh (1986) carried out an experiment on lentil and chick pea where seeds were inoculated with *Rhizobium leguminosarum* (strains L25 and L20). They revealed significant improvement of nodulation and plant N content than other strains.

Ashraf Zahid *et al*. (1984) showed better improvement of nodulation due to inoculation of chickpea.

Bhuiyan *et al*. (1984) reported that inoculated treatment of mungbean gave higher dry weight of nodules over control and produced larger size nodules.

2.2.2. Effect of Biofertilizer on yield attributes and yield

The effect of inoculation on yield and yield contributing characteristics of mungbean and other legumes was investigated by many workers and some of the works are discussed below:

Podder *et al.* (1999) carried out a field trail at Brahmaputra Floodplain to assess the effect of seed inoculation with eight *bradyrhizobial* treatments and noticed that inoculated treatments showed better performance in recording number of pod /plant, seed/plant and number of 1000-seed weight over uninoculated treatment.

Basu and Bandyopadhyay (1990) carried out a field trail in West Bengal where mungbean *(Vigna radiata)* was inoculated with *Rhizobium* strains (M-10 or JCA1) and cultivated association with 30-40 kg N/ha. Inoculation substantially improved numbers of pods/plant and seeds /pod, 1000seed weight and N uptake.

Hasanuzzaman (2001) conducted an experiment on mungbean where seeds were inoculated with *Bradyrhizobium* strain and recorded greatly increased the yield/ ha compared with uninoculated control.

Roy (2001) reported that *Bradyrhizobium* inoculum significantly maximize the seed yield distinguished with control in mungbean cultivars.

Sharma and Sharma (2001) investigated that grain yield were at maximum when mungbean seeds were treated with the local isolate.

Chowdhury *et al.* (2000) carried out a pod experiment on mungbean seed inoculated with *Bradyrhizobium* and stated that seed yield increased highly when the seed were inoculated with *Bradyrhizobium*.

Deb (2000) reported from a pot trial on mungbean (*Vigna radiata*) with *Rhizobium* inoculation and Mo in increased grain yield compared with uninoculated crop.

Gupta *et al.* (1998) conducted an experiment in chickpea where they recorded the highest seed yields obtained with the associated of inoculation and the application 40 kg P_2O_5 as SSP given the highest mean yield of 1.06 t/ha.

Paul (1998) carried out a pot experiment on mungbean where seeds were inoculated with five *Rhizobium* strains and exposed to 3 water regimes. She showed that seed yield was not improved by inoculation under excess water or normal irrigation conditions. But seed yield was enhanced by inoculation under water stress.

Provorov *et al*. (1998) stated that seed yield of mungbean was developed by seed inoculation with biofertilizer usually 39.2% over uninoculated treatment.

Poonom and Khurana (1997) revealed that average, single strain and multi strain *Rhizobium* inoculants highly enhanced the yield of mungbean by 10.4% and 19.3% over uninoculated treatment, respectively.

Saraf and Shivakumer (1997) recorded that seed yield in chickpea became higher with inoculation (1.03 vs. 0.88 t/ ha) and seed yield was the highest with 60 kg P_2O_5/ha.

Sharma and Khurana (1997) studied the utility of single and multi strain inoculants in field trail with summer mungbean (*Vigna radiata*) variety SML 32 and revealed that grain yield was superior in multi strain inoculants. Single strain and multi strain *Rhizobium* inoculants ordinarily increased the average yield by 10.4% and 19.3% over control, respectively.

Deka and Kakati (1996) conducted study on *Vigna radiata* cv. K-851 where seed or soil were inoculation with *Rhizobium* (strains Majuli-10 or CRP-21) and application of 60 kg P_2O_5 /ha. Yield and entire N and P uptake at harvest were not ordinarily different between the two *Rhizobium* strains but seed yield were increased with the association of seed inoculation and 60 kg P_2O_5 compared soil inoculation treatments.

Rajput and Singh (1996) conducted a field trail during the kharif season in Uttar Pradesh on cowpea cv. Pusa komal where seeds were inoculated with *Rhizobium* strain and reported that seed yield became higher by 10.85% compared with control.

Shukla and Dixit (1996) conducted a studies where *Vigna radiata* cv. Pusa Baishakhi was seed inoculated with biofertilizer (*Rhizobium)* or not inoculated, sown in rows 20, 30 or 40 cm apart and given 0-60 kg P_2O_5/ha. They recorded that seed inoculation significantly developed seed yield.

Chowdhury and Rosario (1994) narrated that seed inoculated with *Rhizobium* increased the seed yield of mungbean.

Jet and Rathore (1994) reported that highest seed yield was obtained with inoculation of green gram seed with *Rhizobium* than control.

Tripati *et al.*, (1994) stated that soybeans, mungbean (*Vigna radiata*), Urd (*Vigna mungo*) and groundnuts were cultivated where five N treatments (control, 20 kg/ ha) were applied through *Rhizobium* seed inoculants. They recorded that the integration of inoculants + 20 kg N /ha gave the highest crop yields and lower number of root nodules. Soybeans and groundnuts provided comparatively better yields than *Vigna radiata* and *Vigna mungo.*

Ardeshna *et al*. (1993) reported that seed yield of mungbean was maximum with the application up to 20 kg/ha N as urea, 40 kg /ha P_2O_5 as single super phosphate and seed inoculation with biofertilizer [0.76 t/ha vs. 0.70 t/ha.]

Pandher *et al*. (1991) reported that inoculation of *Vigna radiata* cv. ML 131 with biofertilizer (*Rhizobium)* enhanced seed yield. Multiple strain *Rhizobium* inoculation did not increase dry weight of plants compared with control.

Yousef *et al*. (1989) stated a field experiment of mungbean where seeds were also inoculated with *Rhizobium* before sowing and irrigation at 80 and 120% PET was applied. Here, the maximum number of pods per plant and pod dry weight plant^{-1} were acquired from combined applicable of irritation and seed inoculation. Biofertilizer also improved N and P uptake with 80% potential evapo-transpiration.

Prasad and Ram (1988) carried out a pot experiment with *Vigna radiata* cv. Pusa Baisakhi, response of mixing into soil of 0, 2.5 and 5.0 ppm Zn and/or *Rhizobium* on nodulation and seed yields were recorded. Where, Inoculation + 2.5 ppm Zn + 2.5 ppm Cu given the highest amounts for seed yield / ha.

Ali and Chandra (1985) investigated that biofertilizer raised the seed formation of most of the pulse crops about 10-15% but the legume needed a specific group of *Rhizobia*.

Boruah and Borthakur (1984) reported with mungbean (*Vigna radiata*) that seed inoculation given the higher seed yields similar to that of recommended uninoculated seeds.

Iswarna and Marwaha (1982) marked that seed yield of mungbean (*Vigna radiata*) substantially elevated as a result for *Rhizobium* inoculation in pot culture experiment.

Muhammad *et al*. (2004) carried out a field study on mungbean (*vigna rediata*) and ascertained that both P and inoculum substantialy affected seed yield. The highest grain yield (1018 kg/ha) was acquired from 65 kg P_2O_5/ha + inoculum.

Satish *et al*. (2003) conducted a field experiment to investigate the effect of biofertilizer (*Rhizobiumsp.*) on seed inoculation and they recorded that *Rhizobium sp*. inoculation significantly enhanced the seed yield /ha.

Chatterjee and Bhattacharjee (2002) invested the effect of inoculation with *Rhizobium sp.* on yield of mungbean cv. B-l in field trials and discovered that the plants inoculated with *Rhizobium* strains showed maximum grain yield.

Malik *et al*. (2002) conducted a field experiment on mungbean to investigate the effects of seed inoculation with *Rhizobium* on the growth, yield and quality of mungbean cv. NM-98. They recorded that seed inoculation with *Rhizobium* resulted in the highest number of pods per plant (22.47), number of seeds per pod (12.06), 1000-seed weight (42.27 g), seed yield (1158 kg/ha) and protein content (24.61%).

Saraf *et al*. (1997) recorded that seed yield was enhanced with inoculation than without inoculation and seed yield was highest with 60 kg P_2O_5/ha (1.24 t/ha) in chickpea.

2.3 Effect of inorganic fertilizer

2.3.1 Effect of inorganic fertilizer on growth and development

Mathur *et al*. (2007) conducted an experiment at Jodhpur with two fertility levels (10 + 20 and 20 + 40 kg N + P $_2O_5$/ha) and ascertained that fertility level from 10 + 20 to 20 + 40 kg N + P_2O_5/ha greatly enhanced mean plant height (24.4 %) and number of branches per plant (22.7%) of mungbean.

Soodi *et al*. (1994) noticed that no. of nodules and dry weight of nodules per plant in mungbean were expanded with the application of 25 kg N/ha and/or along with 50 kg P_2O_5 /ha over no nitrogen.

Yakadri *et al*. (2002) carried out an experiment at Rajendranagar (Hyderabad) and reported that application of nitrogen (20 kg/ha) and phosphorus (60 kg/ha) caused significant difference in leaf area index indicating better partitioning of dry matter.

Sharma *et al*. (2003) carried out a field experiment at Palampur, Himachal Pradesh, to determine the effects of N (0, 10 and 20 kg/ha) and P (0, 30 and 60 kg/ha) on the growth and yield of *V. radiata* cv. Pusa Baisakhi and ascertained that crop growth rate, relative growth rate, photosynthetic efficiency, number of days to 50% flowering and maturity and seed yield enhanced with increasing rates of N and P.

Manpreet *et al*. (2004) conducted an experiment to investigated the response of P application (0, 20, 40 and 60 kg P_20_5/ha) on mungbean and they reported that the increase in P level provided significant improvement in the number of pods per plant, which accounted for significantly higher grain and stover yields at higher levels (40 and 60 kg/ha) compared to lower levels (0 and 20 kg/ha).

Singh and Pareek (2003) carried out a field trail to investigate the effect of P fertilizer (at 0, 15, 30, 45 and 60 kg P_20_5/ha) on the growth and yield of mungbean cv. RMG 62. They showed that the dry matter accumulation, pods/plant, number of seeds/plant and seed yield were highest with application of P at 45 kg P_2O_5/ha over the other P rates.

Satish *et al*. (2003) investigate the response of mungbean cultivars to several P levels (0, 20, 40 and 60 kg P_2O5/ha) and recorded that total dry matter above-ground as well as the dry matter accumulation in leaves, stems and pods increased with increasing P level up to 60 kg P/ha.

Singh *et al*. (2001) studied that the effect of phosphorus (30, 60 and 90 kg P_20_5/ha) application on mungbean biomass and reported that maximum dry biomass/plant (24.8 g/plant) was recorded from 60 kg phosphorus followed by 30 kg (24.7 g/plant).

Pangsakul and Jensen (1991) reported that phosphorus supply increased top dry matter production at flowering and the dry matter production of seeds, straw, pod shells and roots at late pod filling stage of soybeans. Phosphorus supply did not influence the uptake of fertilizer or soil nitrogen in soybeans

Thakuria and Saharia (1990) narrated that phosphorus levels significantly influenced the grain yield of summer greengram. The highest plant height, pods/plant and grain yield were recorded with 20 kg P_20_5/ha.

Upadhyay *et al*. (1988) stated that leaf area index of soybean highly increased with P level upto 69 kg P_20_5/ ha from 40 days after sowing to reproductive stage. Total dry matter at harvest was maximum with 69 P_20_5/ha, although statistically similar with that of 46 kg P_20_5/ha. The grain and straw yield increased significantly with increasing levels of phosphorus upto 46 kg P_2O_5/ha.

Kausale *et al.* (2007) on the basis of a field trail carried out on a medium deep black soil having low nitrogen content, medium amount of phosphorus and higher potassium content with an aim to determine the effect of nitrogen and phosphorus levels on dry matter segmentation viewed that application of 25 kg N/ha and 50 kg P/ha recorded significantly highest leaf, stem, total dry matter accumulation and number of root nodules at 30, 45, 60, 90 DAS and at harvest.

Jena *et al*. (1995) reported that highest green and dry fodder yield of cowpea forage were received by fertility level of 20:40 kg N and P_2O_5/ha over other combinations. Growth of plant in tthe term of no. of branches per plant, leaves per plant and LAI were also showed significantly higher result with 20 kg N and 40 kg P_2O_5/ha.

Oad and Buriro (2005) at Tandojam, Pakistan, during the time of spring in 2004 conducted a field trail to investigate the effect of several NPK levels (0-0-0, 10-20-20, 10-30-30, 10-30-40 and 10-40-40 kg/ha) on the growth and yield of mungbean

(*Vigna radiata* cv. AEM 96). The different NPK levels substantially affected the crop parameters and application of 10-30-30 kg NPK/ha was detected as the best treatment, recording plant height of 56.3 cm and germination of 90.5%, plant population of 162.0 and prolonged days taken to maturity of 55.5.

2.3.2 Effect of inorganic fertilizer on yield attributes and yield

Malik *et al.* (2003) from a study conducted in Pakistan to determine the effect of varying levels of nitrogen (0, 25 and 50 kg/ha) and phosphorus (0, 50, 75 and 100 kg/ha) on the yield of mungbean cv. NM-98 reported that a fertilizer combination of 25 kg N + 75 kg P_2O_5/ha resulted in the maximum seed yield (1112.96 kg/ha).

Sharma *et al.* (2003) at Palampur, found that photosynthetic efficiency, number of days to 50% flowering and maturity and seed yield of mungbean enhanced with increasing rates of N and P upto 20 and 60 kg/ha, respectively.

Yakadri *et al.* (2004) in a experiment at Rajendranagar (Hyderabad) discovered that application of 20 kg N + 60 kg P_2O_5/ha substantially improved the seed and haulm yield of greengram over control.

Mathur *et al*. (2007) from an experiment carried out at Jodhpur with two fertility levels (10 + 20 and 20 + 40 kg N + P_2O_5/ha) reported that improved in fertility level from 10 + 20 to 20 +40 kg N + P_2O_5/ha significantly enhanced pods per plant (25.6%), seeds per pod (21.3%), 1000-seed weight (7.3%) and biomass per plant (15.5%). As a consequence of higher values of yield parameters, seed (9.6%) and stover (24.4%) yield of mungbean also increased significantly.

Sheoran *et al.* (2008) conducted a field experiment to study the performance of mungbean genotypes in relation to their nutritional requirement under rainfed conditions where the application of 12.5 kg N + 40 kg P_2O_5/ha increased the yield compared to 12.5 kg N + 20 kg P_2O_5/ha, which in turn, recorded significant yield enhanced by 15.4% over no fertilizer application (NoPo).

Gandhi *et al.* (1991) reported that number of pods per plant, seeds per pod, weight of seeds per plant, seed yield and straw yield of cowpea were higher with integrated application of 25 kg N and 50 kg P_2O_2/ha.

Srinivas *et al.* (2002) conducted an experiment on the performance of mungbean at various levels of nitrogen and phosphorus where different rates of N (0, 25 and 60 kg/ha) and P (0, 25, 50 and 60 kg/ha) were tested. They recorded the highest number of pods/ plant, 1000-seed weight and seed yield were received with the increasing rates of N up to 40 kg /ha followed by a decrease with further increase in N.

Mahboob and Asghar (2002) at the Agronomic Research Station, Farooqabad in Pakistan, investigated the response of seed inoculation at several nitrogen levels on mungbean at the Agronomic Research Station, Farooqabad in Pakistan. They revealed that various yield components was significantly affected with 50-50-0 N kg/ ha, P kg/ha, K kg/ha application. Again they reported that seed inoculation with 50-50-0 N kg/ha, kg/ha, K kg/haexhibited superior performance in respect of seed yield (955 kg / ha).

More *et al*. (2008) at Nagpur (Maharashtra), investigated the impacte of nutrient management treatments on yield attributes and yield of soybean and find out the impact of treatment 30 : 70 : 00 kg NPK/ha (RDF) was most pronounced on the above parameters.

Tickoo *et al*. (2006) at India carried out an experiment during the summer season in 2000 on mungbean cv. Pusa 105 and Pusa Vishal which were maintained at 22.5 and 30.0 m spacing at the time of sowing with association of 36-46 and 58-46 kg of N and P per ha . Cultivar Pusa Vishal provided higher biological and seed yield (3.66 and 1.63 t/ha) compared to cv. Pusa 105 where nitrogen and phosphorus rates had no great effects on both the biological and grain yield of the crop.

Nadeem *et al.* (2004) studied the performance of mungbean (cv. NM-98) at various levels of fertilizer (0-0, 15-30, 30-60 and 45-90 kg N and P_2O_5 under field conditions. The yield was greatly influenced due to the application of fertilizer and the maximum seed yield was acquired when 30 kg/ha N was applied along with 60 kg/ha P_2O_5..

Rajender *et al*. (2002) investigated the effects of N (0, 10, 20 and 30 kg ha^{-1}) and P (0, 20, 40 and 60 kg / ha) fertilizer rates on mungbean genotypes MH 85-111 and T44. By increasing N rates up to 20 kg/ha substantially enhanced seed yield of mungbean .Further increase the rates of N did not influence seed yield. Yield contributing characters viz. number of pods /plant, numbers of seeds /pod, 1000-seed weight and stover yield became higher with raising rates of P. whereas seed yield enhanced with increasing rates of P up to 40 kg/ha only.

Karle and Pawar (1998) examined the response of summer mungbean under the application of varying levels of N and P fertilizers where they revealed that higher seed yield were oobtained with the application of 15 kg N ha^{-1} and 40 kg P_2O_5/ha.

Oad and Buriro (2005) at Tandojam, Pakistan, during the time of spring in 2004 conducted a field trail to investigate the effect of several NPK levels (0-0-0, 10-20-20, 10-30-30, 10-30-40 and 10-40-40 kg/ha) on the growth and yield of mungbean(*Vigna rediata* cv. AEM 96) . The different NPK levels substantially affected the crop parameters and application of 10-30-30 kg NPK/ha was detected as the best treatment, recording yield parameters in the term of pod length 5.02 cm, seed weight 10.5 g, seed index 3.5 g and the highest seed yield 1205.2 kg/ha.

A field experiment was carried out by Sharma and Sharma (1999) during summer seasons at Golaghat. Assam. India. Mungbean was grown using farmers practices (no fertilizer) or using a combinations of fertilizer application (30 kg N + 35 kg P_2O_5 ha^{-1}). Seed yield was 0.40 ton ha^{-1} with farmer practices, while the highest yield was obtained by the fertilizer application (0.77 ton ha^{-1}).

Mandal and Sikdar (1999) laid out a greenhouse pot experiment where mungbean (BARI Mung-5) grown on saline soil and given 0, 50 or 100 kg N/ha and 0, 75 or 150 kg P/ha. Growth and yield increased significantly with N application while P significantly increased the setting of pods and seeds. Root growth was significantly improved by both individual and combined application of these two fertilizers.

Tank *et al*. (1992) found that mungbean fertilized with 20 kg N ha^{-1} along with 40 kg P_2O_5 ha^{-1} produced significantly higher number of pods $plant^{-1}$ over the unfertilized control

CHAPTER III

MATERIALS AND MATHOD

A field experiment entitled "Performance of Mungbean Varieties Under Organic and Inorganic Fertilizer Managements" was carried out at Sher-e-Bangla Agricultural University research farm, Dhaka, Bangladesh during the period from April 2017 to June 2017. This chapter presents a brief statement of the experimental site, experimental period, climatic condition, crop or planting materials, land preparation, experimental design and layout, crop growing procedure, treatments, intercultural operations, data collection, preparation and chemical analysis of soil and plant samples along with statistical analysis.

3.1 Description of the experimental site

3.1.1 Location of experiment

The present item of research work was carried out in the research field of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka. The location of the site is 90°33´ E longitude and 23°77´ N latitude with an elevation of 8.2 m from the sea level. Location of the experimental site presented in Appendix I.

3.1.2 Soil

The soil of the experimental sites belongs to the “The Modhupur Tract”, AEZ – 28. Texture of upper level soil was silty clay and color content was olive-gray with ordinary fine to medium distinct dark yellowish brown mottles with 0.45% organic carbon content. The Soil pH was 5.6 and the selected research plot was medium high land. The research area was plain having available irrigation and drainage system and above flood level. The details were presented in Appendix II.

3.1.3 Climate and weather

The experimental site is located in the subtropical area which is characterized by high temperature and heavy rainfall during kharif season (March-September) and nominal rainfall during Rabi season (October-March) associated with moderately low temperature. The prevailing weather conditions during the research period have been presented in Appendix-III

3. 2 Planting materials

Mungbean variety BARI mung-6 and BINA moog-8 were used in the study. The salient characteristics of these two varieties are presented below:

BARI mung-6

BARI released BARI mung 6 in 2003. Plant height of this variety ranges from 40 to 45 cm and can be grown in Kharif-I, Kharif-II and late Rabi. One thousand seed weight is about 51-52 g and seed are deep green in colors. The variety requires 55 to 60 days to mature, and average yield is very high usually 1,500 kg/ha. It is also capable to resistant to Cercospora leaf spot and yellow mosaic virus.

BINAmoog 8

Binamoog-8 is a summer mungbean variety released by BINA in 2010. Maximum grain yield is about av. 1.8 t/ha and seed is medium size with green shiny color.

