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Effect of Bio-fertilizer on Different Varieties of Black Gram (*Vigna mungo* L)

Pushkar Choudhary[1], Gajendra Singh[1], Gunapati Lakshma Reddy[2] and Bhanwar Lal Jat[3]*

[1]Department of Agriculture, Bhagwant University, Ajmer, Rajasthan, India
[2]Department of Agriculture, Bhagwant University, Ajmer, Rajasthan, India
[3]Department of Agriculture Biotechnology, Bhagwant University, Ajmer, Rajasthan, India
**Corresponding author*

ABSTRACT

Keywords

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A field experiment entitled effect of bio fertilizers on growth and yield of black gram under the Arid zone of Rajasthan was conducted in sandy loamy soil having the medium in available nitrogen (181.21), low phosphorus (16.0) and medium potassium (257.37) with pH of 7.5 at the instructional farm Bhagwant University, Ajmer during the Rabi season of 2015-2016 with the objectives of select appropriate variety and to evaluate the effect of bio-fertilizers on growth and yield of black gram the experiment consists of 8 treatments T1 (Biofertilizer + Black-gram KU96-3), T2 (Biofertilizer +Black-gram pu30), T3 (Biofertilizer + Black gram PU35), T4 (Biofertilizer=Black-gram ITI941), T5 (Biofertilizer + Black-gram ITI956), T6 (Biofertilizer + Black-gram JU86), T7 (Biofertilizer + Black-gram NUL7) and T8 (Biofertilizer + Black-gram -PU31). The result showed that significant plant height, number of leaves, number of branches per plant, length of pod, number of seeds per pod, number of pods per plant. The highest number of pods per plant was found in T5 (980kg/ha). The lowest number of pods per plant was recorded at T1 (736Kg/ha) and significantly T5 treatment was found to be superior in all the characters and higher benefit cost ratio. It can be concluded that the cultivation is beneficial.