Year: Kharif-I, 2017

3. 3 Treatments under investigation

There were two factors in the experiment namely variety and fertilizer managements as mentioned below:

Factor A: Variety (2)

V_1= BARI mung 6

V_2 = Binamoog 8

Factor B: Fertilizer management (5)

F_1= NPKBS (RDF)

F_2= cowdung (10 t/ha)

F_3= Vermicompost (7 t/ha)

F_4= Poultry manures (5 t/ha)

F_5= *Rhizobium sp* (80 g/Kg seed)

Treatment combination: Ten treatment combinations

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V_1F_1	V_2F_1
V_1F_2	V_2F_2
V_1F_3	V_2F_3
V_1F_4	V_2F_4
V_1F_5	V_2F_5

3.4 Experimental design and layout

The experiment was arranged in RCBD (Factorial) having 3 replications. Each plot size was 6 m^2 (3m × 2 m).There are 10 treatment combinations and 30 unit plots. The blocks and unit plots were maintained the spacing about 1.0 m and 0.5m respectively.

3.5 Land preparation

The land of the experimental plot were opened with a power tiller on 25th March, 2017 and subsequently ploughed twice followed by laddering. Different wastes like crop residues, weed stubble etc were removed. Finally, the land was leveled and fully prepared for crop cultivation. At last the experimental place was partitioned into the unit plots in accordance with the experimental design mentioned in the following section.

3.6 Fertilizer application

Organic fertilizers (poultry manure, vermicompost and cowdung) were applied on the selected plot before 7 days of seed sowing so that the toxic materials of row organic fertilizers could not harm the crops seed. Inorganic fertilizer viz, urea (50kg/ha), TSP (85kg/ha), MoP(35 kg/ha), gypsum (30 kg/ha) and boric acid (1.5 kg/ha) were applied as selected plots during land preparation.

3.7 Seed sowing

Mungbean was sown in research field at 3rd April 2017. Healthy seeds of mungbean varieties were sown by hand as uniformly as possible in furrows. Light irrigation was given into the furrow before seed sowing. Seeds were sown maintaining 30 cm line to line distance in the early morning and immediately covered with soil to avoid early sunlight. Seeds were mixed thoroughly with *Rhizobium* strain in the term of

Rhizobium treatment and then treated seeds were sown in selected plot for this treatment.

3.8 Intercultural operations

3.8.1 Thinning

Seeds started germination of three days after sowing (DAS).Thinning was done at 8 days after sowing to maintain optimum plant density with properplant to plant spacing of 10 cm.

3.8.2 Irrigation and weeding

Weeding was done at two times. First weeding was done at the same days of thinning and second weeding was done at 35 days after sowing. Irrigation was done as per requirements.

3.8.3 Protection against insect and pest

At the early stage pest did not infest the mungbean crop. Ripcord 10 EC @ 1 ml L^{-1} was applied two times at an interval of one week to control insect.

3.8.4 Crop sampling and data collection

Five plants from each treatment were randomly selected and uprooted at different growth stage of plant which was used for data recording. Plant height, number of leaves per plant, dry matter accumulation were recorded at 10 days intervals started from 10 DAS to harvest.

3.9 Harvesting

The crops were started to harvest at the time of contemporaneous maturity of maximum pods. At first 80% of matured pods were harvested by hand picking at 65 days after sowing and 7 days after first harvesting 2nd harvest was done. Finally, all plants were harvested plot-wise by uprooting at the same days of second pod picking and were bundled separately. Then all harvested plants were tagged and brought to the threshing floor of the SAU farm. At last, all of the harvested pods were kept apart in properly tagged gunny bags.

3.10 Threshing and winnowing

The harvested produce from each plot was allowed to dry in sun on the threshing floor and the bundles were weighed for biological yield. Seeds were separated from the plants by beating the bundles with bamboo sticks and collected seeds were sun dried up to lower the moisture content of seed at 12% level. From the dried and cleaned seed, the seed yield per plot was recorded and converted into t/ ha. The stover yield also was computed by deducting the seed yield from the biological yield.

3.11 Observations for treatment evaluation

Necessary periodical observations were recorded to evaluate the effect of different treatments on growth, yield and quality of crop, particulars of which are given as below,

The data were recorded on the following parameters

i. Plant height (cm)

ii. Leaf area plant $^{-1}$ (cm^2)

iii. Number of leaves plant^{-1}

iv. Dry matter weight plant^{-1} (g)

v. Nodules plant^{-1} (no.)

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

vii. Pod length (cm)

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

ix. 1000 seed weight (g)

x. Seed yield (t ha^{-1})

xi. Stover yield (t ha^{-1})

xii. Biological yield (t ha^{-1})

xiii. Harvest index (%)

Data recording procedures:

i. Plant height

Five plants were randomly collected from each plot and measured from base of the plant to the tip of the main shoot with the help of scale. The average of five plants at different growth stage (10 DAS, 20 DAS, 30 DAS, 40 DAS,50 DAS and harvest) were computed and expressed as the plant height in centimeters.

ii. Number of leaves plant^{-1}

The numbers of green trifoliate leaves present on each plant were recorded manually from the randomly selected five plants at different growth stage (10 DAS, 20 DAS, 30 DAS, 40 DAS, 50 DAS and harvest). The mean number of leaves per plant was computed and expressed in number plant^{-1}.

iii. Leaf area plant^{-1}

Two plants were randomly selected from each plot and measured leaf area from fresh leaf by leaf area meter and recorded the results.

iv Dry matter accumulation

Data from five sample plants from each plot were collected and fresh weight was recorded immediately. After recording fresh weight, the sample was oven dried at 70^0C for 72 hours. Then oven-dried samples were placed into a desicator and allowed to cool down to room temperature, after that dry weight of plant was measured and expressed in gram. Dry matter content per plant was recorded at 10, 20, 30, 40 and 50 DAS and harvest.

v No. of Nodules /plant

Five plants from selected rows was uprooted from treatment and total number of nodules from five plants was counted at 30 DAS, 45 DAS and harvest and the mean value was determined.

vi Pods per plant

Numbers of total pods of selected plants from each treatment were counted and the calculated mean numbers were expressed as per plant basis. Data were recorded as the average of 5 plants randomly collected from the marked rows of each plot.

vii Seeds per pod

The number of seeds per pod was calculated and recorded randomly from selected plants at the time of harvest. Data were recorded as the average of 20 pods selected at random from harvested pods.

viii Pod length

Pod length was also taken of randomly selected twenty pods from the hervested pod of selected plant and the mean length was expressed on cm.

ix Weight of 1000-seed

One thousand cleaned, well dried seeds were counted from each harvest sample. The weight of 1000 seeds was taken by using a digital electric balance and weight was expressed in gram (g).

x Seed yield (t/ha)

The seeds harvested from $2.00m^2$ (2m × 1m) of each plot were sun dried properly. The weight of seeds was recorded and converted the yield in kg/ ha

xi Stover yield (t/ha)

The stover collected from $2.00m^2$ (2 m × 1m) from each plots was sun dried properly. Then the weight of stover was recorded and converted the yield in kg/ ha.

xii Biological yield (t/ha)

The aggregate of seed yield and stover yield is regarded as biological yield and it was determined by the using the following formula –

Biological yield (t/ ha) = Seed yield (t/ ha) + Stover yield (t/ha)

xiii Harvest Index (%)

Harvest index (HI) was calculated by using the following formula

Harvest index = Seed yield/ Biological yield × 100

3.12 Statistical analysis

The data recorded for different parameters were statistically analyzed with the help of Statistix 10 software to determine the significant dissimilation among several treatments on growth, yield and yield contributing characters of mungbean. The collected data were computed and analyzed statistically using the analysis of variance (ANOVA) technique and the mean differences were adjusted by Least Significance Difference (LSD) test at 5% level of probability (Gomez & Gomez, 1984).

CHAPTER IV

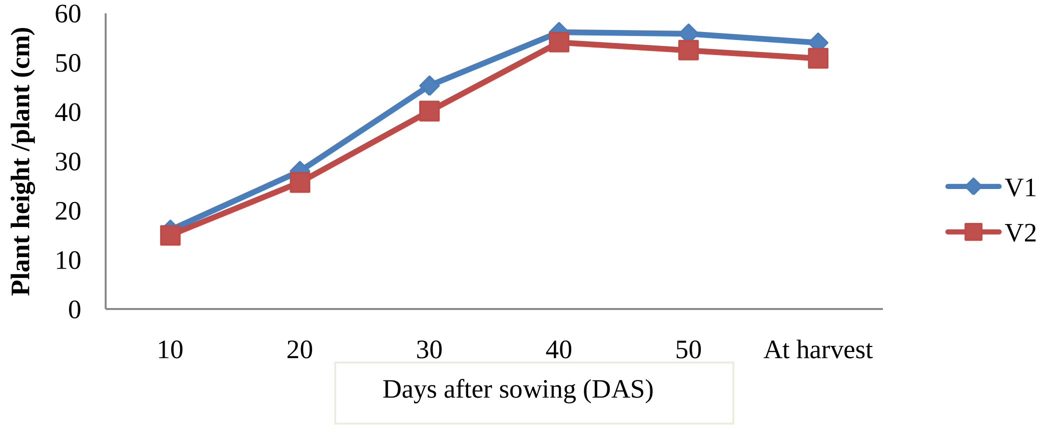
RESULTS AND DISCUSSION

The study was conducted to observe the performance of mungbean varieties under organic and inorganic fertilizer managements. Data on different growth and yield contributing characters with yield were recorded to investigate the combined effect of varieties and inorganic or organic fertilizer managements on the growth and yield of mungbean. The recorded results have been presented with possible discussion and possible interpretations have been given under the following headings:

4.1 Plant height (cm)

4.1.1 Effect of varieties on plant height

The performance of mungbean varieties are presented in the figure 1 where significant variation was observed on plant height between two mungbean varieties. Data on plant height were collected periodically at 10, 20, 30, 40, 50 days after sowing (DAS) and harvest. Between two varieties, V_1 (BARI mung 6) showed the higher plant height (16.03, 27.96, 45.28, 56.14, 54.00 and 55.82 cm at 10, 20, 30, 40, 50 DAS and harvest, respectively). The lower plant height (14.97, 25.7, 40.14, 54.11, 50.84 and 52.51 cm at 10, 20, 30, 40, 50 DAS and harvest, respectively) was recorded from V_2 (Binamoog 8).



Here, V_1= BARI mung 6 and V_2= Binamoog 8

Figure 1. Effect of varieties on plant height of mungbean at different days after sowing (LSD $_{(0.05)}$ = 0.377, 0.63, 2.67, 2.75, 1.99 and 1.99 at 10, 20, 30, 40, 50 DAS and at harvest, respectively).

4.1.2 Effect of organic and inorganic fertilizers application on the plant height

Plant height of mungbean assorted considerably due to the application of different organic or inorganic fertilizers (Fig. 2). Plant height (cm) speedily increased from 20 DAS to 40 DAS and after that the rate of plant height increased very slowly. The highest plant height (16.94, 30.01, 51.62, 64.28, 59.38 and 62.24 cm at 10, 20, 30, 40, 50 and harvest, respectively) wasrecorded from treatment F_1 (NPKSB) (RDF) which was statistically similar with F_4 (Poultry manure 5t/ha) at 40, 50 DAS and harvest. The lowest plant height (14.05, 24.16, 35.04, 48.73, 47.01 and 47.90 cm at10, 20, 30, 40, 50 DAS and harvest respectively) were obtained from F_5 (*Rhizobium sp*) which was statistically similar with F_2 and F_3. This result was partly supported by Menon *et al*. (2010) who carried his study on cowpea.

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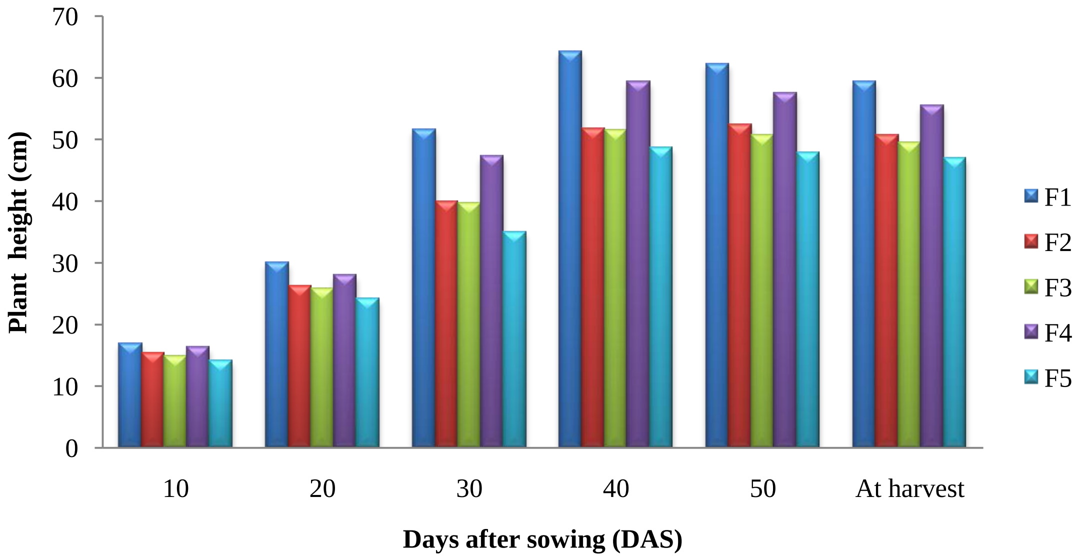


Here, F_1= NPKSB (RDF) F_2= Cowdung (10 t/ha)
F_3= Vermicompost (7 t/ha) F_4= Poultry manure (5 t/ha)
F_5= *Rhizobium sp* (80 g/Kg seed)

Figure 2. Effect of different organic and inorganic fertilizer application on plant height of mungbean at different days after sowing ($LSD_{(0.05)}$ = 0.59, 1.0, 4.23, 4.35, 3.14 and 3.15 at 10, 20, 30, 40, 50 DAS and harvest, respectively)

4.1.3 Combined effect of varieties and fertilizer on plant height

Effect of organic and inorganic fertilizer application on plant height of two mungbean varieties are presented in Table 1.The highest plant height (17.70, 31.98, 54.77, 69.24, 66.2 and 62.5 cm at 10, 20, 30, 40, 50 DAS and harvest, respectively) was recorded under the treatment combination of V_1F_1 which was statistically similar with V_2F_4 treatment combination at 30, 40, 50 DAS and harvest. The lowest plant height (12.8, 22.1, 31.0, 46.5, 44.0 and 44.4 cm at 10, 20, 30, 40, 50 DAS and harvest, respectively) was obtained from treatment V_2F_5 which is identical with V_2F_2, V_2F_3 at 30 DAS; identical with V_1F_5, V_2F_2, V_1F_4 and V_2F_3 at 40 DAS; identical with V_2F_3 at 50 DAS ; identical withV_2F_2, V_2F_2 at harvest.

Table 1: Combined effect of mungbean varieties and different organic or inorganic fertilizer application on plant height (cm) of mungbean at different days after sowing (DAS)

Treatment combination	Plant height (cm)					
	Days after sowing (DAS)					
	10	20	30	40	50	At harvest
V_1F_1	17.70 a	31.98 a	54.77 a	69.24 a	66.2 a	62.5 a
V_1F_2	15.85 bc	27.32 b-c	43.4 cd	53.4 b-d	54.4 cd	52.6 cd
V_1F_3	15.89 bc	27.15 cd	45.32 bc	55.3 bc	53.7 d	52.7 cd
V_1F_4	15.44 b-d	27.18 cd	43.93 cd	51.9 c-e	53.0 d	52.5 cd
V_1F_5	15.27 cd	26.15 de	39.00 de	50.9 c-e	51.8 bc	49.6 de
V_2F_1	16.18 bc	28.04 bc	48.47 bc	59.3 b	58.2 bc	56.2 bc
V_2F_2	14.84 d	25.1 ef	36.4 ef	50.1 c-d	50.4 de	48.6 ef
V_2F_3	13.9 e	24.3 e	33.9 ef	47.6 de	47.6 ef	46.2 ef
V_2F_4	17.0 a	28.7 b	50.7 ab	66.8 a	62.1 ab	58.5 ab
V_2F_5	12.8 f	22.1 g	31.0 f	46.5 e	44.0 f	44.4 f
LSD (0.05)	**0.801**	**1.413**	**5.990**	**6.152**	**4.451**	**4.455**
CV (%)	3.18	3.07	8.18	6.18	4.79	4.96

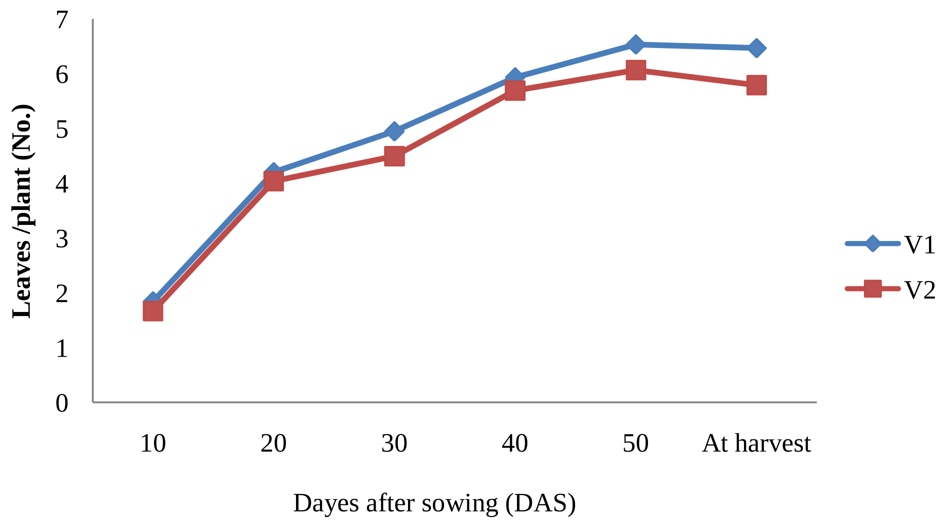
Here, F_1= NPKSB (RDF)
F_2= Cowdung (10 t/ha)
F_3= Vermicompost (7 t/ha)
F_4= Poultry manure (5 t/ha)
F_5= *Rhizobium sp* (80 g/kg seed)

V_1= BARI mung 6 and
V_2= Binamoog 8

4.2 Leaves plant $^{-1}$ (No.)

4.2.1 Effect of varieties on number of leaves plant^{-1}

The performance of mungbean varieties are presented in the Figure 3 where significant variation was not observed on leaves plant^{-1} at 10 and 20 DAS but observed significant variation after 30 DAS between two mungbean varieties. The no. of leaves plant^{-1} counted at different days was significantly affected by varieties. Between two varieties V_1 (BARI mung 6) was given maximum no of leaves plant^{-1}. The higher no.of leaves plant^{-1} (1.8, 4.2, 4.94, 5.93, 6.53, and 6.4 at 10, 20, 30, 40, 50 DAS and harvest) was obtained from V_1 (BARI mung 6). The lower number of leaves plant^{-1} (1.6, 4.04, 4.4, 5.6, 6.0 and 5.7 at 10, 20, 30, 40, 50 DAS and harvest) was observed from V_2 (Binamoog 8). Similar result was observed by Jahan (2015) in a field experiment on mungbean varieties.

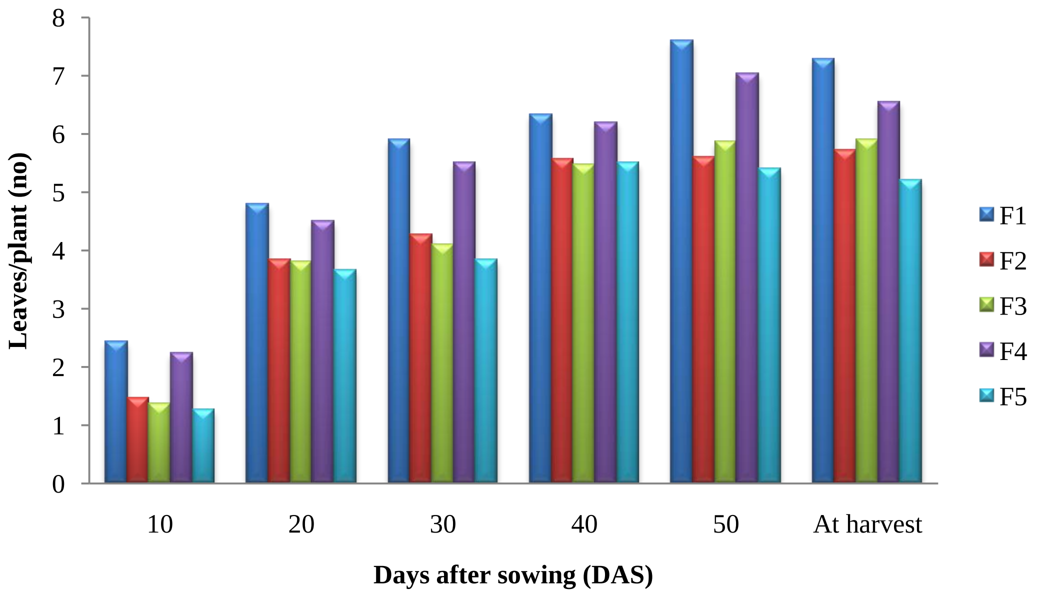


V_1= BARI mung 6 and V_2= Binamoog 8

Figure 3. Effect of varieties on leaves plant $^{-1}$ (no.) of mungbean at different days after sowing (LSD $_{(0.05)}$= 0.408, 0.2426, 0.287, 0.24, 0.32 and 0.35 at 10, 20, 30, 40, 50 DAS and harvest, respectively)

4.2.2 Effect of organic or inorganic fertilizers on leaves plant^{-1}

Number of leaves plant^{-1} was significantly varied due to application of different organic or inorganic fertilizer (Fig. 4). Number of leaves were speedily increased from 20 to 50 DAS. The maximum number of leaves (2.4, 4.8, 5.9, 6.3, 7.6 and 7.2 at 10, 20, 30, 40, 50 DAS and harvest, respectively) was recorded under the treatment F_1 (NPKSB) that was identical with treatment F_4 (5 t poultry manure ha^{-1}) at 10, 20, 30 and 40 DAS. The lowest no. of leaves plant^{-1} (1.2, 3.6, 3.8, 5.5, 5.4 and 5.2 at 10, 20, 30, 40, 50 DAS and harvest, respectively) was recorded under the treatment F_5 which was statistically similar with F_2 and F_3. This results was supported by Amanullah *et al.* (2007) who reported that the organic manure treatments, i.e. poultry manure @ 10 t/ha, composted poultry manure @ 10 t/ha, FYM @ 12.5 t/ha + poultry manure @ 5 t/ha, FYM @ 12.5 t/ha + composted poultry manure @ 5 t/ha provided better growth and yield of pulses crop over control.