Introduction

Black gram (*Vigna mungo L*) is a short duration crop belongs to leguminacae family. Black gram is rich in protein (25-26%) and grown as intercrop, catch crop also as solo crop. It is also called as urd bean. In India the area under black gram cultivation is 3.30 million ha producing 1.60 million tonnes, with the mean productivity of 0.49 kg ha^{-1} and contributes 11% of total production in the country. Black gram is one of the important crops among the pulses crop. English word pulse is taken from the Latin *Puls*, meaning pouage or thick pap. The pulses are a large family and various species are capable or surviving in very different climates and soils. Pulses are cultivated in all parts of the world and they occupy an important place in human diet. Blackgram (*Vigna mungo* L.) is one of the important pulse crops grown in India. Pulses are the cheapest source of quality protein for human being. Blackgram is also grown as a cover crop as well as catch crop due to short duration. The importance of phosphorus application to black gram crop has been recognized since long (Patil and jadhav, 1994). Application of phosphorus plays an important role in growth, development and maturity of crop. Phosphorus helps to increase grain yield, seed quality, regulate the photosynthesis, govern physico- bio chemical process and also in development of roots and nodulation. Therefore application of phosphorus is must incentive coupled with increased use of phosphorus with organic manure (Vermicompost) and bio fertilizers PSB. To compensate the short supply and price hike of chemical fertilizers, use of indigenous sources like vermicompost has to be encouraged as it supplies essential plant nutrients and improves physical, chemical and biological conditions of the soil, soil microbial activities, soil structure, water holding capacity and thereby increase the fertility and productivity of soil. Vermicompost is a potential source due to the presence of available plant nutrients, growth enhancing substances like nitrogen fixing, phosphorus solubilising and cellulose decomposing organism. Vermicompost alone or in combination with fertilizer improve the N, P and K status of soil. Its application realized highest number (24.33) of nodules / plant (Rajkhowa *et al*., 2003). Many investigators reported that crop utilizes only 15- 20 % of the applied phosphorus and rest is retained in the form which is not readily available to the crop. The PSB like *Pseudomonas* and *Bacillus* also enhance the availability of phosphorus to plant by converting insoluble phosphorus from the soil into soluble form. Hence the present investigation was undertaken to study the effects of judicious use of inorganic phosphorus, organic vermicompost, and Biofertilizer PSB on yield attributes, seed yield and quality of black gram. In India, especially people who are mostly vegetarian depend largely on cereals and pulses as their staple food, which serve as the main source of dietary protein and energy. Pulses contain more protein than any other plant. They serve as a low-cost protein to meet the needs of the large section of the people. They have, therefore, been justifiably described as 'the poor man's meat'. Their low moisture content and hard test or seed-coat permits storage over long periods. In addition to providing dry pulses, many of the crops are grown for their green edible pods and un-ripe seeds. Nutritionally, immature fruits have distinctly different properties to those of the mature seed; the protein content is lower, but, they are relatively richer in some of the crops are used as pot herbs. In general, pulses contain 20 to 28% protein with the exception of soybean which has as much as 42%. Their carbohydrate content is about 60% except soybean which has about 30%. Pulses are also fairly good sources of thiamin and niacin and provide calcium, phosphorus and iron. On an average, 100 g of pulses contain 345 Kcal of energy, 24.5g of protein, 140 mg of calcium, 300mg of phosphorus, 8 mg of iron, 0.5 mg of thiamin, 0.3mg of riboflavin and 2 mg of niacin. Pulses play a vital role in Indian agriculture. Pulses are important sources of food. They are very rich in protein, particularly to the vegetarian who constitutes the bulk of population in India. Black gram is an annual food legume. It is very nutritious and is recommended for diabetics. Black gram is a grain legume widely cultivated in Pakistan, India and other Asian countries. It is part of diet for millions of people in these countries and a cheap source of protein with 17 - 34% of protein in seeds (Gour, 1993). An important feature of the mash bean plant is its ability to establish a symbiotic partnership with specific bacteria, setting up the biological N2-fixation process in root nodules by rhizobia that may supply the plant's needs for N (Mandal *et al*., 2009). The present study was carried out to investigate the effect of two *Bradyrhizobium japonicum* strains; TAL- 102 (soybean isolate) and MN-S (mungbean isolate) on growth, nodulation and yield of mash bean and role of EM in improving the efficacy of these strains in different soil amendment systems. Integrating chemical fertilizers with organic manures has been found to be quite promising not only in maintaining higher productivity but also in providing greater stability in crop production (Nambiar and Aborol, 1992). Legumes constitute an important group of crops and have mainstay in Indian agriculture, as they restore fertility and improve physicochemical properties of the soil. The nutrient management for legumes, particularly pulses should be studied on cropping system basis and quantitative estimates of carry over effects of nutrients should beworked out (Ahlawat and Ali, 1993). The concept of sustainability in agriculture with respect to maintenance of soil fertility and stabilized crop production it's the main concern in the present situation. Use of organic manures to meet nutrient requirement of crop would be an inevitable practice in the years to come for sustainable agriculture, since these manures generally improve the physical, chemical and biological properties along with conserving and improving the moisture and nutrient holding capacity of the soil and thereby resulting in enhanced crop productivity along with maintaining the quality of crop produce. Urd bean (Black gram) is one of the important pulse crops in Indian agriculture. The importance of this crop than other pulse crop is by virtue of its high nutritional value, short duration, adaptability to all season and suitability to various cropping systems. Nitrogen and phosphorus are most important plant nutrient for crop production. Nitrogen constituent of chlorophyll, harnesses solar energy and fixes atmospheric CO_2 as carbohydrates. Phosphorus play important role in root development, nodulation, flowering, fruiting and is usually a constituent of phospholipids, nucleic acid, protein, coenzyme, NAD, NADP, and ATP. (Yugandhar and Savithramma, 2013). It is prime necessity to maintain optimum plant population by maintaining inter and intra row spacing properly. Maximum or minimum plant density may minimize yield of Blackgram causing physiological change in plant. Hence appropriate Fertilizer dose with adequate plant population may increase crop yield of Blackgram. Similar results were noted by Mehmet (2008). Optimum row spacing plays an important role in contributing to the high yield because thick plant population will not get proper light for photosynthesis and can easily be attacked by diseases. Today's agriculture. About 60% of humanity eventually owes its nutritional survival to N fertilizers (Fixon and West, 2002). However, growing concern about the environmental consequences of mineral N use and its future cost perspectives emphasize the need to develop new production technologies that are sustainable both economically and ecologically (Khaliq *et al*., 2006). Organic materials hold great promise as a source of multiple nutrients and ability to improve soil characteristics (Soumare *et al*., 2003; Moller, 2009). Since the effect of organic nutrients on crop yield is long term and not immediate, thus farmers are reluctant to use organic fertilizers in their cropping system. Use of EM (effective microorganisms) along with organic materials possibly is an effective technique for stimulating release of nutrients from organic sources. The Mungbean is ranked as drought crop and successfully grown in rainfed areas. In Pakistan, the average yield during the year 2009-10 was 709 kg per hectare which is much lower than that of other countries. Today, global agriculture is at crossroads and this is the consequence of climatic change, increased population pressure and detrimental environmental impacts and new mechanism must be found to ensure food security through sustainable crop production system that will supply adequate nutrition without harming the agro ecosystem. Biofertilizers are commonly called microbial inoculants which are capable of mobilizing important nutritional elements in the soil from non-usable to usable form by the crop plants through their biological processes. For the last one-decade, Biofertilizers are used extensively as an eco-friendly approach to minimize the use of chemical fertilizers, improve soil fertility status and for enhancement of crop production by their biological activity in the rhizosphere. Extensive researches were carried out on the use of bacteria (*Azotobacter, Azospirillum, Rhizobium,* phosphobacteria) and VAM fungi as biofertilizers to supplement nitrogen and phosphorus fertilizers and observed considerable improvement in the growth of several crop plants. Dual inoculation of VAM and bacteria biofertilizers proved more effective in increasing the growth of different crop plants. In recent years, biofertilizers have emerged as a promising component of integrating nutrient supply system in agriculture. Our whole system of agriculture depends in many important ways, on microbial activities and there appears to be a tremendous potential for making use of microorganisms in increasing crop production.

Microbiological fertilizers are an important part of environment friendly sustainable agricultures practices. Biofertilizers include mainly the nitrogen fixing, phosphate solubilizing and plant growth-promoting microorganisms. Among, biofertilizers benefiting the crop production are *Azotobacter, Azospirillum*, blue green algae, *Azolla,* P-solubilizing microorganisms, mycorrhizae and sinorhizobium.

In this field, many experiments were conducted to study the effect of biofertilizers alone or in combination with other chemical fertilizers. Therefore, the present study entitled "Effect of Bio-fertilizer on different varieties of Black gram (*Vigna mungoL*)'' has been proposed with the following objectives:- (i) To study the effect of bio-fertilizer on growth characteristics of different black gram varieties. (ii) To study the effect of bio-fertilizer on Yield characteristics of different black gram varieties. (iii) To find out the economics of bio-fertilizer application on black gram.

Materials and Methods

The experiment entitled "Effect of Bio-fertilizer on different varieties of Black gram (*Vigna mungoL*)'' was carried out in the experimental Research Farm of Department of Agricultural sciences, Bhagwant University, ajmer campus, during the period of June to October, 2015.

Location:- The experimental farm is situated at 25, 45'43" N latitude and 93, 54'04 " E longitude at an elevation of 310 meters above the mean sea level.

Climate:-The experimental farm lies in humid sub tropical zones with an average rainfall ranging from 2000 to 2500 mm the maximum rain fall received during may to Oct. The mean temperature ranges from 21 to 32 during summer and rarely goes below 8 in winter due to high atmospheric humidity. The data are present on weakly interval basis from May to December in table 3.1 and illustrated in fig, 3.1

Soil condition:-The soil of the experimental field was found to be well drained and sandy loam in texture. The texture and fertility of the soil were ascertained by taking soil samples from a depth of 0 to 15 cm from different locations of the experimental plots with the help of soil auger which were processed and analysed by methods of mechanicals and chemicals analysis. The results thus obtained are present in table.

Experimental details: (i) Crop – Black gram (ii) Variety – KU 96, PU30, PU35,ITI94-1, JU 86, NUL 7, PU 31 (iii) Experimental design-Randomized Block Design (RDB) (iv) Number of replications- 3 (v) Treatment – The experiment has been planned with the following treatments:-

Control (No fertilizer)	T_1
Bio-fertilizer + Black gram (KU 96-3)	T_2
Bio-fertilizer + Black gram (PU 30)	T_3
Bio-fertilizer + Black gram (PU 35)	T_4
Bio-fertilizer + Black gram (ITI 94-1)	T_5
Bio-fertilizer + Black gram (JU 86)	T_6
Bio-fertilizer + Black gram (NUL 7)	T_7
Bio-fertilizer + Black gram (PU 31)	T_8

(vi) Number of treatment combinations – 7 (vii) Total numbers of experimented units – 10 × 3 = 21 (viii) Layout of the experimental field- (a) Plot length- 4.5 meters (b) Plot width – 2.7 meters (c) Plot size – 4.5m × 2.7m = 12.2 m^2 (d) Net area of experimental plot – 485 m^2 (ix) Spacing:- (a) Row to Row – 45cm (b) Plant to Plant – 10cm

Cultivation details:-Selection of variety: KU 96, PU30, PU35,ITI94-1, JU 86, NUL 7, PU 31-Varieties are selected to compare their growth characteristics and evaluate the superior variety among them which have good response towards bio-fertilizer.

Selection and preparation of field: Suitable plane land was selected having good fertility status. The experimental plot was ploughed one month ahead of sowing by using tractor drawn disc plough. The clods were then broken by using disc harrow and leveled properly. The stubbles and weeds were then removed manually. Then the layout of the field was done according to the plan and design of the experiment.

Manures and fertilizers application:-The manures were applied as per the requirement and well decomposed FYM also applied.

Seed treatment:-Before sowing the seeds were treated with Rhizobium culture. The seeds were soaked in slurry made from Rhizobium culture and then dried under shade just before been sown in the field.

Seed rate and sowing: The seeds were sown in furrows at a depth of 3 to 4 cm with 45 cm row to row and 10 cm plant to plant spacing. The crop was shown on 23rd June, 2015

After care: To maintain the uniform plant population, thinning and gap filling were done after 12 days of sowing. To control the weeds in the plots two hand weeding were done first after 20 days and second after 40 days of sowing. It was observed that the crop was infested by the blister beetle during the flowering stage and was controlled by the application of Endosulfon.

Harvesting and threshing: Harvesting was done 2nd Oct, 2015, after the crop has attained proper maturity. The crop was harvested at ground level by cutting with hand sickle and the harvested plant of each plot was labeled and bundled and sun dried separately, threshed and cleaned manually.

Determination of some nutrients status of soil: To determine the nutrients status of the soil, soil sample of the experimental field were analysed for ph, organic carbon, available N, P, K content.

Organic carbon: Organic carbon was determined by Walkely and Black method as outlined by Jackson (1967)

Available nitrogen: The procedure involves distillation of soil with alkaline potassium permanganate solution and determining the ammonia liberate. This serves as a a index of the available N status of the soil by Subbiah and Asijia (1956).

Plant sampling and observation

Growth parameter: For recording the vegetative character, five randomly selected plants are tagged in each plot and their growth observation was recorded at 30, 60, and 90 after sowing.

Plant height (cm): The height of the plant was measured by the linear scale from the ground level up to the tips of the plant at 30, 60, and 90 DAS. The average plant height was calculated for each treatment.

Shoot fresh weight (g/plant): The shoot fresh Wight was taken at 30, 60 and 90 DAS. The fresh weight of plants were taken the data obtained were expressed as shoot fresh weight.

Shoot dry weight: The shoot dry weight was taken at 30, 60 and 60 DAS. The plants were sundried and finally over dried at 45 c for 48 hours and weights of the plants samples were taken. The data were obtained expressed as shoot dry weight in g / plants.

Number of nodulation per plant: The numbers of nodules were counted from the tagged plants and averaged values were obtained.

Yield attributes: After proper maturity of crops, five plants were randomly, selected and averaged data was worked out

Number of pods per plants: The pods of 5 plants were counted and their average was estimated.

Number of branches per plants: The number of branches from the tagged plants was counted and average was estimated.

Number of seed per pod: From the selected samples, the number of seeds per pod were counted and average were obtained

1000 grain weight or test weight (g): From the individual plot the threshed grain samples were taken randomly for test weight 1000 seed were counted and weight to get the test weight of grains.

Seed yield (q/ha): The harvested plants from net area of each plot were threshed separately. The weights of the stover per plot were recorded separately.

Chemical analysis of plant materials: The Black gram grains and straw samples were washed with demonized water and dried in sun followed by oven dry at 70^0C and powdered and packed in polythene bags with proper labeling for chemical analysis.