F_1= NPKSB (RDF)
F_2= Cowdung (10 t /ha)
F_3= Vermicompost (7t/ha)
F_4= Poultry manure (5 t /ha)
F_5= *Rhizobiumsp* (80 g seed kg $^{-1}$)

Figure 4. Effect of different organic or inorganic fertilizer application on leaves plant^{-1} (no.) of mungbean at different days after sowing (LSD$_{(0.05)}$ = 0.59, 1.0, 4.23, 4.35, 3.14 and 3.15 at 10, 20, 30, 40, 50 DAS and harvest, respectively)

4.2.3 Combined effect of varieties and different organic or inorganic fertilizer managements on leaves plant^{-1}

The combined effect of different organic and inorganic fertilizer application and varieties on the leaves plant^{-1} of mungbean was significant (Table 2). The highest number of leaves plant^{-1} (2.6, 5.0, 6.2, 6.4, 8.3 and 8.0 at 10, 20, 30, 40, 50 DAS and harvest) was recorded in treatment V_1F_1 which was statistically similar with V_2F_4 at 10, 20, 30, 40 and 50 DAS ; statistically similar with V_2F_1 at 10, 20, 30, 40 DAS ; V_1F_2 and V_1F_3 at 40 DAS. The lowest number of leaves plant^{-1} (1.2, 3.6, 3.6 and 5.2, 5.0 and 5.2 at 10, 20, 30, 40, 50 DAS and harvest, respectively) was recorded in the treatment V_2F_2 which was statistically similar with V_2F_5.

Table 2. Combined effect of mungbean varieties and different organic and inorganic fertilizer application on leaves plant^{-1}(no.) of mungbean at different days after sowing (DAS)

Treatment combination	Leaves plant^{-1} (No.)					
	Days after sowing (DAS)					
	10	20	30	40	50	At harvest
V_1F_1	2.6 a	5.0 a	6.2 a	6.4 a	8.3 a	8.0 a
V_1F_2	1.7 a-c	4.0 c-d	4.8 cd	5.8 a-d	6.1 c	6.23 b-d
V_1F_3	1.5 bc	3.8 d-e	4.4 de	5.7 b-d	6.0 c	6.2 b-d
V_1F_4	2.0 a-c	4.3 b-c	5.3 bc	6.0 a-c	6.4 bc	6.3 bc
V_1F_5	1.3 c	3.7 e	3.9 ef	5.6 c-d	5.8 c	5.5 de
V_2F_1	2.27 ab	4.6 a-c	5.6 ab	6.2 ab	6.8 b	6.5 b
V_2F_2	1.2 c	3.6 e	3.6 f	5.2 e	5.0 de	5.2 e
V_2F_3	1.2 c	3.7 e	3.8 ef	5.2 e	5.7 cd	5.5 c-e
V_2F_4	2.47 a	4.7 ab	5.6 ab	6.4 a	7.6 a	6.7 b
V_2F_5	1.2 c	3.6 e	3.7 f	5.3 de	5.0 e	4.8 e
$LSD_{(0.05)}$	**0.9**	**0.5**	**0.6**	**0.5**	**0.7**	**0.7**
CV (%)	30.3	7.68	7.98	5.45	6.74	7.5

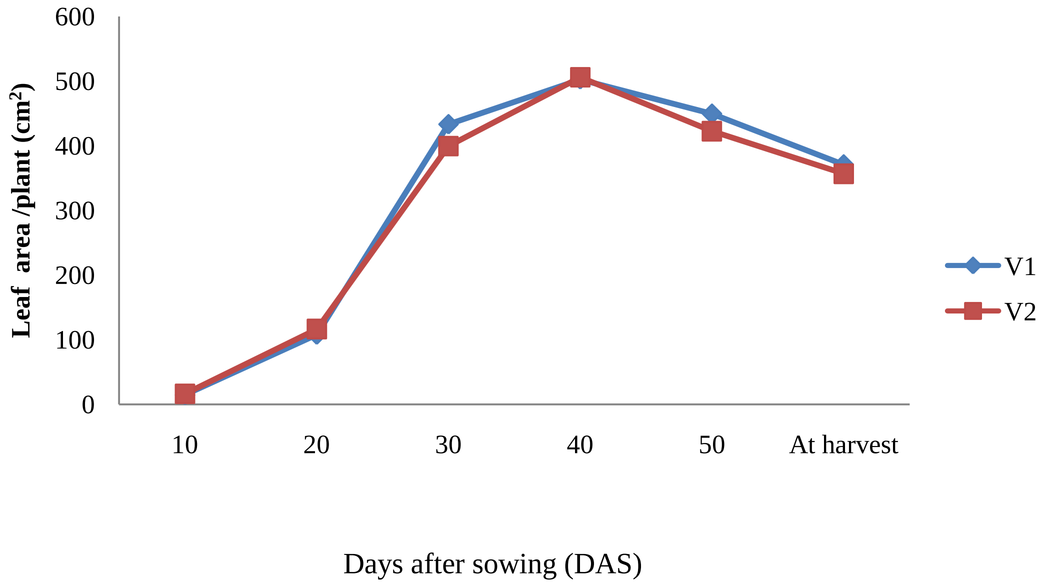
Here, F_1= NPKSB (RDF)
F_2= Cowdung (10 t/ha)
F_3= Vermicompost (7t /ha)
F_4= Poultry manure (5 t/ha)
F_5= *Rhizobium sp (*80 g /kg seed)

V_1= BARI mung 6
V_2= Binamoog 8

4. 3 Leaf area plant^{-1} (cm^2)

4.3.1 Effect of varieties on leaf area plant^{-1}

Leaf area plant^{-1} varied significantly between two varieties (Fig. 5). Between two mungbean varieties V_1 (BARI mung 6) showed the maximum leaf area per plant (16.95, 118.00, 464.66, 549.72, 471.69 and 399.07 cm^2 at 10, 20, 30, 40, 50 DAS and harvest, respectively). On the other hand, the minimum leaf area plant^{-1} (13.78, 106.28, 368.16, 458.88, 400.29 and 328.64 cm^2 at 10, 20, 30, 40, 50 DAS and harvest, respectively) was recorded for V_2 (Binamoog 8).

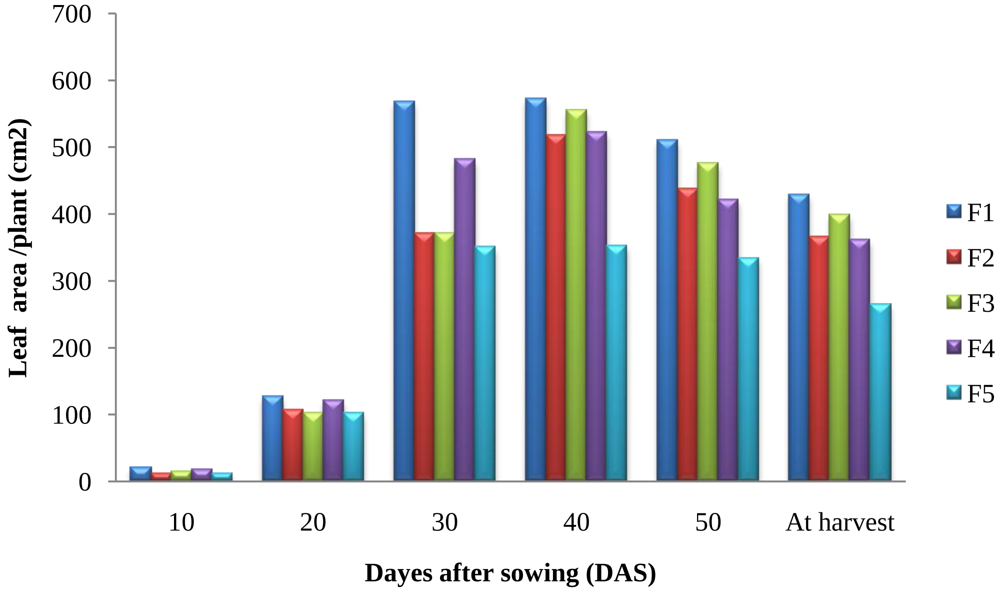


Here, V_1= BARI mung 6 and V_2= Binamoog 8

Figure 5. Effect of varieties on leaf area plant^{-1} (cm^2) of mungbean at different days after sowing (LSD $_{(0.05)}$= 0.2.82, 7.53, 60.32, 62.17, 48.79 and 47.58 at 10, 20, 30, 40, 50 DAS and harvest respectively)

4.3.2 Effect of organic and inorganic fertilizers on leaf area plant^{-1}

Significant variation was observed on leaf area plant^{-1} of mungbean due to the application of organic and inorganic fertilizer (Fig. 6). Leaf area plant^{-1} (cm^2) speedily increased from 20 DAS to 40 DAS thereafter a slow rate of decrease was recorded up to harvest. The highest leaf area per plant (20.90, 126.88, 568.80, 573.18, 510.14 and 428. 93 cm^2 at 10, 20, 30, 40, 50 DAS and harvest, respectively) was recorded in F_1 treatment which was statistically identical with F_4 at 10 DAS; F_2 at 20 DAS; F_4 at 30 DAS; F_2, F_3 and F_4 at 40, 50 DAS and harvest. The lowest leaf area plant^{-1} (11.62, 102.41, 350.95, 352.39, 334.20 and 256.13 cm^2 at 10, 20, 30, 40, 50 DAS and harvest, respectively) was recorded from F_5.



F_1= NPKSB (RDF)
F_2=Cowdung (10 t /ha)
F_3= Vermicompost (7t /ha)
F_4= Poultry manure (5 t /ha)
F_5= *Rhizobium sp* (80 g /kg seed)

Figure 6. Effect of different organic and inorganic fertilizer application on leaf area plant^{-1}of mungbean at different days after sowing ($LSD_{(0.05)}$ = 4.45, 11.90, 95.38, 98.305, 77.145, 75.234 at 10, 20, 30, 40, 50 DAS and harvest, respectively)

4.3.3 Combined effect of varieties and different organic or inorganic fertilizer managements on leaf area plant $^{-1}$

Application of different organic or inorganic fertilizer on mungbean varieties affected significantly on leaf area plant^{-1}. The maximum leaf area plant^{-1} (23.21 cm^2 at 10 DAS) was observed in the treatment combination of V_1F_1 which was identical with V_2F_4, V_2F_1 and V_2F_3 at 10 DAS; (148.8 cm^2 at 20 DAS) was observed in treatment combination of V_2F_4 which was statistically similar with V_1F_1, V_2F_1, V_1F_2, V_1F_3, at 20 DAS; (587.90 cm^2 at 30 DAS) was obtained from the treatment combination of V_1F_1, which was statistically similar with V_1F_2,V_1F_3, V_1F_5, V_2F_1,V_2F_4 ; (628.9 and 571.9 cm^2 at 40 and 50 DAS) was recorded from V_1F_3 which was identical with all treatment without V_1F_5 at 40 Das and V_1F_4 with V_2F_5 at 50 DAS ; (462.4 cm^2 at harvest) was recorded from treatmentV_1F_1 which was identical with all treatment without V_1F_4, V_1F_5 and V_2F_5. The minimum leaf area $plant^{-1}$ (9.5, 90.5 and 262.0 and 312.2 cm^2 at 10, 20, 40 and 50 DAS) was recorded from the treatment combination of V_1F_5; (258.3 cm^2 at 30 DAS) was obtained from treatment V_2F_2; (259.0 cm^2 at harvest) was recorded from treatment combination of V_2F_5.

Table 3: Combined effect of mungbean varieties and different organic or inorganic fertilizer application on leaf area $plant^{-1}$ (cm^2) of mungbean at different days after sowing.

Treatment combination	Leaf area $plant^{-1}$ (cm^2)					
	Days after sowing (DAS)					
	10	20	30	40	50	At harvest
V_1F_1	23.2 a	127.2 ab	587.5 a	594.9a	546.2 ab	462 4 a
V_1F_2	12.5 cd	124.6 ab	485.3 a-d	582.6 a	479.4 a-c	392.2 a-d
V_1F_3	12.2cd	102.2 bc	406.1 a-d	628.9 a	571.79 a	454.2 ab
V_1F_3	14.8 b-d	94.2 c	293.0 d	444.5 ab	337.0 bc	274.5 b-d
V_1F_5	9.5 d	90.5 c	393.2 a-d	262.0 b	312.2 c	271.2 cd
V_2F_1	18.6 a-c	126.5 ab	550.0 ab	551.4 a	474.7 a-c	359.4 a-d
V_2F_2	11.3 cd	89.4 c	258.3 d	453.6 ab	395.1 a-c	337.9 a-d
V_2F_3	16.3 a-d	103.2 bc	337.6 b-d	481.2 ab	380.4 a-c	343.2 a-d
V_2F_4	21.4 ab	148.8 a	543.8 a-c	600.8 a	506.6 a-c	448.1 a-c
V_2F_5	13.7 b-d	114.2 bc	308.6 cd	442.7 ab	356.1 bc	259.0d
LSD $_{(0.05)}$	**6.29**	**16.83**	**134.9**	**139.02**	**109.1**	**106.4**
CV (%)	23.87	8.75	18.89	16.06	14.59	17.05

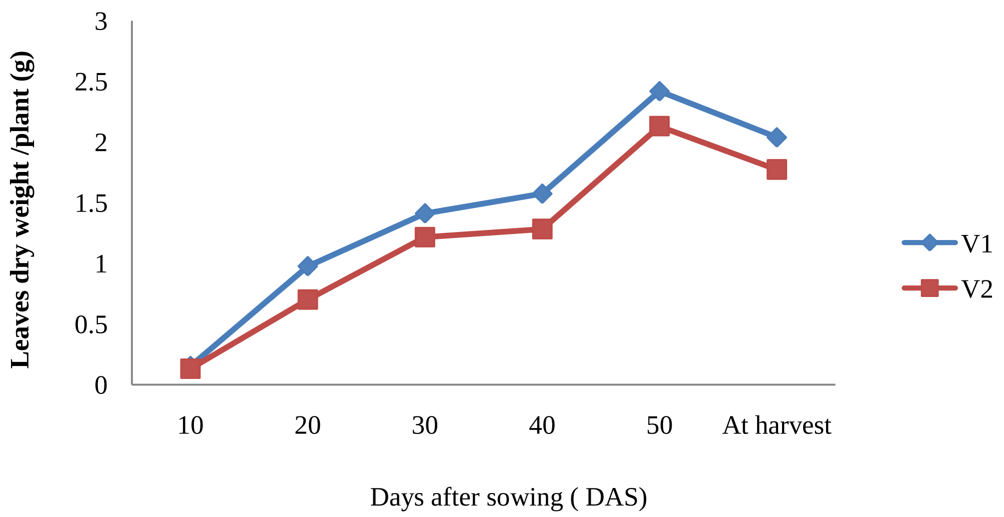
Here, F_1= NPKSB (RDF)
F_2= Cowdung (10 t/ha)
F_3= Vermicompost (7t /ha)
F_4= Poultry manure (5 t /ha)
F_5= *Rhizobium sp* (80 g /kg seed)

V_1= BARI mung 6
V_2= Binamoog 8

4.4 Leaves dry weight plant^{-1} (g)

4.4.1 Effect of varieties on leaves dry weight plant $^{-1}$

Leaves dry weight plant^{-1} was significantly varied between two mungbean varieties (Fig. 7). Leaves dry weight plant^{-1} was recorded periodically at different days after sowing (10, 20, 30, 40, 50 DAS and harvest) among them leaves dry weight plant^{-1} increased rapidly from 20 to 50 DAS than decrease slowly after 50 DAS up to harvest. The higher values of leaves dry weight plant^{-1} (0.15, 0.97, 1.41, 1.57, 2.41 and 2.03 g at 10, 20, 30, 40, 50 DAS and harvest, respectively) was obtained from variety V_1 (BARI mung 6) while the lower leaves dry weight plant^{-1} (0.13, 0.7, 1.21, 1.2, 2.12 and 1.77 g at 10, 20, 30, 40, 50 DAS and harvest, respectively) was obtained from variety V_2 (Binamoog 8).



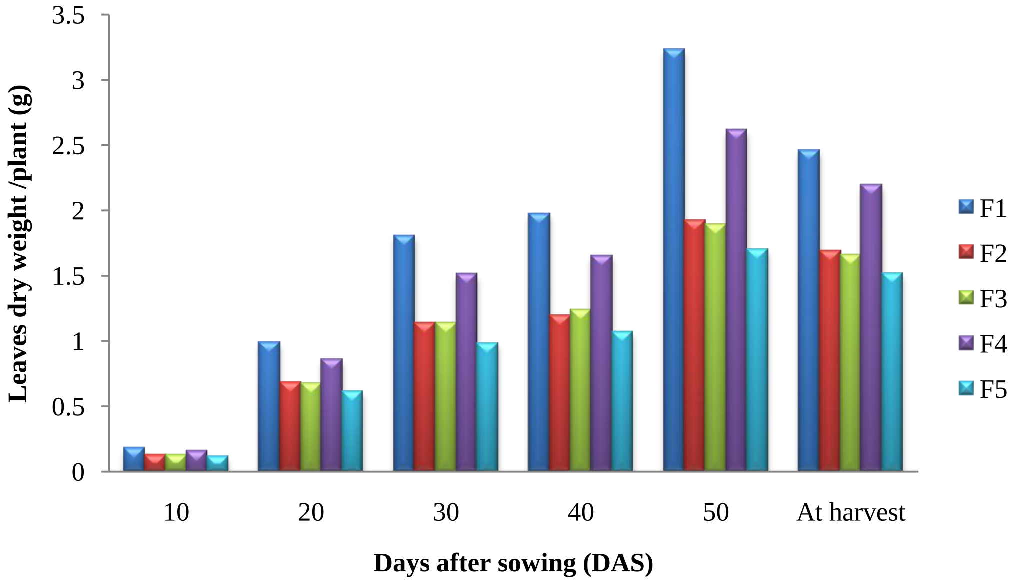
Here, V_1= BARI mung 6 and V_2= Binamoog 8

Figure 7. Effect of different varieties on leaves dry weight plant^{-1} (g) of mungbean at different days after sowing (LSD $_{(0.05)}$= 0.0547, 0.125, 0.121, 0.27 and 0.167at 20, 30, 40, 50 DAS and harvest respectively)

4.4.2 Effect of organic and inorganic fertilizers application on leaves dry weight plant $^{-1}$

Significant variation was noted on leaves dry weight plant $^{-1}$ of mungbean by reasone of the application of different organic and inorganic fertilizer (Fig. 8). Leaves dry weight plant $^{-1}$ speedily increased from 20 to 50 DAS and then slowly decreased up to harvest. The highest leaves dry weight plant^{-1} (0.99, 1.81, 1.97, 3.23, and 2.45 g at

20, 30, 40, 50 DAS and harvest, respectively) was recorded in the treatment F_1 which was statistically similar with F_4. The lowest leaves dry weight plant^{-1} (0.61, 0.98, 1.07, 1.70 and 1.51 g at 20, 30, 40, 50 DAS and harvest, respectively) was recorded in the treatment F_5 which was identical with F_2 and F_3.



F_1= NPKSB (RDF) F_2= Cowdung (10 t /ha)
F_3= Vermicompost (7 t/ha) F_4= Poultry manure (5 t /ha)
F_5= *Rhizobium sp* (80 g /kg seed)

Figure 8. Effect of different organic or inorganic fertilizer application on leaves dry weight plant^{-1} (g) of mungbean at different days after sowing ($LSD_{(0.05)}$ = 0.089, 0.19, 0.192, 0.42 and 0.264 at 20, 30, 40, 50 DAS and harvest, respectively)

4.4.3 Combined effect of varieties and different organic or inorganic fertilizer managements on leaves dry weight plant^{-1}

Interaction effect of variety and different organic or inorganic fertilizer application on leaves dry weight plant^{-1} was highly significant from 20 DAS up to harvest (Table 4). The maximum leaves dry weight plant^{-1} (1.01, 1.93, 2.18, 3.52 and 2.76 g at 20, 30, 40, 50 DAS and harvest, respectively) was recorded from V_1F_1 treatment combination which was identical with V_2F_4 at 20, 30, 50 DAS and harvest ; V_2F_1 at harvest. The lowest leaves dry weight plant $^{-1}$ (0.52, 0.78, 0.82, 1.44 and 1.24 g at 20, 30, 40, 50

DAS and harvest, respectively) was recorded in the treatment combination of V_2F_5 which was statistically identical with V_2F_3 and V_2F_3.