Nitrogen: Nitrogen in plant and grain sample was analysed by Kjeldhal method.

Statistical analysis: The data recorded during the course of this experiment were statistically analysed by following "Randomized Block Design" as described by Panse and Sukhatme (1985). Significance or non-significance of variance due to treatment was determined by calculating respective "F" values. The standard error of differences (S.Ed ±) was calculated by using the following expression. The significance was tested by calculating the critical difference (CD) at 5% level of significance wherever, "F" test was found significant the critical difference (CD) was calculated to find out the significance or non-significance of mean differences among treatments by using the following formula

$$S.Ed.(\pm) = \sqrt{\frac{2 \times Error\ mean\ square}{Replication}}$$

CD = S.Ed. ×'t' (Fisher)

Where, t= Tabulated value of't' at 5 per cent probability level of error degree of freedom (D.F)

Results and Discussions

The experimental findings based on the observation recorded during the course of investigation at various stages has been critically examined and statistically analysed which are illustrated in this chapter. Records of various field observations as well as those of laboratory analysed are presented in this chapter with tables and diagrams, wherever necessary. The tables of analysis of variance are given in appendix section.

Growth components of black gram

Plant height: The data on plant height of Black gram was recorded at 30, 60 and at harvest are given in the table 4.7 and appendix I. At all the DAS the plant height of the crop differs significantly due to various treatments of intercropping. At 30 DAS, height plant height of black gram (18.20cm) was recorded by T_5 which was statistically at par with all the treatments. The lowest plant height at 30DAS was recorded in T_1 i.e., 16.20 cm. At 60 DAS, among various treatments of black gram T_5 recorded the highest plant height (39.50 cm) which was significantly different from the intercropping treatments. At harvest, treatment T_5 produced the highest plant height (41.60 cm) which was significantly different from the other treatments. T_1 recorded the lowest plat height (38.80cm).

Number of leaves: The number of leaves of black gram was recorded at 30 DAS, 60 DAS and at harvest stage is given in the table 4.8 and Appendix II. At all the DAS the number of leaves of the crop differs significantly due to various treatments of intercropping. At 30 DAS, among various treatments of black gram T_5 recorded the number of leaves (5.10) which was significantly different from the intercropping treatments and the lowest was recorded in T_1 (4.10). At 60 DAS, among various treatments of black gram T_5 recorded the number of leaves (9.80) which was significantly different from the intercropping treatments and the lowest was recorded in T_1 (8.30). At harvest, treatment T_5 produced the number of leaves (11.40) which was significantly different from the other treatments. T_1 recorded the lowest plat height (9.70).

Number of branches per plant: The number of branches per plant of black gram was recorded at 30 DAS, 60 DAS and at harvest stage are tabulated in Table 4.6 and appendix III. At 30 DAS T_5 recorded the highest branches per plant (2.40) which was significantly different from other and the lowest observation under this category was recorded at T_1 i.e., 1.50. At 60 DAS T_5 recorded the highest branches per plant (3.76) which was significantly different from other and the lowest observation under this category was recorded at T_1 i.e., 3.10.At harvest T_5 recorded the highest branches per plant (4.80) which was significantly different from other and the lowest observation under this category was recorded at T_1 i.e., 3.60

Yield components:

Length of the pod (cm): The data of pod length was collected at harvesting stage. It was further analysed and tabulated in Table 4.7 and appendix IV The highest length of the pod was recorded at T_5 treatment i.e., 10.60 cm which was significantly different from the rest of the treatment and the lowest pod length was recorded at T_1 treatment i.e., 8.60 cm.

Number of seed per pod: The data pertaining the number of seeds per pod is presented in Table 4.7 and appendix V which indicated that, the highest number of seeds per pod was found in T_5 (8.42). The lowest number of seeds per pod was recorded at T_1 (6.17).

Number of pods per plant: The data pertaining the number of Number of pods per plant is presented in Table 4.7 and appendix VI which indicated that, the highest Number of pods per plant was found in T_5 (28.60). The lowest number of Number of pods per plant was recorded at T_1 (25.42).

Seed yield: The data pertaining the number of Number of pods per plant is presented in Table 4.7 and appendix VII which indicated that, the highest Number of pods per plant was found in T_5 (980 kg/ha). The lowest number of Number of pods per plant was recorded at T_1 (736 kg/ha).

Economics: The details of gross and net realization of different treatments are given in Table 4.21 and their analysis of variance is provided in Appendix VII. The data are also depicted in Fig. 4.10. The cost of farm operations, and other inputs as well as selling price of gram and straw are given in Appendix VIII to X.

Gross realization: Gross realization was found significantly influenced by different treatments in Table 4.21.Treatment T_5 (Bio-fertilizer + Black gram (JU 86) secured significantly maximum gross realization of 23143 Rs ha^{-1}. Significantly the lowest gross realization (19454 Rs ha^{-1}) was recorded with treatment T_3 (Bio-fertilizer + Black gram (PU 35). However, the next best treatments were T_2 (Bio-fertilizer + Black gram (PU 30)

Net realization: Net realization was found significantly influenced by different treatments in both the years as well as in pooled results (Table 4.21) The highest net realization of 15127 Rs ha^{-1} was recorded in treatment T_5 (Bio-fertilizer + Black gram (JU 86) which was significantly higher from rest of the treatments.

In conclusion, the field experiment was conducted during June to October 2015 at Experimental research farm of Bhagawant University, Ajmer campus on "Effect of Bio-fertilizer on different varieties of Black gram (*Vigna mungo L*)'' The experiments were conducted in Randomize Block Design with three replications. All together 7 treatments were selected for the study. The response of different varieties black gram to various treatments was selected. The response of different varieties black gram to various treatments was measured with growth attributes and yield parameters.