Table 4: Combined effect of mungbean varieties and different organic or inorganic fertilizer application on leaves dry weight plant^{-1} (g) of mungbean at different days after sowing (DAS)

Treatment combination	Leaves dry weight plant^{-1} (g)					
	Days after sowing (DAS)					
	10	20	30	40	50	At harvest
V_1F_1	0.19	1.01 a	1.93 a	2.18 a	3.52 a	2.76 a
V_1F_2	0.14	0.7c	1.357 c	1.45 c	2.23 b	1.91 b
V_1F_3	0.14	0.77 c	1.3 c	1.46 c	2.18 bc	1.85 b
V_1F_4	0.14	0.77 c	1.24 c	1.43 c	2.18 bc	1.85 b
V_1F_5	0.13	0.70 cd	1.18 cd	1.32 c	1.96 b-d	1.79 bc
V_2F_1	0.16	0.8 d	1.64 b	1.76 d	2.94 a	2.15 b
V_2F_2	0.10	0.58 de	0.91 de	0.93 d	1.61 cd	1.4 cd
V_2F_3	0.11	0.58 de	0.95 de	1.01 d	1.60 cd	1.46 cd
V_2F_4	0.16	0.94 a-c	1.77 ab	1.87 b	3.04 a	2.53 a
V_2F_5	0.10	0.52 e	0.78 e	0.82 d	1.44 d	1.24 d
$LSD_{(0.05)}$	**NS**	**0.1242**	**0.28**	**0.27**	**0.60**	**0.37**
CV (%)	9.00	10.68	12.43	11.11	15.48	11.42

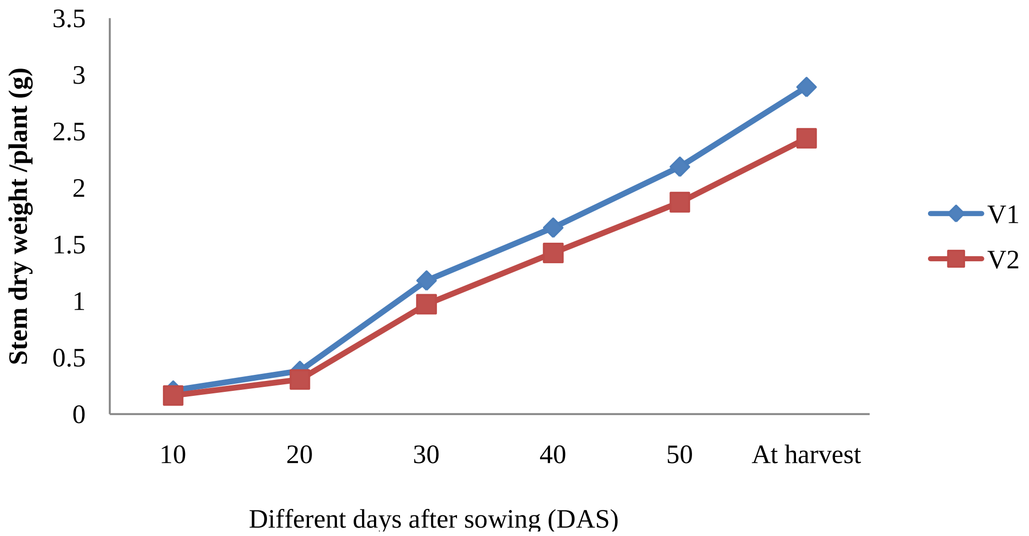
F_1= NPKSB (RDF)
F_2= Cowdung (10 t /ha)
F_3= Vermicompost (7t /ha)
F_4= Poultry manure (5 t /ha)
F_5= *Rhizobium sp* (80 g /kg seed)

V_1= BARI mung 6 and V_2= Binamoog 8

4.5 Stem dry weight plant $^{-1}$ (g)

4.5.1 Effect of varieties on stem dry weight plant $^{-1}$

The stem dry weight plant^{-1} was significantly assorted among mungbean varieties, presented in the following figure 9. The higher stem dry weight per plant (0.38, 1.18, 1.64, 2.18 and 2.89 g at 20, 30, 40, 50 DAS and harvest, respectively) was recorded in variety V_1 (BARI mung 6) while the lower stem dry weight plant^{-1} (0.30, 0.97, 1.42, 1.87 and 2.43 g at 20, 30, 40, 50 DAS and harvest, respectively) was recorded in variety V_2 (Binamoog 8).

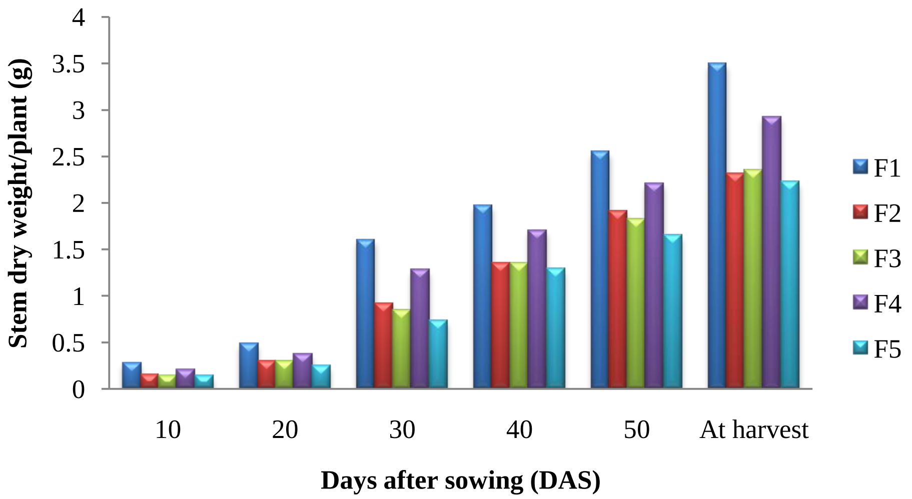


Here, V_1= BARI mung 6 and V_2= Binamoog 8

Figure 9. Effect of different varieties on stem dry weight plant^{-1} (g) of mungbean at different days after sowing (LSD $_{(0.05)}$= 0.024, 0.208, 0.1917,0.161 and 0.143 g at 20, 30, 40, 50 DAS and harvest, respectively)

4.5.2 Effect of organic and inorganic fertilizers application on stem dry weight plant $^{-1}$

Stem dry weight plant $^{-1}$ responsed significantly due to the application of different organic and inorganic fertilizer (Fig. 10). The stem dry weight plant^{-1} is highly enhanced from 20 DAS to 50 DAS and after that slow rate of increase showed from 50 DAS up to harvest. The highest stem dry weight plant $^{-1}$ (0.28, 0.48, 1.60, 1.97, 2.55 and 3.49 g at 10, 20, 30, 40, 50 DAS and harvest respectively) was recorded in treatment F_1 which was statistically identical with F_4 at 30 and 40 DAS. The lowest stem weight (0.14, 0.25, 0.73, 1.28, 1.65 and 2.22 g at 10, 20, 30, 40, 50 DAS and harvest respectively) was recorded in treatment F_5 which was identical with F_2 and F_3.



Here, F_1= NPKSB (RDF) F_2= Cowdung (10 t /ha)
F_3= Vermicompost (7t /ha) F_4= Poultry manure (5 t /ha)
F_5= *Rhizobium sp* (80 g /kg seed)

Figure 10. Effect of different organic and inorganic fertilizer application on stem dry weight plant^{-1} (g) of mungbean at different days after sowing (LSD $_{(0.05)}$ = 0.038, 0.329, 0.303, 0.255 and 0.227 g at 20, 30, 40, 50 DAS and harvest, respectively)

Combined effect of varieties and different organic or inorganic fertilizer application on stem dry weight plant^{-1}

Interaction effect of variety and different organic or inorganic fertilizer application highly influenced the stem dry weight of plant $^{-1}$The stem dry weight given the highest values (0.33, 0.57, 1.91, 2.15, 2.73 and 3.84 g at 10, 20, 30, 40, 50 DAS and harvest, respectively) from the treatment V_1F_1 which was identical with treatment combination of V_2F_1 at 10 and 40 DAS; statistically identical with V_2F_4 at 10, 30, 40 and 50 DAS. The lowest values of stem dry weight plant $^{-1}$ (0.1, 0.16, 0.47, 1.06, 1.24 and 1.75 g at 10, 20, 30, 40, 50 DAS and harvest, respectively) was obtained from the interaction treatment V_2F_5 which was identical with V_2F_3, V_2F_2 at 10, 20, 30, 40, 50 DAS and harvest ; identical with V_1F_5 at 10 DAS.

Table 5: Combined effect of mungbean varieties and different organic or inorganic fertilizer application on stem dry weight plant^{-1}(g)of mungbean at different days after sowing (DAS)

Treatment combination	Stem dry weight plant^{-1} (g)					
	Different days after sowing (DAS)					
	10	20	30	40	50	At harvest
V_1F_1	0.33 a	0.57 a	1.91 a	2.15 a	2.73 a	3.84 a
V_1F_2	0.17 bc	0.33 c	1.06 c-e	1.56 b-d	2.11 cd	2.62 cd
V_1F_3	0.18 bc	0.34 c	1.08 cd	1.54 b-d	2.09 cd	2.81 c
V_1F_4	0.16 bc	0.31 cd	0.84 c-f	1.45 c-f	1.92 de	2.47 d
V_1F_5	0.17 bc	0.33 c	0.98 c-e	1.50 cd	2.05 c-e	2.70 cd
V_2F_1	0.23 ab	0.40 b	1.28 bc	1.78 a-c	2.35 bc	3.15 b
V_2F_2	0.13 bc	0.26 de	0.77 d-f	1.14 de	1.69 ef	2.00 e
V_2F_3	0.11 bc	0.025 e	0.60 ef	1.16 de	1.55 fg	1.89 e
V_2F_4	0.23 ab	0.44 b	1.70 ab	1.95 ab	2.50 ab	3.37 b
V_2F_5	0.10 c	0.16 f	0.47 f	1.06 e	1.24 g	1.75 e
LSD $_{(0.05)}$	**0.1231**	**0.2084**	**0.4661**	**0.4286**	**0.3607**	**0.3217**
CV (%)	38.53	9.1	25.26	16.27	10.36	7.04

F_1= NPKSB (RDF) V_1= BARI mung 6 and V_2= Binamoog 8
F_2= Cowdung (10 t /ha)
F_3= Vermicompost (7t /ha)
F_4= Poultry manure (5 t /ha)
F_5= *Rhizobium sp* (80 g /kg seed)

4.6 Dry matter weight plant^{-1} (g)

4. 6.1 Effect of of varieties on dry matter weight plant^{-1}

The dry matter weight plant^{-1} of mungbean varieties was significantly influenced at different days after sowing (DAS) (Fig. 11) .The maximum dry weight plant^{-1} (0.34, 1.22, 2.47, 3.77, 7.47 and 8.48 g at 10, 20, 30, 40, 50 DAS and harvest, respectively) was obtained from variety V_1. The minimum dry matter weight plant $^{-1}$ (0.28, 1.07, 2.09, 3.27, 6.68 and 7.46 g at 10, 20, 30, 40, 50 DAS and harvest, respectively) was obtained from V_2.

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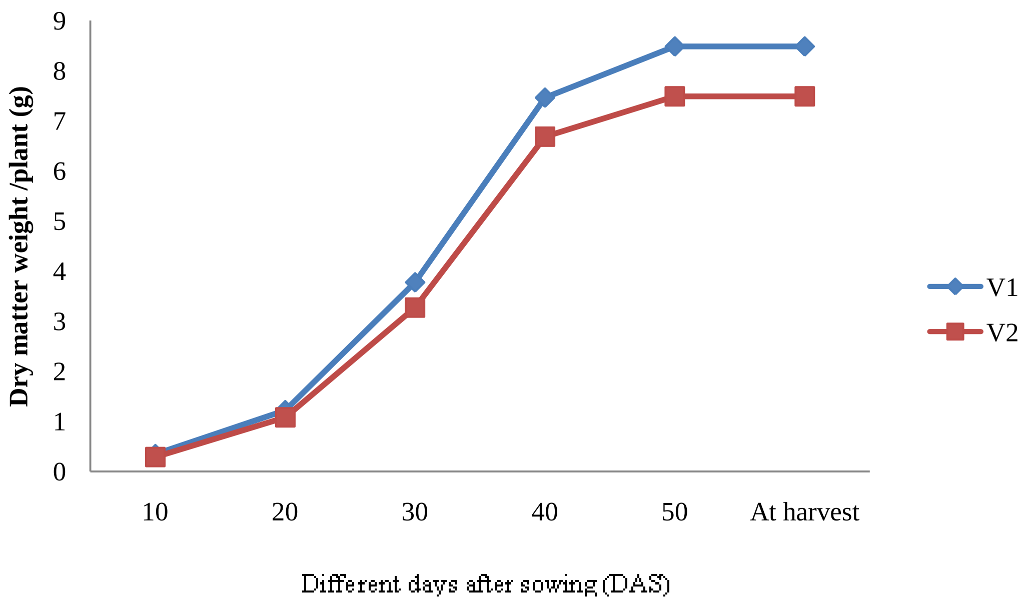
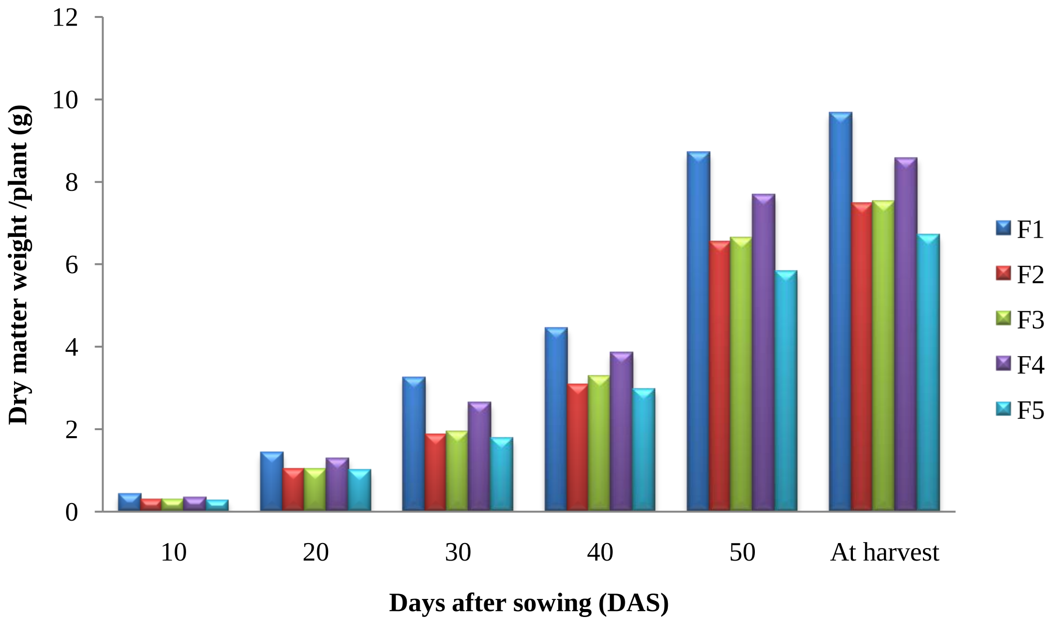


Here, V_1= BARI mung 6 and V_2= Binamoog 8

Figure 11. Effect of different varieties on dry matter weight plant^{-1}(g) of mungbean at different days after sowing (LSD $_{(0.05)}$ =0.02, 0.024, 0.208, 0.1917, 0.161 and 0.143 g at 10, 20, 30, 40, 50 DAS and harvest respectively)

4.6.2 Effect of organic or inorganic fertilizers on dry matter weight plant^{-1}

The dry matter weight plant^{-1} was significantly influenced by different organic or inorganic fertilizer application (Fig.12). The dry matter weight plant^{-1} speedily increased from 20 DAS to 50 DAS thereafter increasing rate became slower up to harvest. The maximum dry weight plant^{-1} (0.41, 1.42, 3.24, 4.44, 8.70 and 9.65 g at 10, 20, 30, 40, 50 DAS and harvest, respectively) was obtained from treatment F_1 which was statistically similar with F_4 at 20 DAS. The minimum dry matter weight plant^{-1} (0.26, 0.99, 1.76, 2.95, 5.81 and 6.70 g at 10, 20, 30, 40, 50 DAS and harvest, respectively) was obtained from treatment F_2 which was statistically similar with treatment F_5 and F_3 . Menon *et al*. (2010) observed that plant height and dry matter production of cowpea were maximum under the treatment received poultry manure and cowdung.



F_1= NPKSB (RDF) F_2= Cowdung (10 t /ha)
F_3= Vermicompost (7t/ha) F_4= Poultry manure (5 t /ha)
F_5= *Rhizobium sp* (80 g /kg seed)

Figure 12. Effect of different organic and inorganic fertilizer application on dry matter weight plant^{-1} (g) of mungbean at different days after sowing ($LSD_{(0.05)}$ = 0.0318, 0.147, 0.344,0.445, 0.88 and 0.62 g at 10, 20, 30, 40, 50 DAS and harvest, respectively)

4.6.3 Combined effect of varieties and different organic or inorganic fertilizer application on dry matter weight plant^{-1}

Application of different organic or inorganic fertilizer had significant effect on dry matter weight plant^{-1} of different mungbean varieties (Table 6). Thehighest dry matter weight plant^{-1} (0.49, 1.58, 3.72, 4.85, 9.01 and 10.29 g at 10, 20, 30, 40, 50 DAS and harvest, respectively) was obtained fromtreatment combination V_1F_1 which was statistically similar with V_2F_4 at 20, 40, 50 DAS and harvest; V_2F_1 at 50 DAS. The minimum dry matter weight plant^{-1} (0.23 g at 10 DAS) obtained from V_2F_5 which was statistically similar with V_2F_2 and V_2F_3 ; (0.82 g at 20 DAS) obtained from V_2F_3 which was statistically similar with V_2F_5; (1.36, 2.49, 4.67 and 5.50 g at 30, 40, 50 DAS and harvest, respectively) was obtained from V_2F_5.

Table 6: Combined effect of mungbean varieties and different organic and inorganic fertilizer application on dry matter weight plant^{-1} of mungbean at different days after sowing (DAS)

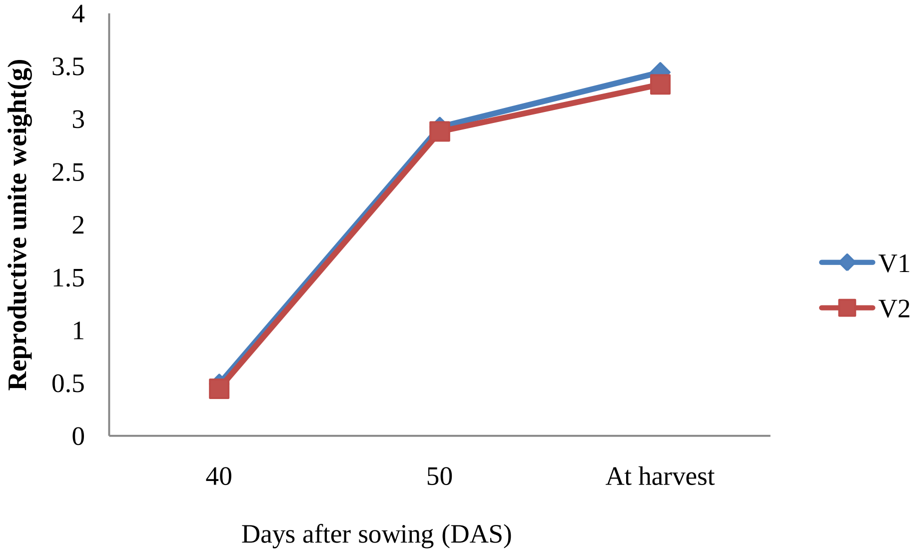
Treatment combination	Dry matter weight plant^{-1} (cm^2)					
	Different days after sowing (DAS)					
	10	**20**	**30**	**40**	**50**	**At harvest**
V_1F_1	0.49 a	1.58 a	3.72 a	4.85 a	9.01 a	10.29 a
V_1F_2	0.30 cd	1.08 b-c	2.07 be	3.41 cd	6.94 c	7.89 cd
V_1F_3	0.32 cd	1.22 bc	2.38 cd	3.98 bc	7.63 bc	8.58 bc
V_1F_4	0.29 cd	1.099 bc	2.04 de	3.19 de	6.76 c-d	7.75 cd
V_1F_5	0.30 b-c	1.11 bc	2.16 d	3.41cd	6.95 cd	7.89 cd
V_2F_1	0.33 bc	1.25 b	2.76 bc	4.04 b	8.39 ab	9.01 b
V_2F_2	0.26 de	0.96 cd	1.64 ef	2.72 ef	6.12 de	7.05 de
V_2F_3	0.24 e	0.82 e	1.50 f	2.60 ef	5.64 ef	6.45 e
V_2F_4	0.34 b	1.46 a	3.20 bc	4.48 ab	8.58 ab	9.40 ab
V_2F_5	0.23 e	0.87 de	1.36 f	2.49 f	4.67 f	5.50 f
$LSD_{(0.05)}$	**0.045**	**0.209**	**0.4877**	**0.6299**	**1.241**	**0.89**
CV (%)	8.32	10.62	12.42	10.42	10.3	6.49

F_1= NPKSB (RDF) V_1= BARI mung 6 and V_2= Binamoog 8
F_2= Cowdung (10 t/ha)
F_3= Vermicompost (7 t/ha)
F_4= Poultry manure (5 t/ha)
F_5= *Rhizobium sp* (80 g /kg seed)

4.7 Reproductive unit dry weight (g)

4.7.1 Effect of varieties on reproductive unit dry weight plant

Figure 13 present the variation of two mungbean varieties on reproductive unit dry weight plant^{-1}. The V_1 (BARI mung 6) showed the maximum weight of reproductive unit plant^{-1} (0.49, 2.92 and 3.44 g at 40, 50 DAS and harvest). The minimum weight of reproductive unit plant^{-1} (0.44, 2.88 and 3.32 g at 40, 50 DAS and harvest, respectively) was recorded from V_2 (Binamoog 8).

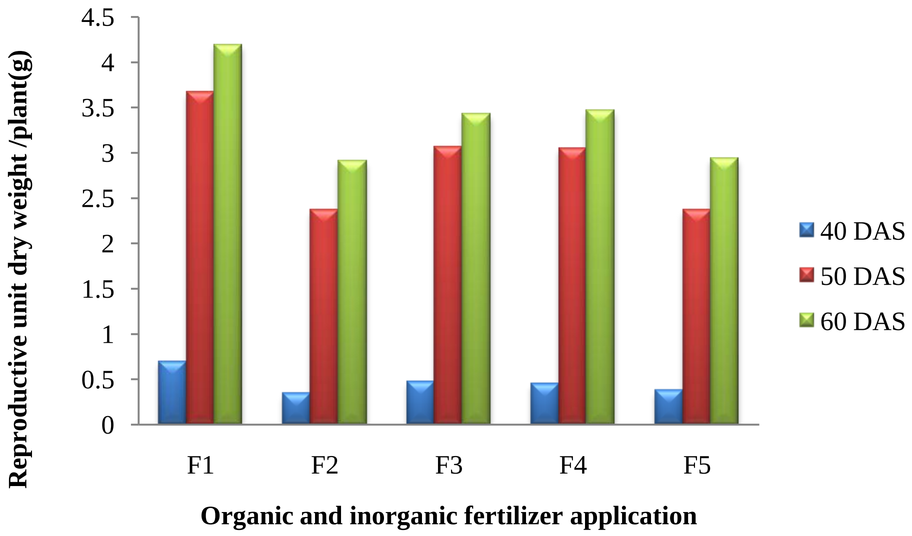


Here, V_1= BARI mung 6 and V_2= Binamoog 8

Figure 13. Effect of varieties on reproductive unit dry weight plant^{-1} (g) of mungbean at different days after sowing (LSD $_{(0.05)}$= 0.216, 0.249 g at 40,50 DAS and harvest, respectively)

4.7.2 Effect of organic and inorganic fertilizers on reproductive unit dry weight plant $^{-1}$

Reproductive unit dry weight plant^{-1} was highly influenced by the application of different organic and inorganic fertilizer (Fig. 14). Significant variation was found on reproductive unit production at 50 DAS and harvest. Reproductive unit was rapidly increased after 40 DAS. The maximum reproductive unit dry weight plant^{-1} (0.69, 3.67 and 4.19 g at 40, 50 and harvest, respectively) was obtained from the treatment F_1 which was identical with F_3 and F_4 . The minimum reproductive unit dry weight plant^{1} (g) (0.34 g at 40 DAS) was obtained from treatment F_2 which was identical with F_5, F_3 and F_4 ; (2.3 and 2.9 g at 50 DAS and harvest respectively) was recorded from treatment F_5 that similar with F_2 at 50 DAS and F_2, F_3 and F_4 at harvest.



F_1= NPKSB (RDF)
F_2= Cowdung (10 t/ha)
F_3= Vermicompost (7t/ha)
F_4= Poultry manure (5 t/ha)
F_5= *Rhizobium sp* (80 g /kg seed)

Figure 14. Effect of different organic or inorganic fertilizer application on reproductive unit dry plant^{-1} (g) of mungbean at different days after sowing (LSD $_{(0.05)}$ = 0.342 and 0.393 g at 50 DAS and harvest, respectively)

4.7.3 Combined effect of varieties and fertilizer on reproductive unit dry weight plant $^{-1}$

Application of different organic or inorganic fertilizer on mungbean varieties had significantly effected on reproductive unit dry weight plant^{-1} (Table 7). The maximum reproductive unit dry weight plant $^{-1}$ (3.91 and 4.52 g at 50 DAS and harvest respectively) was recorded in the treatment V_1F_1 which was statistically similar with V_2F_4 and V_2F_1 at 50 DAS and harvest; similar with V_1F_3 and V_1F_2 at 50 DAS. The minimum reproductive unit dry weight plant $^{-1}$ (1.77 and 2.37 g at 50 DAS and harvest respectively) was recorded from treatment V_2F_2 which was identical with treatment V_1F_4, V_1F_5, V_2F_5.

Table 7: Combined effect of mungbean varieties and different organic or inorganic fertilizer application on reproductive unit dry weight of mungbean at different days after sowing (DAS)

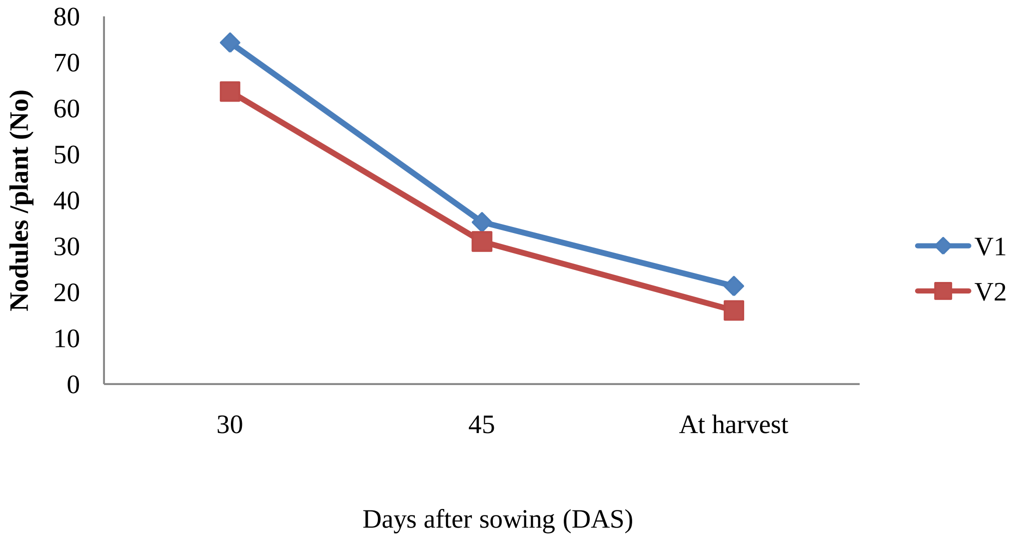
Treatment combination	Reproductive unit dry weight/plant (g)		
	Days after sowing (DAS)		
	40	50	At harvest
V_1F_1	0.83	3.91 a	4.52 a
V_1F_2	0.42	2.96 a-c	3.43 b-d
V_1F_3	0.52	3.28 ab	3.58 b-d
V_1F_4	0.31	2.25 bc	2.73 de
V_1F_5	0.36	2.20 bc	2.94 de
V_2F_1	0.55	3.42 ab	3.86 a-c
V_2F_2	0.27	1.77 c	2.37 e
V_2F_3	0.43	2.83 a-c	3.26 c-e
V_2F_4	0.58	3.84 a	4.20 ab
V_2F_5	0.38	2.52 bc	2.94 de
LSD $_{(0.05)}$	**NS**	**0.484**	**0.557**
CV (%)	28.20	9.73	9.59

Here, F_1= NPKSB (RDF) V_1= BARI mung 6 and V_2= Binamoog 8
F_2= Cowdung (10 t/ha)
F_3= Vermicompost (7t/ha)
F_4= Poultry manure (5 t/ha)
F_5= *Rhizobium sp* (80 g /kg seed)

4.8 Nodules plant^{-1} (No.)

4.8.1Effect of varieties on nodules plant $^{-1}$

Significant variation was observed in nodules plant^{-1} among mungbean varieties (Fig. 15). The higher nodules plant^{-1} (74.31, 35.19, 21.29 at 30, 45 DAS and harvest, respectively) was recorded in mungbean variety V_1 (BARI mung 6). The lower nodules plant^{-1} (63.66, 31.03, 16.04 at 30, 45 DAS and hervest, respectively) was recorded in mungbean variety V_2 (Binamoog 8).

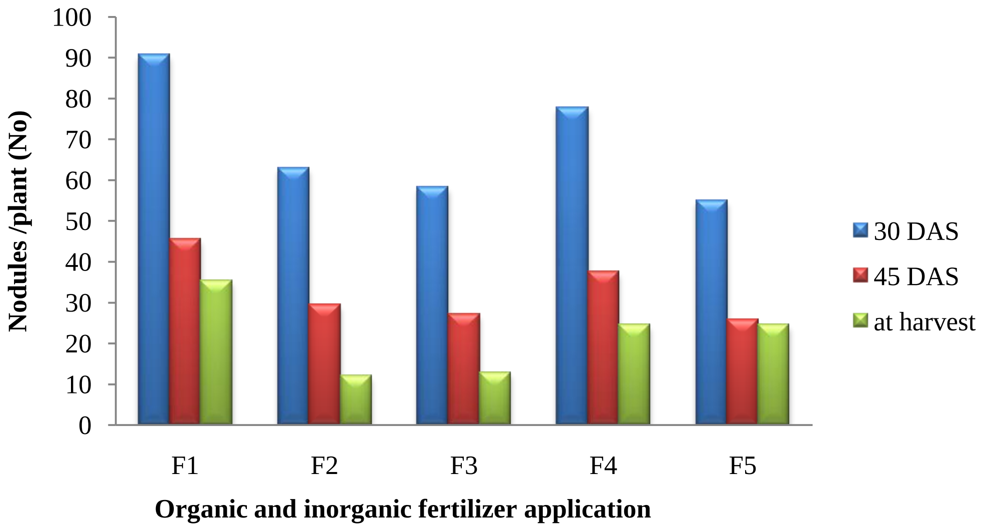


Here, V_1= BARI mung 6 and V_2= Binamoog 8

Figure 15. Effect of varieties on nodules plant^{-1} (no.) of mungbean at different days after sowing (LSD (0.05)= 7.84, 2.58 and 9.586 g at 30, 45 DAS and harvest, respectively)

4.8.2 Effect of organic and inorganic fertilizers application on nodules plant $^{-1}$

The nodules plant $^{-1}$ of mungbean varied significantly as a results of the application of different organic and inorganic fertilizers (Fig.16). The nodules plant $^{-1}$ became higher at 30 DAS thereafter hurriedly reduced from 45 DAS up to harvest. The maximum no of nodules plant $^{-1}$ (90.75, 45.55 and 35.38 at 30, 45 DAS and harvest, respectively) was recorded in treatment F_1 (NPKSB) which was identical with F_4 (5 t poultry manure ha^{-1}) at harvest. The lowest no of nodules plant^{-1} (55.03, 25.72 and 8.44 at 30, 45 DAS and harvest, respectively) was recorded in F_5 which was identical with F_3 and F_2. Madukue *et al*. (2008) observed that organic manure significantly influenced the nodulation of the cowpea and application of poultry manure provided the highest number of nodules (15.9) which was significantly different from the values of nodules (12.2 and 10.3) recorded from cow dung treated plots and untreated plots respectively.



Here, F_1= NPKSB (RDF) F_2= Cowdung (10 t /ha)
F_3= Vermicompost (7 t/ha) F_4= Poultry manure (5 t/ha)
F_5= *Rhizobium sp* (80 g /kg seed)

Figure 16. Effect of organic or inorganic fertilizer application on nodules plant^{-1} (no.) of mungbean at different days after sowing (LSD $_{(0.05)}$ = 11.359, 4.0922 and 15.158at 30, 45 DAS and harvest, respectively)

4.8.3 Combined effect of varieties and organic or inorganic fertilizer application on nodules plant $^{-1}$

The nodules plant^{-1} was significantly influenced by the application of organic or inorganic fertilizer on mugbean varieties (Table 8). The highest nodules plant^{-1} (101.33, 50.22 and 43.77 at 30, 45 DAS and harvest, respectively) was recorded under the treatment V_1F_1 which was statistically similar with V_2F_1 and V_2F_4 at 30 DAS and harvest. The lowest nodules plant $^{-1}$ (46.71 at 30 DAS) was recorded under the treatment V_2F_3 which was statistically identical with all other treatment except $V_1F_1$and V_2F_4 ; (22.21 at 45 DAS) was recorded under the treatment V_2F_3 which was similar with V_2F_5 and V_2F_2; (6.10 at harvest) was recorded from the treatment V_2F_3 that is similar with all other treatment except V_2F_4 at harvest.

Table 8: Combined effect of mungbean varieties and different organic or inorganic fertilizer application on nodules plant^{-1}(no.) of mungbean at different days after sowing (DAS)

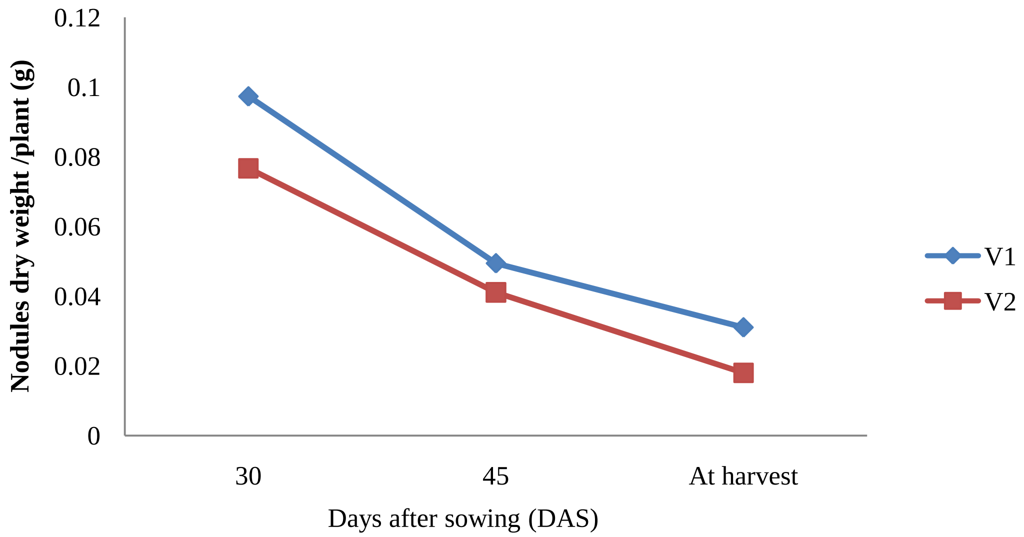
Treatment combination	**Nodules plant^{-1} (No)**		
	Different days after sowing (DAS)		
	30 DAS	45 DAS	At harvest
V_1F_1	101.33 a	50.22 a	43.77 a
V_1F_2	71.55 bc	33.56 c	16.20 bc
V_1F_3	69.73 bc	32.31 c	19.33 bc
V_1F_4	67.82 bc	31.64 c	16.33 bc
V_1F_5	61.13 c	28.22 cd	10.78 c
V_2F_1	80.20 a-c	40.88 b	27.00 a-c
V_2F_2	54.53 c	25.33 de	7.88 c
V_2F_3	46.71 c	22.21 e	6.10 c
V_2F_4	87.93 ab	43.52 b	32.77 ab
V_2F_5	87.93 c	23.21 de	6.44 c
$LSD_{(0.05)}$	**16.065**	**4.092**	**15.158**
CV (%)	13.57	10.19	66.95

Here, F_1= NPKSB (RDF) V_1= BARI mung 6 and V_2= Binamoog 8
F_2= Cowdung (10 t/ha)
F_3= Vermicompost (7 t/ha)
F_4= Poultry manure (5 t/ha)
F_5= *Rhizobium* sp (80 g/kg seed)

4.9 Nodules dry weight plant ^{1} (g)

4.9.1 Effect of varieties on Nodules dry weight plant^{-1}

Nodules dry weight plant^{-1} was significantly assorted by reason of different varieties of mungbean (Fig. 17). The highest nodules dry weight was found at 30 DAS and then the rate of nodules dry weight plant^{-1} started to reduce. The heigher nodules dry weight plant^{-1} (0.09, 0.049 and 0.03 at 30, 45 DAS and harvest, respectively) was obtained from V_1 (BARI mung 6). The lower nodules dry weight plant^{-1} (0.07, 0.041 and 0.018 g at 30, 45 DAS and harvest respectively) was obtained from V_2 (Binamoog 8).

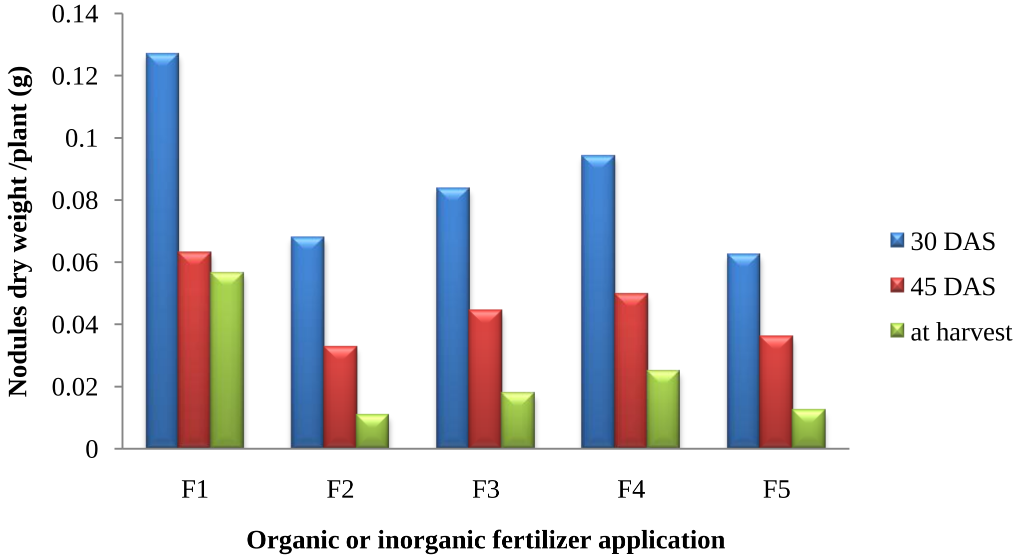


Here, V_1= BARI mung 6 and V_2= Binamoog 8

Figure17. Effect of varieties on nodules dry weight plant^{-1} (no.) of mungbean at different days after sowing (LSD (0.05)= 0.0136, 0.00513 g at 30, 45 DAS)

4.9.2 Effect of organic or inorganic fertilizers application on nodules dry weight plant $^{-1}$

Different organic or inorganic fertilizer management significantly influenced the nodules dry weight plant^{-1} (Fig. 18). The nodules dry weight plant^{-1} became higher at 30 DAS thereafter the rates of nodules dry weight plant^{-1}slowly reduced up to harvest. The maximum nodules dry weight per plants (0.12, 0.06 and 0.05 g at 30, 45 DAS and harvest, respectively) was noted from treatment F_1 which was similar with F_3 and F_4 at harvest. The minimum nodules dry weight plant^{-1} (0.06, 0.03 and 0.012 g at 30, 45 DAS and harvest).



Here, F_1= NPKSB (RDF) F_2= Cowdung (10 t/ha)
F_3= Vermicompost (7 t/ha) F_4= Poultry manure (5 t/ha)
F_5= *Rhizobium sp* (80 g /kg seed)

Figure 18. Effect of different organic or inorganic fertilizer application on nodules dry weight plant^{-1} (no.) of mungbean at different days after sowing (LSD (0.05) = 0.0305, 0.0079 and 0.0414 at 30, 45 DAS and harvest, respectively)

4.9.3 Combined effect of varieties and organic or inorganic fertilizer managements on nodules dry weight plant $^{-1}$

The nodules dry weight plant^{-1} was significantly influenced by the combined effect of different mungbean varieties and various organic or inorganic fertilizers managements (Table 9). The maximum nodules dry weight plant^{-1} (0.15, 0.064 and 0.084 g at 30, 45 DAS and harvest, respectively) was recorded in the treatment combination of V_1F_1 which was similar with V_2F_4 at 45 DAS; V_2F_4 and V_2F_1 at harvest. The minimum nodules dry weight plant^{-1} (0.03, 0.024 and 0.007 g at 30, 45 DAS and harvest respectively) was recorded in the treatment combination of V_2F_5 which was similar with V_2F_2 at 30 DAS; similar with V_2F_2 and V_2F_3 at 45 DAS ; similar with all other treatment except V_1F_1, V_2F_1 and V_2F_4 at harvest.