Black gram

Plant height: (i) At 30 DAS, height plant height of black gram (18.20cm) was recorded by T_5 which was statistically at par with all the treatments. The lowest plant height at 30DAS was recorded in T_1 i.e., 16.20cm. (ii) At 60 DAS, among various treatments of black gram T_5 recorded the highest plant height (39.50 cm) which was significantly different from the intercropping treatments. (iii) At harvest, treatment T_5 produced the highest plant height (41.60 cm) which was significantly different from the other treatments. T_1 recorded the lowest plat height (38.80 cm).

Number of leaves: (i) At 30 DAS, among various treatments of black gram T_5 recorded the number of leaves (5.10) which was significantly different from the intercropping treatments and the lowest was recorded in T_1 (4.10). (ii) At 60 DAS, among various treatments of black gram T_5 recorded the number of leaves (9.80) which was significantly different from the intercropping treatments and the lowest was recorded in T_1 (8.30). (iii) At harvest, treatment T_5 produced the number of leaves (11.40) which was significantly different from the other treatments. T_1 recorded the lowest plat height (9.70).

Table.4.1 Effect of bio-fertilizer on plant height of black gram at different growth stages

Treatments Symbol	Treatment	Plant height (cm)		
		30 DAS	60 DAS	At harvest
T_1	Bio-fertilizer + Black gram (KU 96-3)	16.20	36.60	38.80
T_2	Bio-fertilizer + Black gram (PU 30)	17.80	39.10	41.00
T_3	Bio-fertilizer + Black gram (PU 35)	18.00	39.20	41.20
T_4	Bio-fertilizer + Black gram (ITI 94-1)	17.20	37.30	39.40
T_5	Bio-fertilizer + Black gram (JU 86)	18.20	39.50	41.60
T_6	Bio-fertilizer + Black gram (NUL 7)	17.60	37.45	39.60
T_7	Bio-fertilizer + Black gram (PU 31)	16.80	37.18	39.10
	S.Em.±	1.895	0.023	0.245
	$CD_{0.05}$	5.842	0.071	0.757

Fig. Effect of bio-fertilizer on plant height of black gram at different growth stages

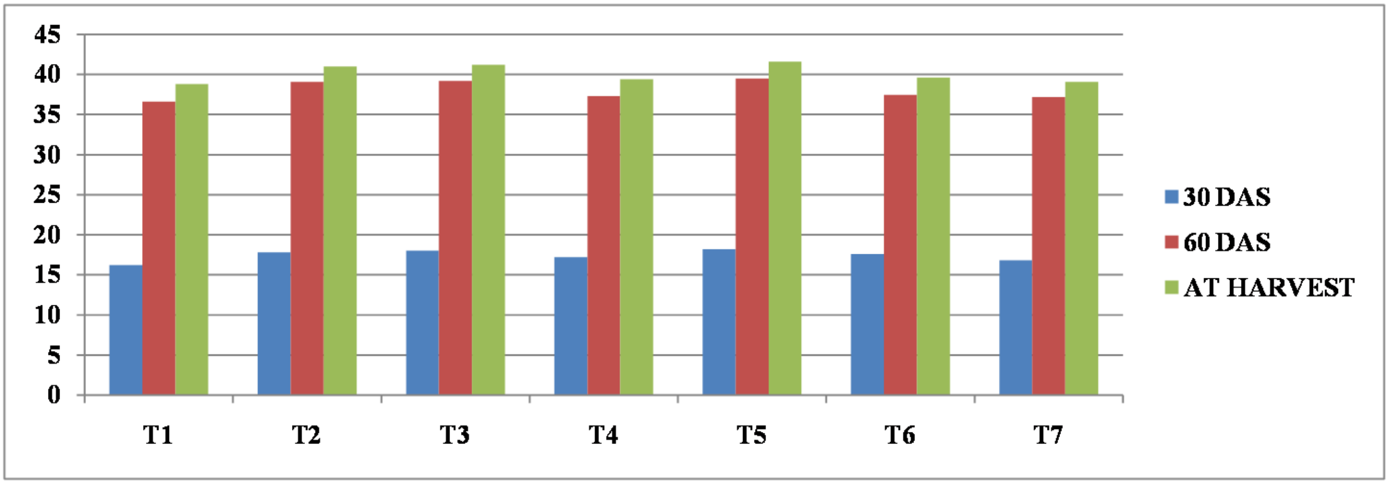


Table.4.2 Effect of Bio-fertilizer on Number of leaves of Black gram at different growth stages

Treatments Symbol	Treatment	Number of leaves		
		30 DAS	60 DAS	At harvest
T_1	Bio-fertilizer + Black gram (KU 96-3)	4.10	8.30	9.70
T_2	Bio-fertilizer + Black gram (PU 30)	4.60	9.50	10.60
T_3	Bio-fertilizer + Black gram (PU 35)	4.80	9.66	11.10
T_4	Bio-fertilizer + Black gram (ITI 94-1)	4.36	8.70	10.10
T_5	Bio-fertilizer + Black gram (JU 86)	5.10	9.80	11.40
T_6	Bio-fertilizer + Black gram (NUL 7)	4.50	9.20	10.40
T_7	Bio-fertilizer + Black gram (PU 31)	4.28	8.60	10.00
	S.Em.±	0.029	0.021	0.094
	$CD_{0.05}$	0.092	0.064	0.020

Fig. Effect of Bio-fertilizer on Number of leaves of Black gram at different growth stages