Table 9. Combined effect varieties and different organic or inorganic fertilizer application on nodules dry weight plant^{-1}(g) of mungbean at different days after sowing (DAS)

Treatment combination	Nodules dry weight^{-1} plant (g)		
	Days after sowing (DAS)		
	30 DAS	45 DAS	At harvest
V_1F_1	0.15 a	0.069 a	0.084 a
V_1F_2	0.07 c-e	0.03 de	0.017 b
V_1F_3	0.09 b-d	0.054 bc	0.023 b
V_1F_4	0.07 c-e	0.037 d-f	0.014 b
V_1F_5	0.08 c-e	0.047 cd	0.017 b
V_2F_1	0.10 bc	0.057 bc	0.028 ab
V_2F_2	0.05 ef	0.027 fg	0.007 b
V_2F_3	0.07 de	0.034 e-g	0.011 b
V_2F_4	0.11 b	0.062 ab	0.035 ab
V_2F_5	0.03 f	0.024 g	0.007 b
$LSD_{(0.05)}$	**0.0305**	**0.0112**	**0.058**
Cv (%)	20.41	14.45	139.98

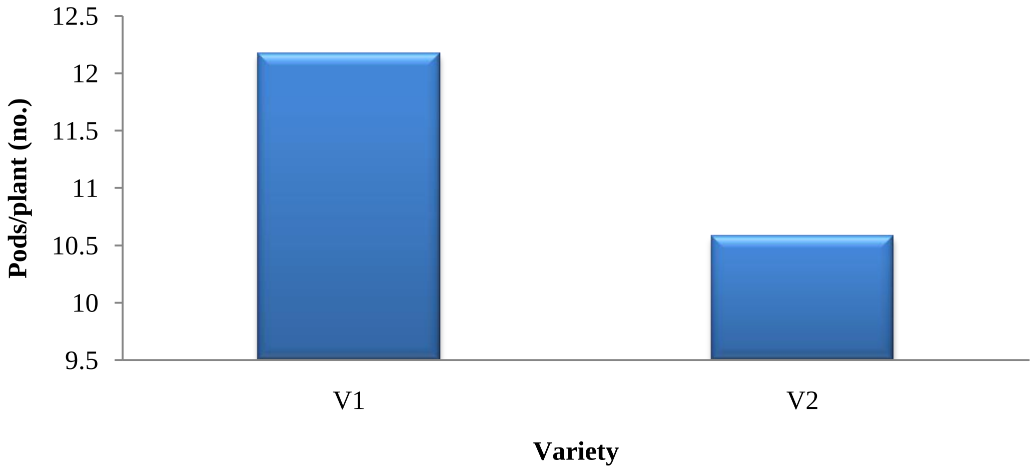
F_1= NPKSB (RDF)
F_2=Cowdung (10 t/ha)
F_3= Vermicompost (7 t/ha)
F_4= Poultry manure (5 t/ha)
F_5= *Rhizobium sp* (80 g /kg seed)

V_1= BARI mung 6 and V_2= Binamoog 8

4.10.3 Pods plant^{-1}(No.)

4.10.1 Effect of varieties on pods plant^{-1}

The number of pod plant^{-1} significantly varied between mungbean varieties (Fig. 25). The maximum no. of pods plant^{1} (12.17) obtained from V_1 (BARI mung 6) while minimum no. of pods plant^{-1} (10.58) was obtained from V_2 (Binamoog 8).

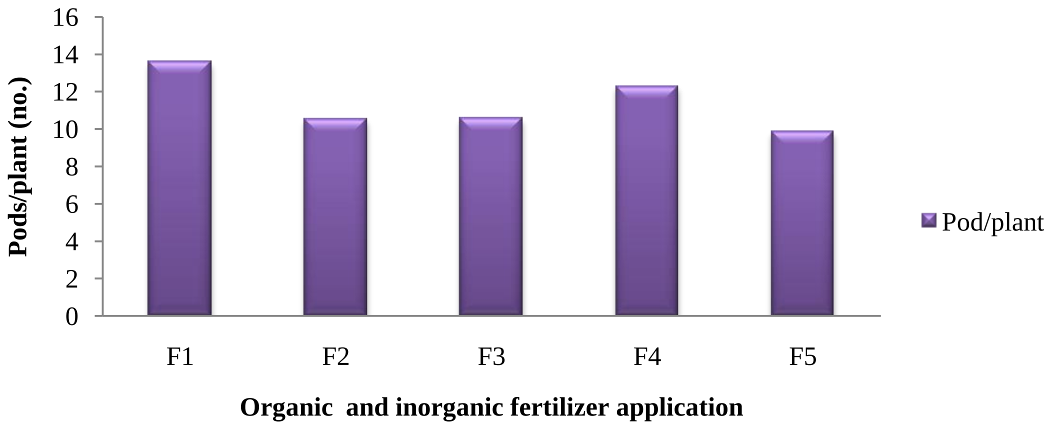


Here, V_1= BARI mung 6 and V_2 = Binamung 8

Figure 19. Effect of varieties on pods plant^{-1} of mungbean (LSD $_{(0.05)}$= 0.99)

4.10.2 Effect of organic or inorganic fertilizers application on pods plant $^{-1}$

Significant variation was viewed on pods plant^{-1} as a result for the application of different organic or inorganic fertilizer (Fig. 26). The highest number pods plant^{-1} (13.6) was acquired from the treatment F_1 which was similar with F_4 treatment. The lowest number of pods plant^{1} (9.86) was acquired from treatment F_5 which was similar with F_2 and $F_{3.}$ Ramesh *et al.* (2006) reported that the application of poultry manure @ 2 t ha^{-1} significantly higher the number of pods plant^{-1} of pigeonpea crop over control. Rao and Shaktawat (2002) reported that the application of poultry manure @ 5 t ha^{-1} significantly higher number of pods plant^{-1} (18.6) in groundnut crop over control.



F_1= NPKSB (RDF) F_2= Cowdung (10 t/ha)
F_3= Vermicompost (7t/ha) F_4= Poultry manure (5 t/ha)
F_5= *Rhizobium sp* (80 g seed kg^{-1})

Figure 20. Effect of different organic or inorganic fertilizer application on pods $plant^{-1}$ ($LSD_{(0.05)}$= 0.62)

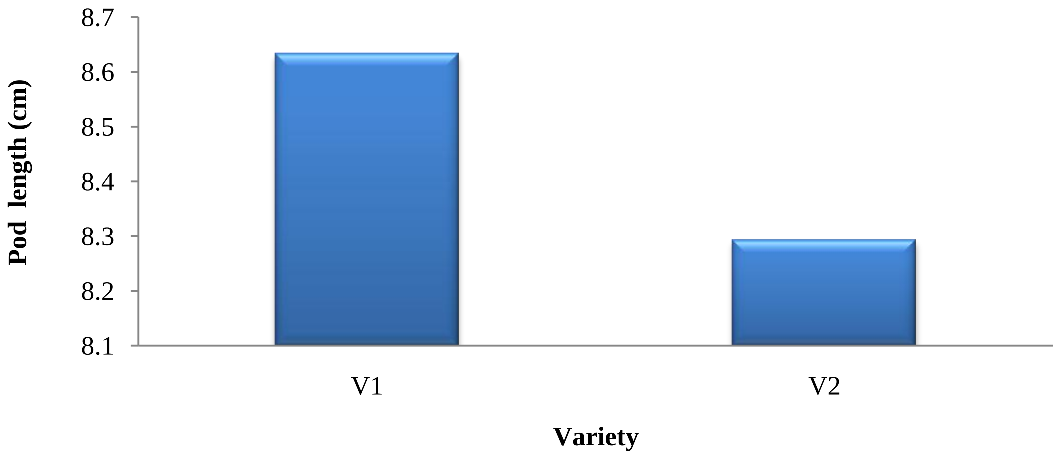
4.10.3 Combined effect of variety and different organic or inorganic fertilizer application on pods $plant^{-1}$

Interaction effect of varieties and fertilizer management showed highly significant variation which are presented in Table 10. The highest number of pods $plant^{-1}$ (14.03) was obtained from the treatment V_1F_1 which was similar with V_2F_4 and V_2F_1. The lowest number of pod $plant^{-1}$ (7.93) was obtained from treatment combination V_2F_5 which was similar withV_2F_3.

4.11 Pod length (cm)

4.11.11 Effect of varieties on Pod length

The pod length was influenced between two mungbean varieties that showed statistically significant variation (Fig. 21). Between two mungbean varieties the higher pod length (8.63 cm) was obtained from V_1 (BARI mung 6) while the lower pod length (8.29 cm) was obtained from V_2 (Binamoog 8).

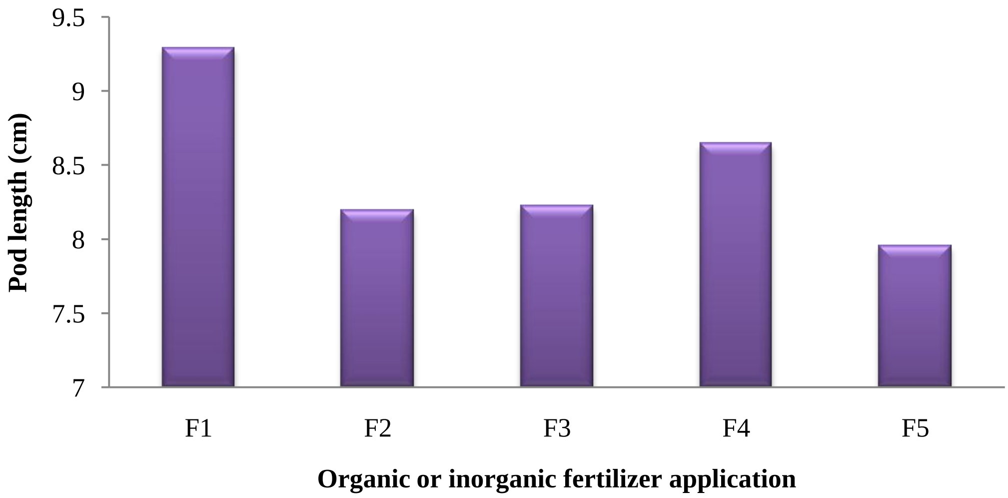


V_1= BARI mung 6 and V_2 = Binamoog 8

Figure 21. Effect of varieties on pod length of mungbean (LSD $_{(0.05)}$ = 0.233).

4.11.2 Effect of organic or inorganic fertilizers application on pod length

Pod length was significantly responded due to the application of different organic and inorganic fertilizer (Fig. 22). Among different organic and inorganic fertilizers F_1 given the highest pod length (9.21cm) which was statistically different from other organic treatment. The lowest pod length (7.96 cm) was recorded from treatment F_5 which was statistically similar with F_2 and F_3.



F_1= NPKSB (RDF)
F_2= Cowdung (10 t/ha)
F_3= Vermicompost (7 t/ha)
F_4= Poultry manure (5 t/ha)
F_5= *Rhizobium sp* (80 g /Kg seed)

Fiagure 22. Effect of different organic or inorganic fertilizer application on pod length (cm) (LSD$_{(0.05)}$= 0.37)

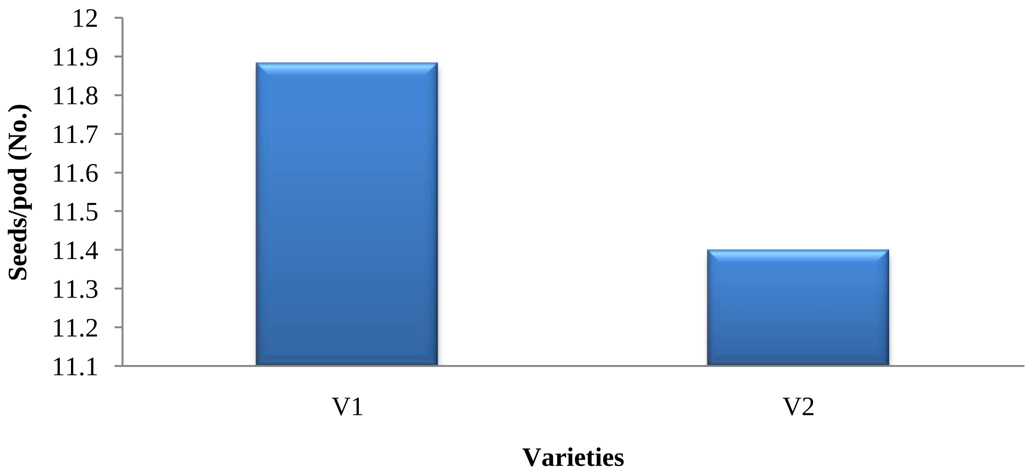
4.11.3 Combined effect of variety and different organic or inorganic fertilizer application on pod length

The interaction effect between variety and different organic or inorganic fertilizer was greatly significant in respect of pod length (Table 10). The maximum pod length (9.51cm) was obtained from V_1F_1 interaction which was identical with V_2F_4 and $V_2F_{1.}$ The minimum pod length (7.55 cm) was obtained from interaction V_2F_5 which was identical with $V_2F_{3.}$

4.12 Seeds pod $^{-1}$ (No.)

4.12.1 Effect of varieties on seeds pod $^{-1}$

There was no significant variation observed on the seed pod^{-1} between mungbean varieties (Fig. 19). The higher seeds pod $^{-1}$ (11.8) was recorded in V_1 (BARI mung 6) and the lower seed pod^{-1} (11.39) was recorded in V_2 (Binamoog 8).

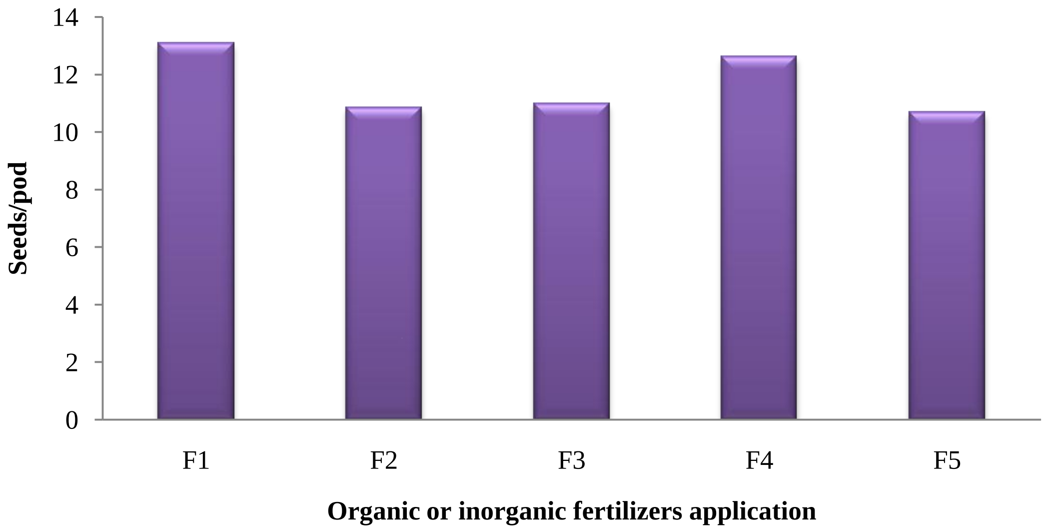


V_1 =BARI mung 6 and V_2 = Binamoog 8

Figure 23. Effect of varieties on seeds pod $^{-1}$ (No.) of mungbean

4.12.2 Effect of organic and inorganic fertilizers application on seed pod $^{-1}$

Application of different organic or inorganic fertilizer demonstrated significant variation on seeds pod ^{1} of mungbean (Fig. 20). The highest no of seed pod^{-1} (13.06) was recorded in the treatment F_1 which was identical with F_4 while the lowest seeds pod $^{-1}$ (10.73) was recorded in the treatment F_2. This findings was partially supported by Menon *et al.* (2010) who reported that application of poultry manure influenced the no of seeds pod^{-1} of cowpea.



F_1= NPKSB (RDF) F_2=Cowdung (10t /ha)
F_3= Vermicompost (7 t/ha) F_4= Poultry manure (5 t/ha)
F_5= *Rhizobium sp* (80 g/kg seed)

Figure 24. Effect of different organic or inorganic fertilizer application on seeds pod $^{-1}$ (LSD$_{(0.05)}$=2.45)

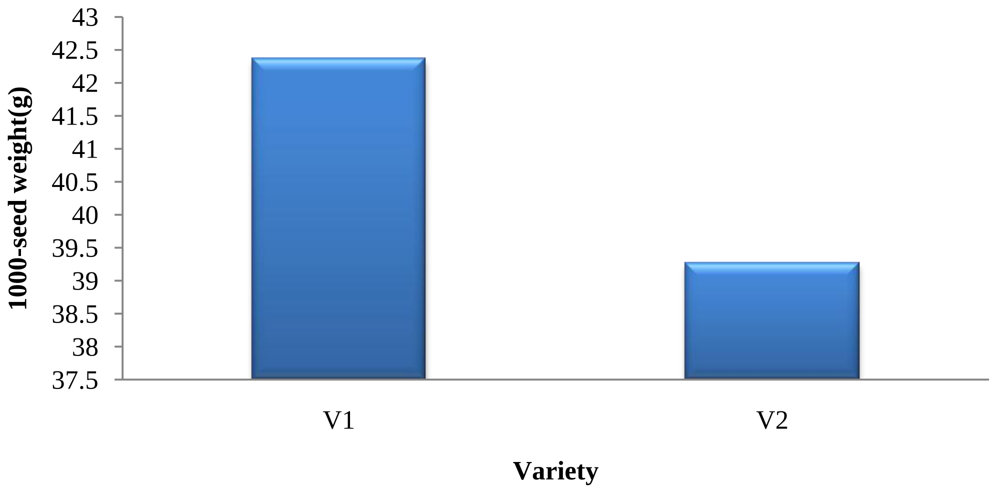
4.12.3 Combined effect of varieties and organic or inorganic fertilizer managements on seeds pod^{-1}

Effect of different organic or inorganic fertilizer managements on seeds pod $^{-1}$ of mungbean varieties are presented in the Table 10. Significant variation was observed on seeds pod^{-1} between mungbean varieties by the effect of different organic and inorganic fertilizer application. The highest no of seeds pod^{-1} (14.49) was recorded in the treatment V_1F_1 which was identical with V_2F_4. The lowest seeds pod^{-1} (10.06) was recorded in V_2F_5 which was similar with V_2F_2 a V_2F_3.

4.13 1000-seed weight (g)

4.13.1 Effect of varieties on 1000-seed weight

The effect of varieties on 1000 seed weight showed significant variation which presented in the Figure 23. The higher 1000 seed weight (42.36 g) was recorded from variety V_1 (BARI mung 6) while V_2 (Binamoog 8) showed the lower result (39.26 g). The present results were dependable with the findings of Thakuria and Saharia (1990).

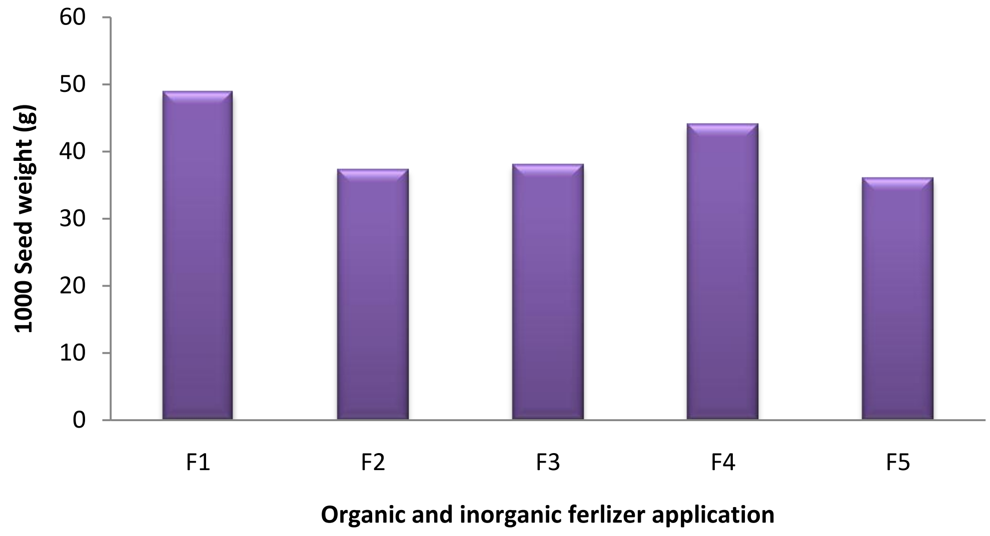


Here, V_1= BARI mung 6 and V_2 = Binamung 8

Figure 25. Effect of varieties on 1000-seed weight of mungbean (LSD $_{(0.05)}$= 1.47)

4.13.2 Effect of organic or inorganic fertilizers application on 1000-seed weight

Different organic and inorganic fertilizer application was highly affected 1000-seed weight (Fig. 24). The maximum 1000-seed weight (48.78 g) was recorded in the treatment F_1 which was similar with F_4 treatment. The lowest 1000-seed weight (35.98 g) was recorded in the treatment F_5 which was statistically similar with F_2 and $F_{3.}$



F_1= NPKSB (RDF) F_2= Cowdung (10 t/ha)
F_3= Vermicompost (7 t/ha) F_4= Poultry manure (5 t/ha)
F_5= *Rhizobium sp* (80 g seed kg^{-1})

Figure 26. Effect of different organic or inorganic fertilizer application on 1000 seed weight ($LSD_{(0.05)}$= 0.62)

4.13.3 Combined effect of variety and different organic or inorganic fertilizer application on 1000-seed weight

The interaction between varieties and different organic or inorganic fertilizer management was greatly significant in respect of 1000seed weight (Table 10). The maximum 1000-seed weight (50.88 g) was recorded in the interaction treatment V_1F_1 which was identical with V_2F_4. The minimum 1000-seed weight (32.23 g) was recorded in treatment V_2F_3 which was similar with the interaction of V_2F_5 and V_2F_2.

Table 10: Combined effect of mungbean varieties and different organic or inorganic fertilizer application on pods plant^{-1} (No.), pod length (cm), seeds pod^{-1} (No.), 1000-seed weight (g) and of mungbean.

Treatment Combinatin	Pods/plant (No)	Pod length (cm)	Seed/pod (No)	1000 Seed weight (g)
V_1F_1	14.03 a	9.513 a	14.49 a	50.88 a
V_1F_2	11.60 d	8.536 cd	11.14 a-c	39.27 d
V_1F_3	12.33 b-d	8.673 bc	11.50 a-c	43.82 c
V_1F_4	11.10 d	8.81 d-f	10.96 bc	38.19 de
V_1F_5	11.80 cd	8.357 c-e	11.29 a-c	39.64 d
V_2F_1	13.16 a-c	9.07 ab	11.66 a-c	46.69 bc
V_2F_2	9.50 e	7.84 e-f	10.54 c	35.32 ef
V_2F_3	8.80 ef	7.78 fg	10.44 c	32.23 f
V_2F_4	13.50 ab	9.21 a	14.27 ab	49.76 ab
V_2F_5	7.93 f	7.55 g	10.06 c	32.31 f
LSD $_{(0.05)}$	**1.47**	**0.521**	**3.45**	**3.29**
CV (%)	17.33	3.59	4.71	7.19

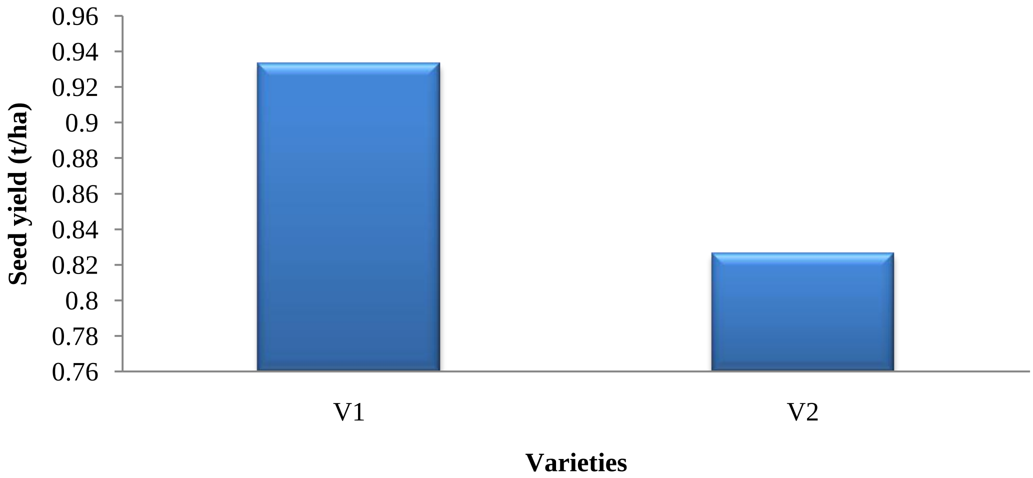
F_1= NPKSB (RDF)
F_2=Cowdung (10 t/ha)
F_3= Vermicompost (7 t/ha)
F_4= Poultry manure(5 t/ha)
F_5=*Rhizobium sp* (80 g/kg seed)

V_1= BARI mung 6 and V_2= Binamoog 8

4.14 Seed yield (t/ha)

4.14.1 Effect of varieties on seed yield

Significant variation was viewed between two mungbean varieties (Fig. 27). The higher seed yield (0.93 t/ha) was obtained from BARI mung 6 and the lower seed yield (0.82 t/ha) was obtained from Binamoog 8. The acquired results were consistent with the findings of Salauddin (2006). Jahan (2015) also found the similar result in her experiment on mungbean. She revealed that BARI mung 6 out by yielded BARI mung 5 (0.29 and 0.14 tha^{-1}, respectively) and Binamoog 8 (0.29 and 0.14 t ha^{-1}, respectively).

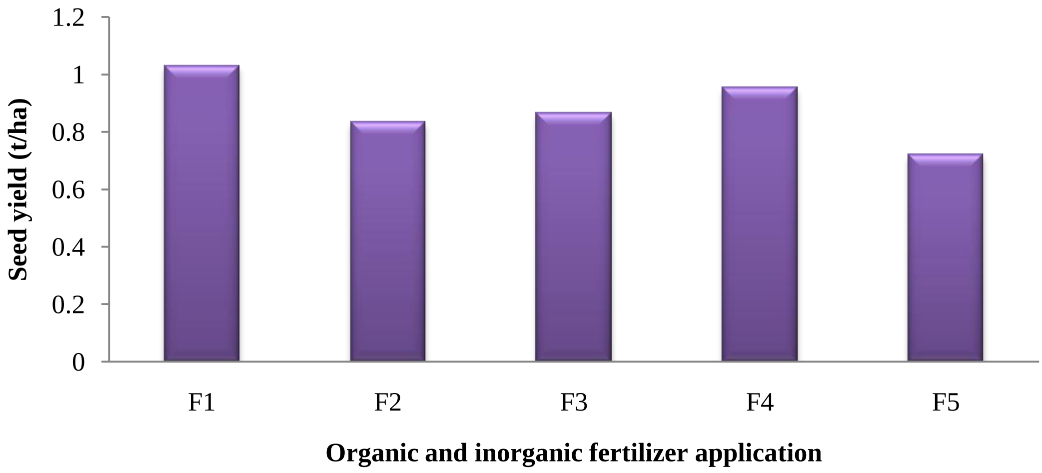


V_1= BARI mung 6 and V_2 = Binamoog 8

Figure 27. Effect of varieties on seed yield (t/ ha) (LSD $_{(0.05)}$= 0.0562)

4.14.2 Effect of different organic or inorganic fertilizers application on seed yield

Application of different organic or inorganic fertilizer showed significant effect of seed yieldof mungbean (Fig. 28). Among different organic or inorganic fertilizer, the highest yield (1.02 t/ha) was obtained from treatment F_1 which was statistically similar with F_4 and the lowest seed yield (0.71 t/ ha) was obtained from treatment F_5 which was identical with F_3 and F_2. Madukue *et al.* (2008) found the yield of cowpea with the application of poultry manure with a mean yield of 744.7 kg/ha, which was significantly different from values (571.9kg/ha and 505.0kg/ha) observed under untreated plots and cowdung treated plots respectively. Adeoya *et al*. (2011) found that the plots treated with poultry waste alone had the highest yield of 854 kg /ha of cowpea crop over control and other treatments.



F_1= NPKSB (RDF) F_2= Cowdung (10 t /ha)
F_3= Vermicompost (7 t/ha) F_4= Poultry manure (5 t/ha)
F_5= *Rhizobium sp* (80 g seed kg^{-1})

Figure 28. Effect of different organic or inorganic fertilizer application on seed yield (t/ha) ($LSD_{(0.05)}$= 0.088)

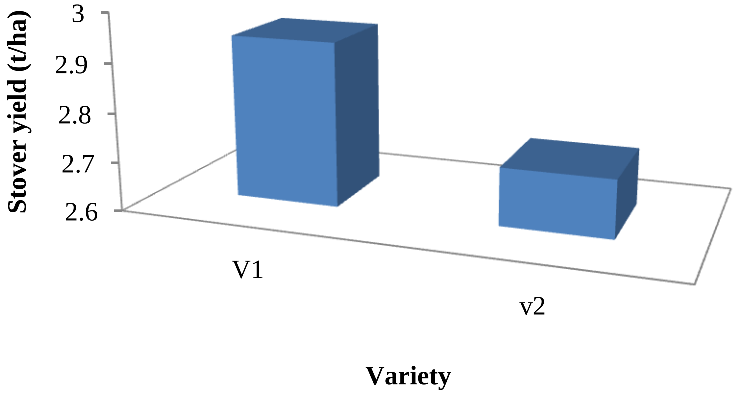
4.14.3 Combined effect of variety and different organic or inorganic fertilizer application on seed yield

Interaction effect of varieties and different organic or inorganic fertilizer application significantly affected the grain yield of mungbean (Table 11). The highest grain yield (1.09 t/ha) of mungbean was recorded from the treatment combination V_1F_1 which was statistically similar with V_2F_4 and V_2F_1. The lowest grain yield (0.57 t/ha) of mungbean was obtained from the treatment combination of V_2F_5.

4.15 Stover yield (t/ha)

4.15.1 Effect of varieties on stover yield

Significant variation was found on stover yield between two mungbean varieties (Fig. 29). Between two varieties, V_1 (BARI mung 6) (2.94 t /ha) gave the higher stover yield while the lower (2.71 t /ha) was found in V_2 (Binamoog 8).

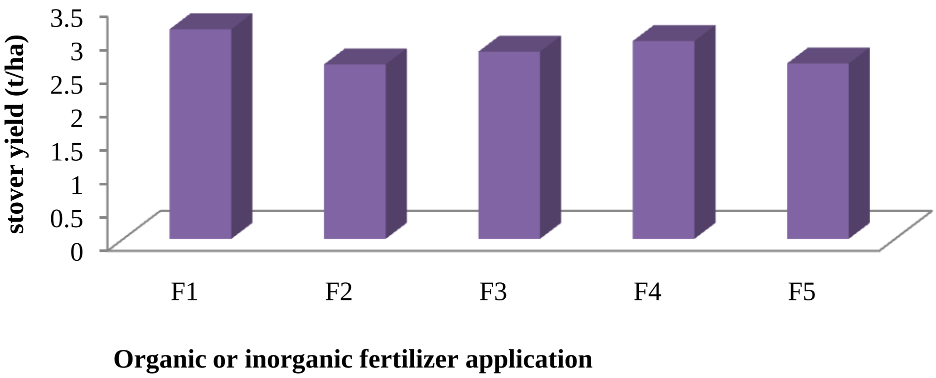


V_1= BARI mung 6 and V_2 = Binamoog 8

Figure 29. Effect on varieties on stover yield (t/ha) of mungbean (LSD $_{(0.05)}$= 0.036)

4.15.2 Effect of different organic and inorganic fertilizers application on stover yield

Different organic and inorganic fertilizer application significantly affected the stover yield (Fig. 30). The highest stover yield (3.14 t/ha) was recorded in F_1 treated plot. The lowest stover yield (2.63 t/ha) was found from F_5 treated plots. This result was supported by Adeoya *et al.* (2011).



F_1= NPKSB (RDF)
F_2= Cowdung (10 t /ha)
F_3= Vermicompost (7t/ha)
F_4= Poultry manure (5 t /ha)
F_5= *Rhizobium sp* (80 g seed/ kg)

Figure 30. Effect of different organic or inorganic fertilizer application on stover yield (t/ha) (LSD$_{(0.05)}$= 0.4279)

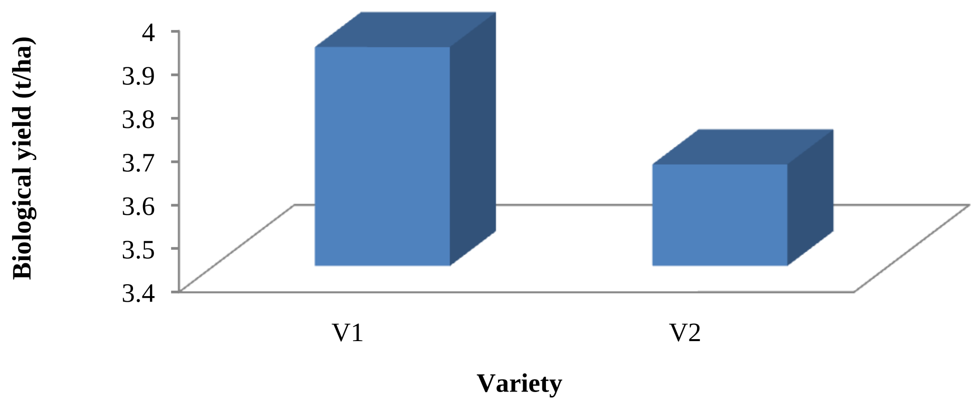
4.15.3 Combined effect of variety and different organic or inorganic fertilizer application on stover yield

The interaction between variety and different organic or inorganic fertilizer application was highly significant in respect of stover yield (Table 11). The highest stover yield (3.22 t/ha) was viewed in V_1F_1 interaction which was statistically similar with treatment combination of V_2F_4. Significantly minimum stover yield (2.28 t /ha) was produced in V_2F_3 combination.

4.16 Biological yield (t/ha)

4.16.1 Effect of varieties on biological yield

The result showed nonsignificant effect on biological yield between two mungbean varieties (Fig. 31). BARI mung 6 showed the higher biological yield (3.90 t/ha) while Binamoog 8 showed (3.63 t/ha) lower biological yield.

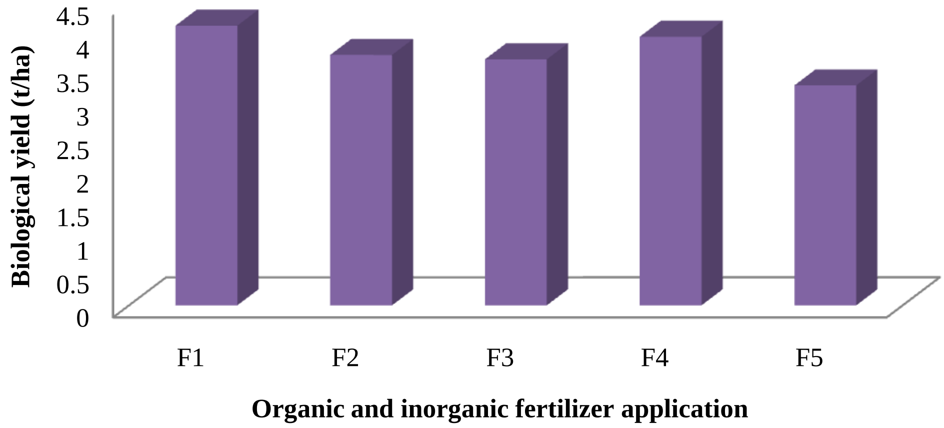


V_1= BARI mung 6 and V_2= Binamoog 8

Figure 31. Effect of varieties on biological yield (t/ha) of mungbean.

4.16.2 Effect of different organic or inorganic fertilizers application on biological yield

Different organic or inorganic fertilizer application significantly affected the biological yield (Fig. 32). The highest biological yield (4.17 t/ha) was obtained from treatment F_1 which was identical with F_4 treatment. The lowest biological yield (3.27 t/ha) was noted under the treatment F_5. ,



F_1= NPKSB (RDF)
F_2= Cowdung (10 t /ha)
F_3= Vermicompost (7t /ha)
F_4= Poultry manure (5 t /ha)
F_5= *Rhizobium sp* (80 g seed/ kg)

Figure 32. Effect of different organic or inorganic fertilizer application on biological yield (t/ha) ($LSD_{(0.05)}$= 0.4279)

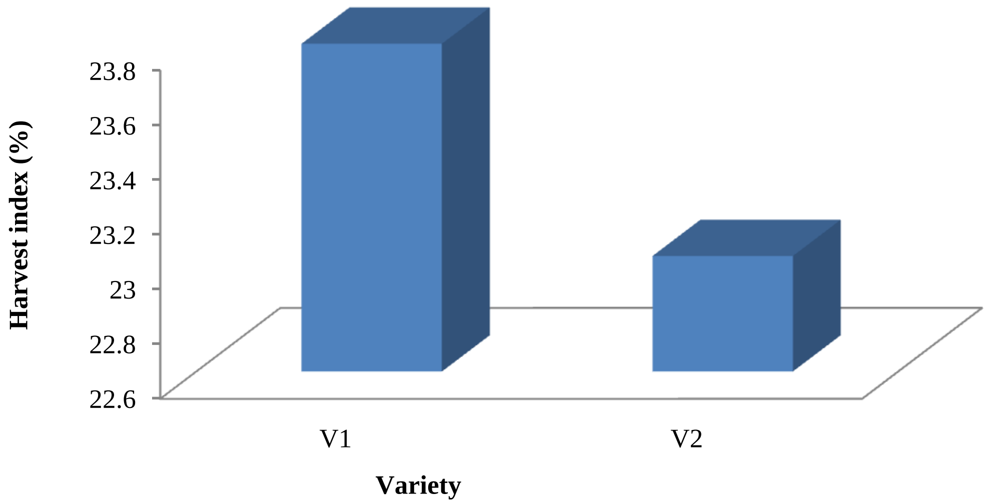
4.16.3 Combined effect of variety and different organic or inorganic fertilizer application on biological yield

The combined effect of mungbean varieties under different organic or inorganic fertilizer application showed significant variation in respect of biological yield (Table 16). The highest biological yield (4.32 t/ha) was observed under the treatment combination of V_1F_1 which was statistically identical with V_2F_4 and V_2F_1 combination. The lowest biological yield (2.85 t/ha) was observed under the treatment combination of V_2F_5.

4.17 Harvest index (%)

4.17.1 Effect of varieties on harvest index

The result exposed that the effect of varieties on harvest index was significant (Fig. 33).The higher harvest index (23.9 %) was recorded from V_1 (BARI mung 6), while the lower harvest index (23.0 %) in V_2 (Binamoog 8).

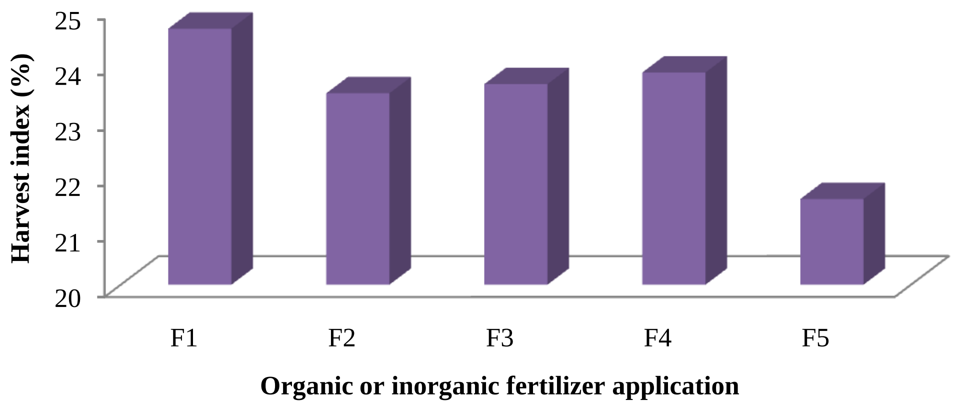


Here, V_1= BARI mung 6 and V_2= Binamoog 8

Figure 33. Effect on varities on harvest index (%) of mungbean

4.17.2 Effect of different organic or inorganic fertilizers application on harvest index

Harvest index significantly affected by different organic or inorganic fertilizer managements (Fig. 34). The highest harvest index (24.61%) was obtained from treatment F_1 which was statistically similar with treatment F_3 and F_4. Treatment F_5 showed the lowest harvest index (20.54 %).



F_1= NPKSB (RDF) F_2= Cowdung (10 t/ha)
F_3= Vermicompost (7 t/ha) F_4= Poultry manure (5 t/ha)
F_5= *Rhizobium* sp (80 g seed/ kg)

Figure 34. Effect of different organic or inorganic fertilizer application on harvest index (%) ($LSD_{(0.05)}$= 0.4279)

4.17.3 Combined effect of different organic or inorganic fertilizers application on harvest index

The combination of variety and different organic or inorganic fertilizer managements showed significant variation in respect of harvest index (Table 11). The highest harvest index (25.14%) was found in V_1F_1 interaction which was statistically similar with treatment combination of V_2F_4, V_2F_1, V_1F_3. The lowest harvest index (20.14 %) was produced in V_2F_5 combination treatment.

Table 11. Combined effect of mungbean varieties and different organic and inorganic fertilizer application on seed yield (t/ha), stover yield (t/ha), biological yield (t/ha) and harvest index (%) of mungbean.

Treatment combination	Seed yield (t/ha)	Stover yield (t/ha)	Biological yield (t/ha)	Harvest index (%)
V_1F_1	1.09 a	3.22 a	4.32 a	25.14 a
V_1F_2	0.89 b-d	2.72 de	3.74 cd	23.9 b-d
V_1F_3	0.92 bc	2.96 cd	3.89 c	23.83 a-d
V_1F_4	0.89 b-d	2.8 c	3.86 c	23.17 b-d
V_1F_5	0.87 cd	2.97 cd	3.7 cd	22.95 b-d
V_2F_1	0.97 a-c	3.04 bc	4.017 ab	24.09 a-c
V_2F_2	0.77 d	2.5 d	3.71 cd	23.0 d
V_2F_3	0.8 d	2.6 d	3.44 de	23.49 cd
V_2F_4	1.01 ab	3.12 ab	4.143 ab	24.48 ab
V_2F_5	0.57 e	2.28 e	2.85 e	20.14 e
$LSD_{(0.05)}$	**0.13**	**1.11**	**0.2051**	**2.28**
CV(%)	8.33	5.48	3.98	7.23

F_1= NPKSB (RDF)
F_2= Cowdung (10 t/ha)
F_3= Vermicompost (7t /ha)
F_4= Poultry manure (5 t/ha)
F_5=*Rhizobium sp* (80 g/kg seed)

V_1= BARI mung 6 and V_2= Binamoog 8

CHAPTER V

SUMMARY AND CONCLUSION

The field experiment was laid out at the Research Farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during April to June 2017 to investigate the performance of mungbean varieties under different organic and inorganic fertilizer managements. Location of the experiment belongs to the Agro-ecological zone (AEZ) of "The Modhupur Tract", AEZ-28 and the soil of the experimental site belongs to the general soil type, Deep Red Brown Terrace Soils under Tejgaon soil series. This field experiment consisted of two factors RCB (Factorial) design. Factor A: Variety (2); V_1 =BARI mung 6, V_2 = Binamoog 8; Factor B: Fertilizer management (5); F_1 = NPKBS (RDF), F_2 = Cowdung (10 t/ ha), F_3 = Vermicompost (7 t/ ha), F_4 = Poultry manure (5 t/ ha) and F_5 = *Rhizobium sp* (80 g/kg seed). There were 10 treatment combination and 30 unit plot. The size of each plot was 6 m^2 (3 m ×2m). All organic manures were applied before 7 days of seed sowing and N, K_2O, P_2O_5, Zn and S were applied during the final land preparation. Biofertilizer was applied by mixing with seed before seed sowing. All organic, inorganic and biofertilizers were applied according to the recommend does. Data on different growth, symbiotic and yield contributing characters with yield were recorded to find out the performance of different organic or inorganic fertilizer managements for higher yield of mungbean varieties.