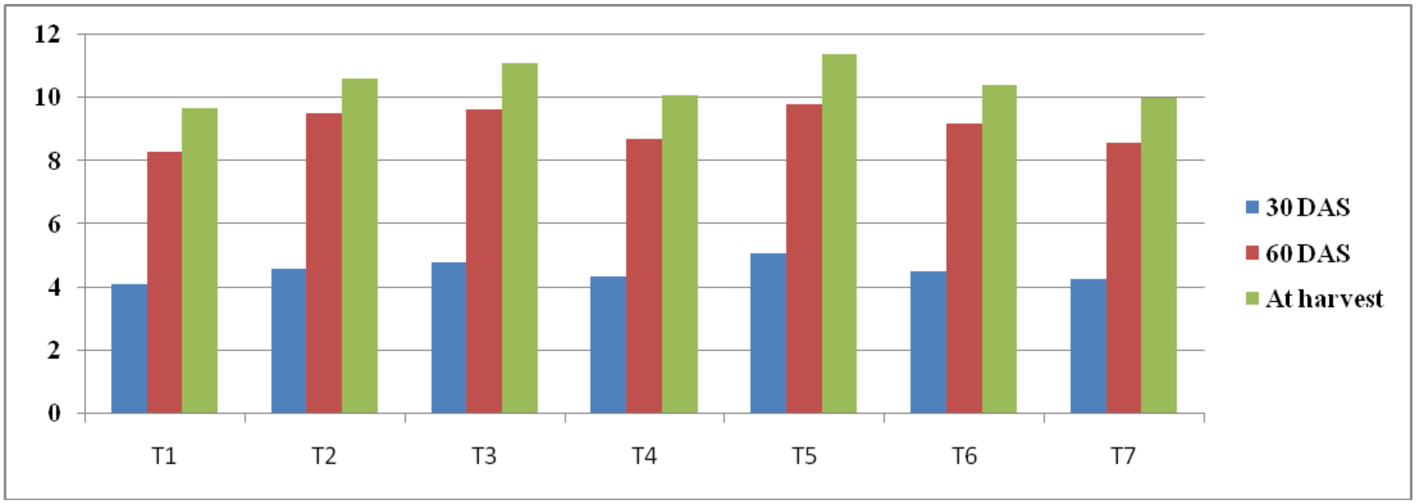


Table.4.3 Effect of Bio-fertilizer on Number of branches of Black gram at different growth stages

Treatments Symbol	Treatment	Number of branches per plant		
		30 DAS	60 DAS	At harvest
T_1	**Bio-fertilizer + Black gram (KU 96-3)**	1.50	3.10	3.60
T_2	**Bio-fertilizer + Black gram (PU 30)**	2.00	3.50	4.36
T_3	**Bio-fertilizer + Black gram (PU 35)**	2.20	3.60	4.50
T_4	**Bio-fertilizer + Black gram (ITI 94-1)**	1.80	3.30	4.10
T_5	**Bio-fertilizer + Black gram (JU 86)**	2.40	3.76	4.80
T_6	**Bio-fertilizer + Black gram (NUL 7)**	1.96	3.42	4.26
T_7	**Bio-fertilizer + Black gram (PU 31)**	1.70	3.20	3.80
	S.Em.±	0.033	0.034	0.036
	$CD_{0.05}$	0.072	0.075	0.080

Fig.-Effect of Bio-fertilizer on Number of branches of Black gram at different growth stages.

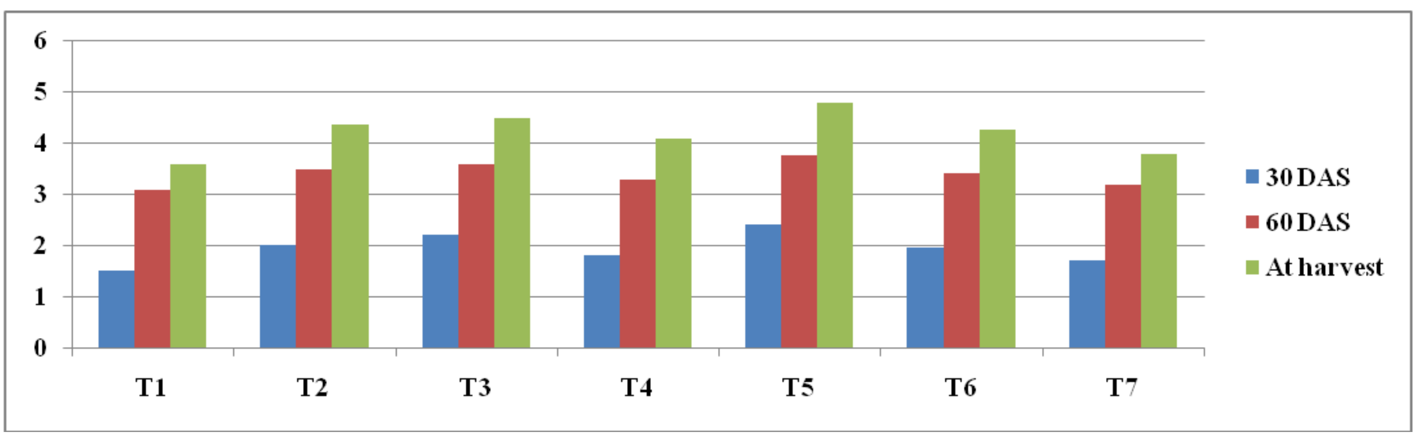


Table.4.4 Effect of Bio-fertilizer on Length of pod (cm) of Black gram

Treatments Symbol	Treatments	Length of pod (cm)
T_1	Bio-fertilizer + Black gram (KU 96-3)	8.60
T_2	Bio-fertilizer + Black gram (PU 30)	10.20
T_3	Bio-fertilizer + Black gram (PU 35)	10.46
T_4	Bio-fertilizer + Black gram (ITI 94-1)	9.50
T_5	Bio-fertilizer + Black gram (JU 86)	10.60
T_6	Bio-fertilizer + Black gram (NUL 7)	9.66
T_7	Bio-fertilizer + Black gram (PU 31)	9.20
	S.Em.±	0.079
	$CD_{0.05}$	0.173

Fig. Effect of Bio-fertilizer on Length of pod (cm) of Black gram

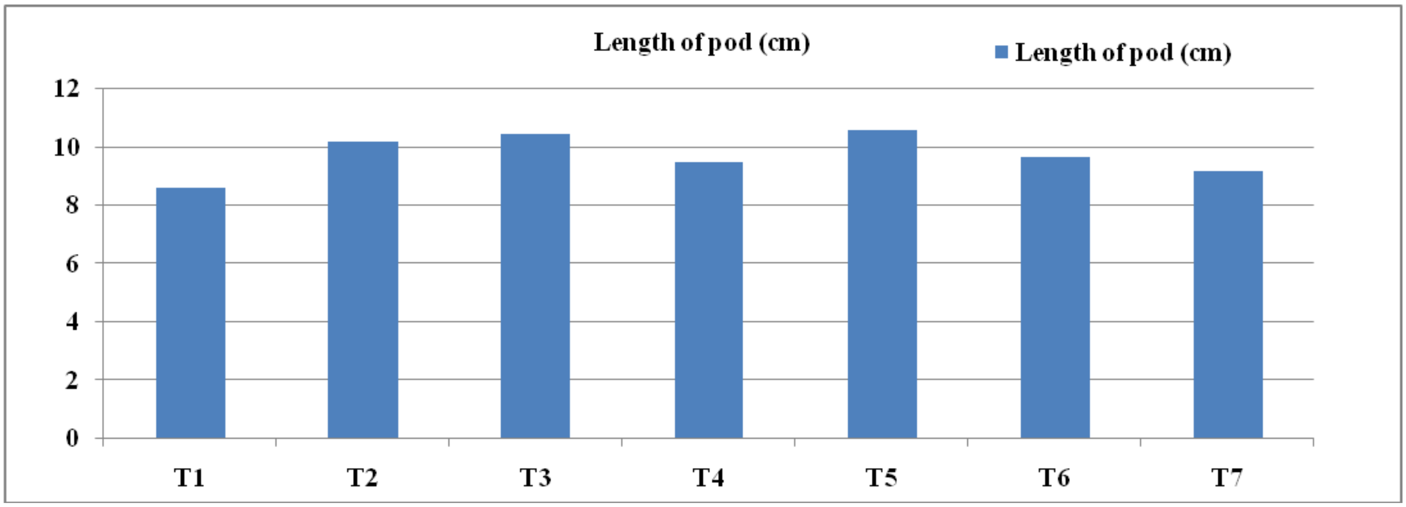


Table.4.5 Effect of Bio-fertilizer on seeds/ pod ha of Black gram

Treatments Symbol	Treatments	Seeds/ pod
T_1	Bio-fertilizer + Black gram (KU 96-3)	6.17
T_2	Bio-fertilizer + Black gram (PU 30)	8.24
T_3	Bio-fertilizer + Black gram (PU 35)	8.30
T_4	Bio-fertilizer + Black gram (ITI 94-1)	7.30
T_5	Bio-fertilizer + Black gram (JU 86)	8.42
T_6	Bio-fertilizer + Black gram (NUL 7)	7.60
T_7	Bio-fertilizer + Black gram (PU 31)	7.10
	S.Em.±	0.040
	$CD_{0.05}$	0.087