Between two varieties, BARI mung 6 showed the higher plant height (55.82 cm at harvest) obtained from BARI mung 6 and the lower plant height (52.51 cm at harvest) was recorded in Binamoog 8. The highest plant height (62.24 cm at harvest) was recorded from treatment F_1 which was statistically similar with F_4 treatment and the lowest plant height (47.90 cm at harvest) was obtained from F_5treatment. Among treatment combination, the highest plant height (62.5 cm at harvest) was recorded under the treatment combination of V_1F_1 which was statistically similar with V_2F_4 and the lowest plant height (44.4 cm at harvest) was obtained from treatment V_2F_5.

BARI mung 6 gave the maximum no of leaves per plant (6.4 at harvest) and the lowest number of leaves per plant (5.7 at harvest) was given by Binamoog 8. The maximum number of leaves plant^{-1} (7.2 at harvest) was recorded under the treatment F_1 and the lowest no. of leaves plant^{-1} (5.2 at harvest) was recorded under the treatment F_5. Among different treatment combination the highest number of leaves plant^{-1}(8.0 at harvest) was recorded in treatment V_1F_1 which was statistically similar with V_2F_4 at 10, 20, 30, 40 and 50 DAS. The lowest number of leaves plant^{-1} (4.8 at harvest) was recorded in treatment V_2F_5.

BARI mung 6 gave the maximum leaf area per plant (399.07 cm^2 at harvest) and minimum result (328.64 cm^2 at harvest) was recorded for Binamoog 8. The highest leaf area per plant (428. 93 cm^2 at harvest) was recorded in F_1 treatment plot which was statistically identical with F_4 at 10 DAS; $F_{2.}$ at 20 DAS; F2, F3 and F4 at 40, 50 DAS and harvest. The lowest leaf area plant^{-1} (256.13 cm^2 at harvest) was recorded from F_5 . The maximum leaf area plant^{-1} (462.4 cm^2 at harvest) was recorded from V_1F_1 and the minimum leaf area plant^{-1} (259.0 cm^2 at harvest) was recorded from the treatment combination of V_1F_5.

BARI mung 6 gave the higher values of leaves dry weight plant^{-1} (2.03 g at harvest) while the lower leaves dry weight plant^{-1} (1.77 g at harvest) was obtained from Binamoog 8. The highest leaves dry weight plant^{-1} (2.48 g at harvest) was recorded in the treatment F_1 which was statistically similar with F_4 and the lowest leaves dry weight plant^{-1} (1.51 g at harvest) was recorded in the treatment F_5. The maximum leaves dry weight plant $^{-1}$ (2.76 g at harvest) was recorded from the V_1F_1 combination which was identical with V_2F_4 and the lowest leaves dry weight plant $^{-1}$ (1.24 g at harvest) was recorded in the treatment combination of V_2F_5.

The maximum stem dry weight per plant (2.89 g at harvest) was recorded in BARI mung 6 and the lower stem dry weight plant^{-1} (2.43 g at harvest) was recorded in Binamoog 8. The highest stem dry weight plant $^{-1}$ (3.49 g at harvest) was recorded in treatment F_1which was identical with F_4 at 30 and 40 DAS and the lowest stem weight (2.22 at harvest) was recorded in treatment F_5. The highest stem dry weight per plant (3.84 g at harvest) from the treatment V_1F_1 which was identical with treatment combination of $V_2F_4$and the lowest values of stem dry weight plant $^{-1}$ (1.75 g at harvest) was obtained from the interaction of V_2F_5.

The maximum dry matter weight plant^{-1} (8.48 g at harvest) was obtained from V_1 and the minimum dry matter weight plant $^{-1}$ (7.46 g at harvest) was obtained from V_2. The maximum dry weight plant^{-1} (9.65 g at harvest) was obtained from treatment F_1 which is statistically similar with F_4 at 20 DAS where the minimum dry matter weight plant^{-1} (6.70 g at harvest) was obtained from treatment F_2. The dry matter weight plant^{-1} (10.29 g at harvest) was obtained from V_1F_1 and the minimum dry matter weight plant^{-1} (5.50 g at harvest) was obtained from V_2F_5.

The higher nodules plant^{-1} (21.29 at harvest) was recorded in BARI mung 6 while the lower nodules plant^{-1} (16.04 at harvest) was recorded in Binamoog 8. The maximum no. of nodules (35.38 at harvest) was recorded in treatment F_1 (NPKSB). The lowest no of nodules plant^{-1} (8.44 at harvest) was recorded in F_5 . The highest nodules plant $^{-1}$ (43.77 at harvest) was recorded under the treatment V_1F_1 which was identical withV_2F_4. The lowest nodules dry weight (6.10 at harvest) was recorded under the treatment V_2F_5.

The higher nodules dry weight /plant (0.03g at harvest) was obtained from V_1 (BARI mung 6). The lower nodules dry weight plant^{-1} (0.018 g at harvest) was obtained from V_2 (Binamoog 8). The maximum nodules dry weight per plants (0.05g at harvest) was noted from treatment F_1 andthe minimum nodules dry weight per plant (0.012 g at harvest). The maximum nodules dry weight per plant (0.084 g at harvest) was recorded in V_1F_1 and the lowest result and the minimum nodules dry weight per plant (0.007 g at harvest) was recorded in the treatment combination of V_2F_5.

The maximum no. of pods plant^{-1} (12.17) obtained from V_1 (BARI mung 6) while minimum no. of pods plant^{-1} (10.58) was obtained from V_2 (Binamoog 8). The highest number pods plant^{-1} (13.6) was acquired from the treatment F_1 which was identical with F_4 treatment. The lowest number of pods plant^{-1} (9.86) was acquired from treatment F_5 which was identical with F_2. The highest number of pods plant^{-1} (14.03) was obtained from the treatment V_1F_1 which was identical with V_2F_4 and $V_2F_{1.}$ The lowest number of pod plant^{-1} (7.93) was obtained from treatment combination V_2F_5. The maximum seed yield (0.93 t/ha) was obtained from V_1 (BARI mung 6) while the minimum seed yield (0.82 t/ha) was obtained from V_2 (Binamoog 8). The highest yield (1.02 t/ha) was obtained from treatment F_1 which was statistically similar with F_4 and the lowest seed yield (0.71 t/ha) was recorded in treatment F_5. The heights grain yield of mungbean (1.09 t/ha) was recorded from the treatment combination V_1F_1 which was statistically similar with V_2F_2. The lowest grain yield of mungbean (0.57 t/ha) was obtained from the treatment combination of V_2F_5. The highest biological yield (4.32 t/ha) was observed under the treatment combination of V_1F_1 which was statistically identical with V_2F_4. combination. The lowest biological yield (2.85 t/ha) was observed under the treatment combination of V_2F_5 .The highest harvest index (23.9 %) was recorded from V_1 (BARI mung 6), while the lowest harvest index (23.0 %) in V_2 (Binamoog 8). The highest harvest index (24.61%) was obtained from treatment F_1 which was statistically similar with treatment F_3 and F_4. Treatment F_5 showed the lowest harvest index (20.54 %). The highest harvest index (25.14%) was found in V_1F_1 interaction which was statistically similar with treatment combination of V_2F_4, V_2F_1 and V_1F_3. The lowest harvest index (20.14%) was produced in V_2F_5 combination.

The results indicated that BARI mung 6 is superior to Binamoog 8 in respect of growth and yield obtained. Recommended dose of fertilizer gave maximum yield but poultry manures (5 t/ha) had statistically similar yield with recommended dose of chemical fertilizer. It may be concluded that BINA moog 8 along with poultry manure (5 t/ha) gave maximum yield (1.01 t/ha).However, this experiment could be tested in different mungbean growing area of Bangladesh to have combined treatment variety for field recommendation.

CHAPTER VI

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APPENDICES

Appendix I. Agro-Ecological Zone of Bangladesh showing the experimental location

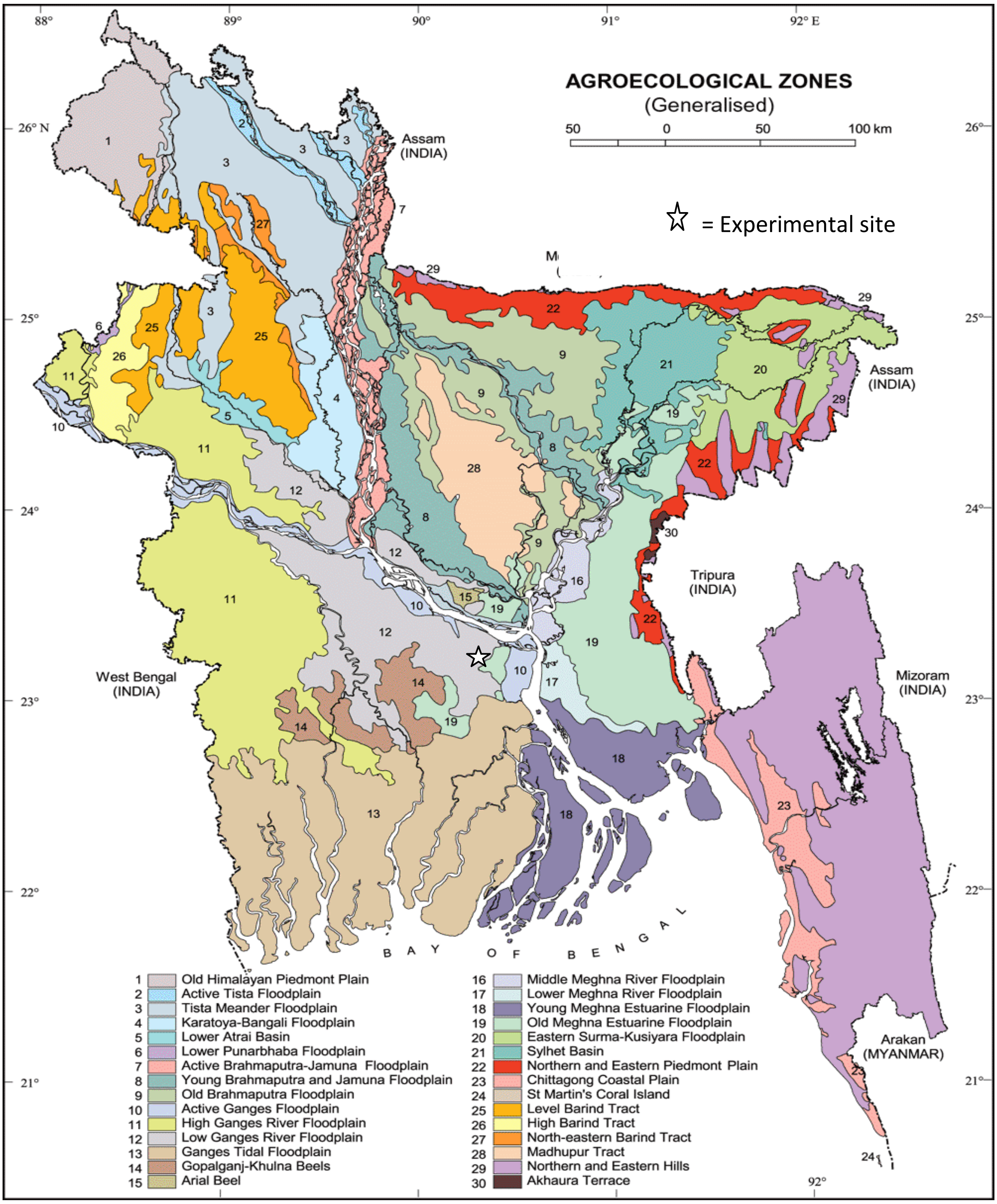

Fig. 22. Experimental site

Appendix II. Characteristics of experimental soil analyzed at Soil Resources Development Institute (SRDI), Farmgate, Dhaka.

A. Morphological characteristics of the experimental field

Morphological features	Characteristics
Location	Agronomy Farm, SAU, Dhaka
AEZ	Modhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained
Cropping pattern	Not Applicable

Source: Soil Resource Development Institute (SRDI)

B. Physical and chemical properties of the initial soil

Characteristics	Value
Partical size analysis % Sand	27
%Silt	43
% Clay	30
Textural class	Silty Clay Loam (ISSS)
Ph	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20
Exchangeable K (me/100 g soil)	0.1
Available S (ppm)	45

Source: Soil Resource Development Institute (SRDI)

Appendix III. Monthly meteorological information during the period fromMarch to June, 2017

Month and year	RH (%)	Air temperature (C)			Rainfall (mm)	Sunshine (Hours)
		Max.	*Min.*	*Mean*		
December, 2017	72.70	25.40	17.30	21.35	Trace	196.00
January, 2018	70.50	30.20	20.40	25.30	Trace	223.00
February, 2018	66.40	32.60	21.80	27.20	2.00	220.00

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

Appendix IV. Analysis of variance of data on plant height (cm) of mungbean varieties influenced by effect of different organic or inorganic fertilizer application

Source of variation	Df	Mean square of plant height (cm)at different days after sowing (DAS)					
		10	20	30	40	50	At harvest
Replication	2	4.578	0.72	84.98	47.05	3.83	34.64
Variety	1	8.36*	38.25*	197.7*	30.84^{NS}	82.36*	74.80*
Fertilizer	4	7.64*	29.92*	265.3*	250.92*	197.1*	148.6*
Variety ×Fertilizer	4	3.73*	7.64*	72.67*	146.27*	75.83*	41.57*
Error	18	0.242	0.67	12.20	12.87	6.73	6.75

*Significant at 5% level of significanc. ^{NS} Non significant

Appendix V. Analysis of variance of data on leaves plant^{-1}(No.) of mungbean varieties influenced by effect of different organic or inorganic fertilizer application

Source of variation	Df	Mean square of no. of leaves per plant at different days after sowing (DAS)					
		10	20	30	40	50	At harvest
Replication	2	0.641	1.90	0.10	0.257	0.33	0.51
Variety	1	0.225	0.190	1.54*	0.43*	1.63*	3.40*
Fertilizer	4	1.742*	1.495*	5.06*	1.048*	5.57*	3.89*
Variety ×Fertilizer	4	0.222	0.148	0.48	0.24*	1.69*	0.72*
Error	18	0.282	0.100	0.140	0.100	0.180	0.214

*Significant at 5% level of significance. ^{NS} Non significant

Appendix VI. Analysis of variance of data on leaf area plant^{-1} (cm^2) of mungbean varieties influenced by effect of different organic or inorganic fertilizer application.

Source of variation	Df	Mean square of leaf area plant^{-1} (cm^2) at different days after sowing (DAS)					
		10	20	30	40	50	At harvest
Replication	2	69.66	3662	33817.0	75375	6352	59335.
Variety	1	75.45*	1030*	69779*	61886*	3823*	37208*
Fertilizer	4	98.8*	2182*	87223*	87874*	7195*	47829*
Variety ×Fertilizer	4	52.2*	1072*	51190*	37076*	2473*	17297*
Error	18	13.47	96.26	6184.2	6568.4	4045	3847.

*Significant at 5% level of significanc ^{NS} Non significan

Appendix VII. Analysis of variance of data on leaves dry weight plant^{-1} (g) of mungbean varieties influenced by effect of different organic or inorganic fertilizer application

Source variation	Df	Mean square of leaf dry weight (g) at different days after sowing (DAS)					
		10	20	30	40	50	At harvest
Replication	2	0.00011	159.64	0.078	0.3162	0.1473	1.066
Variety	1	0.0003*	172.5^{NS}	0.291*	0.639*	0.629*	0.530*
Fertilizer	4	0.0004*	171.6^{NS}	0.683*	0.848*	2.436*	0.972*
Variety ×Fertilizer	4	0.0008*	165.6^{NS}	0.24*	0.248*	0.612*	0.418*
Error	18	0.0006	162.7	0.026	0.0251	0.1238	0.047

*Significant at 5% level of significanc ^{NS} Non significant

Appendix VIII. Analysis of variance of data on stem dry weight plant^{-1} (g) of mungbean varieties influenced by effect of different organic and inorganic fertilizer application

Source of variation	Df	Mean square of stem dry weight (g) at different days after sowing (DAS)					
		10	20	30	40	50	At harvest
Replication	2	0.723	0.004	0.018	0.047	0.205	0.208
Variety	1	0.0139^{NS}	0.042*	0.329*	0.374^{NS}	0.737*	1.542*
Fertilizer	4	0.0214^{NS}	0.521*	0.765*	0.520*	0.749*	1.754*
Variety ×Fertilizer	4	0.006^{NS}	0.023*	0.555*	0.242	0.413*	0.896*
Error	18	0.005	0.00	0.073	0.062	0.044	0.035

*Significant at 5% level of significance ^{NS} Non significant

Appendix I X. Analysis of variance of data on dry matter weight plant^{-1} (g) of mungbean varieties influenced by effect of different organic and inorganic fertilizer application

Source of variation	Df	Mean square of dry matter weight plant $^{-1}$ at different days after sowing (DAS)					
		10	20	30	40	50	At harvest
Replication	2	0.0128	0.04	0.067	0.99	0.76	0.69
Variety	1	0.025*	0.157*	1.08*	1.189*	4.55*	7.46*
Fertilizer	4	0.02*	0.223*	2.41*	2.30*	7.61*	7.9*
Variety ×Fertilizer	4	0.008*	0.139*	1.18*	1.61*	3.9*	3.9*
Error	18	0.000	0.014	0,08	0.13	0.53	0.26

*Significant at 5% level of significance ^{NS} Non significant

Appendix X. Analysis of variance of data on reproductive unite dry weight plant^{-1} (g) of mungbean varieties influenced by effect of different organic and inorganic fertilizer application

Source of variation	Df	Mean square of reproductive dry unite /plant at different days after sowing (DAS)		
		40	50	At harvest
Replication	2	0.27098	0.58885	0.32356
Variety	1	0.13315	4.3106*	2.144*
Fertilizer	4	0.11951*	2.7990*	2.192*
Variety ×Fertilizer	4	0.04697	1.5453*	1.0632*
Error	18	0.01750	0.07977	0.10542

*Significant at 5% level of significance ^{NS} Non significant

Appendix XI. Analysis of variance of data on nodules plant^{-1} (no.) of mungbean varieties influenced by effect of different organic or inorganic fertilizer application

Source of variation	df	Mean square nodules plant^{-1} (No.) at different days after sowing (DAS)		
		30	45	At harvest
Replication	2	604.64	272.517	817.279
Variety	1	850.76*	129.709*	206.509
Fertilizer	4	1384.92*	415.697*	753.768
Variety ×Fertilizer	4	469.65*	126.239*	251.859
Error	18	87.7	11.382	156.156

*Significant at 5% level of significance ^{NS} Non significant

Appendix XII. Analysis of variance of data on nodules dry weight plan^{-1} (g) of mungbean varieties influenced by effect of different organic or inorganic fertilizer application

Source of variation	df	Mean square of nodules dry weight plant^{-1} (g) at different days after sowing (DAS		
		30	45	At harvest
Replication	2	0.00000528	0.00007475	0.000185
Variety	1	0.0003189*	0.0000513*	0.000126^{NS}
Fertilizer	4	0.000393*	0.000087*	0.000210^{NS}
Variety ×Fertilizer	4	0.000226*	0.000056*	0.000118^{NS}
Error	18	0.0000315	0.0000045	0.000116

*Significant at 5% level of significanc ^{NS} Non significant

Appendix XIII. Analysis of variance of the data on pods plant^{-1}(No.), pod length (cm), seeds pod^{-1} (No.) and 1000-seed weight (g) of mungbean varieties as influenced by effect of different organic or inorganic fertilizer application

Source of variation	Df	Seeds/pod (no)	Pod length (cm)	1000-seed Weight (g)	Pods/plant
Replication	2	6.1906	0.0941	11.804	1.509
Variety	1	1.755	0.86530*	71.793*	19.043*
Fertilizer	4	7.543	01.6593*	175.643*	14.123*
Variety ×Fertilizer	4	7.81	1.05269*	115.225*	9.623*
Error	18	4.071	0.0925	3.699	0.6693

*Significant at 5% level of significanc ^{NS} Non significant

Appendix XIV. Analysis of variance of the data on seed yield, stover yield, biological yield and harvest index of mungbean varieties as influenced by effect of different organic or inorganic fertilizer application

Source of variation	Df	Seed yield /plant	Stover yield	Biological yield	Harvest index
Replication	2	0.28877	0.127	2.573	0.0124
Variety	1	0.08555*	0.0358*	0.5451*	4.516*
Fertilizer	4	0.08400*	0.03036*	0.7000*	6.729*
Variety ×Fertilizer	4	0.03258*	0.02968*	0.2723*	3.262*
Error	18	0.00538	0.0386	0.086	2.47

*Significant at 5% level of significance ^{NS} Non significant