Fig.-Effect of Bio-fertilizer on seeds/ pod ha of Black gram

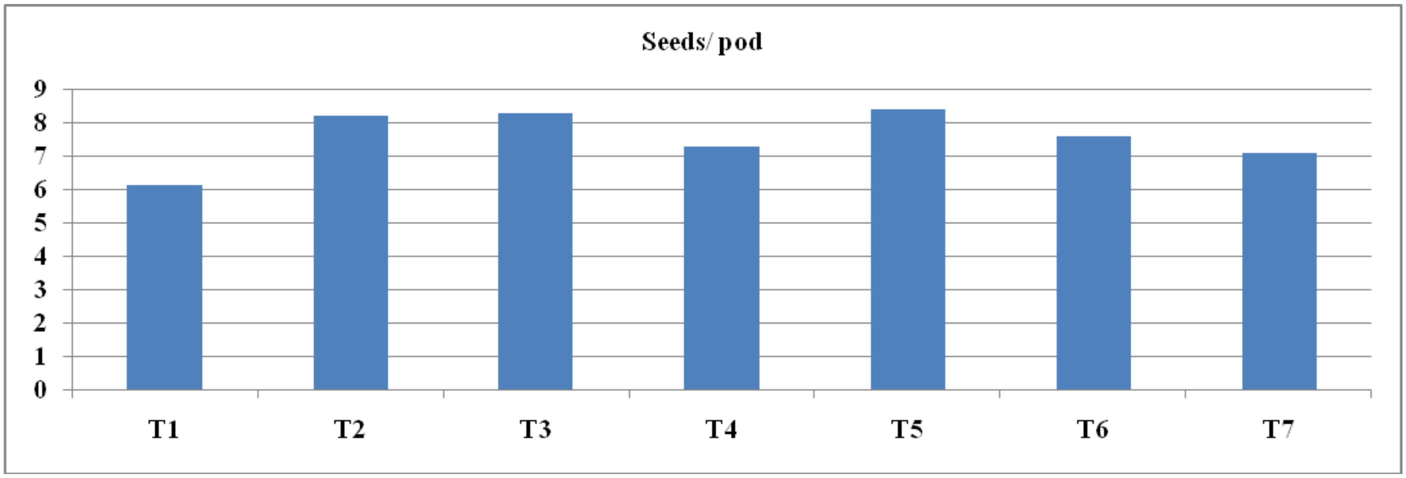


Table.4.6 Effect of Bio-fertilizer on number of pods/plant of Black gram

Treatments Symbol	Treatments	Number of pods/plant
T_1	Bio-fertilizer + Black gram (KU 96-3)	25.42
T_2	Bio-fertilizer + Black gram (PU 30)	27.40
T_3	Bio-fertilizer + Black gram (PU 35)	27.80
T_4	Bio-fertilizer + Black gram (ITI 94-1)	26.90
T_5	Bio-fertilizer + Black gram (JU 86)	28.60
T_6	Bio-fertilizer + Black gram (NUL 7)	27.20
T_7	Bio-fertilizer + Black gram (PU 31)	26.70
	S.Em.±	0.038
	$CD_{0.05}$	0.0837

Fig.-Effect of Bio-fertilizer on number of pods/plant of Black gram.

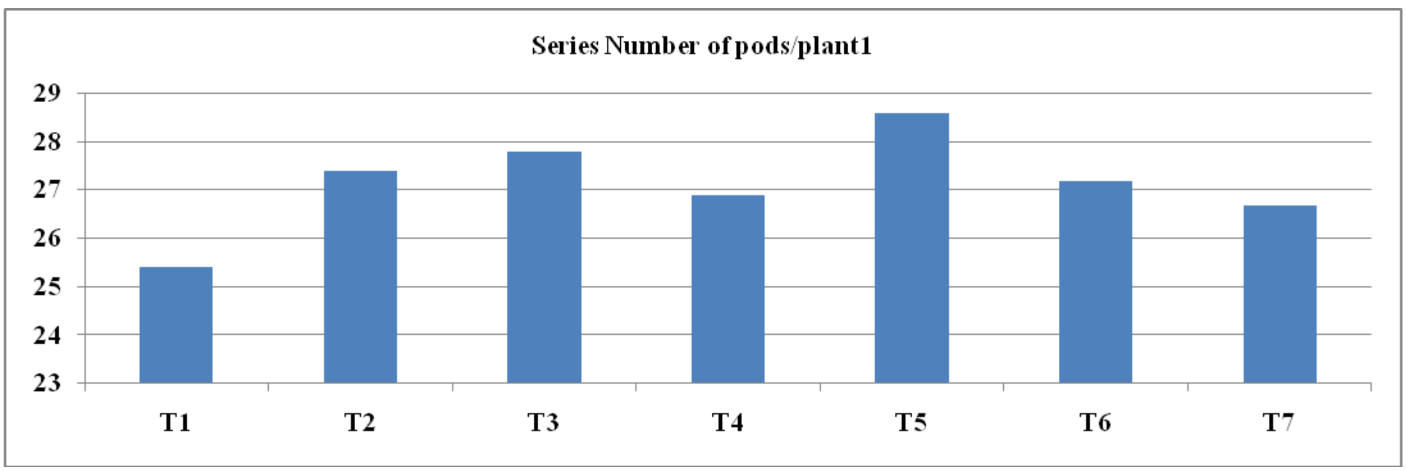
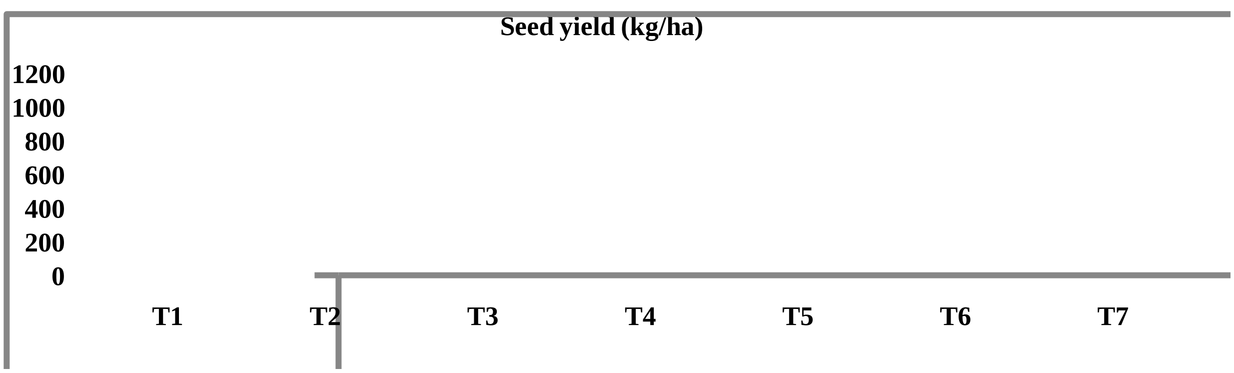


Table.4.7 Effect of Bio-fertilizer on seed yield/ha of Black gram

Treatments Symbol	Treatments	Seed yield (kg/ha)
T_1	**Bio-fertilizer + Black gram (KU 96-3)**	736.00
T_2	**Bio-fertilizer + Black gram (PU 30)**	944.00
T_3	**Bio-fertilizer + Black gram (PU 35)**	962.00
T_4	**Bio-fertilizer + Black gram (ITI 94-1)**	885.00
T_5	**Bio-fertilizer + Black gram (JU 86)**	980.00
T_6	**Bio-fertilizer + Black gram (NUL 7)**	924.00
T_7	**Bio-fertilizer + Black gram (PU 31)**	870.20
	S.Em.±	7.178
	$CD_{0.05}$	15.640

Fig.-Effect of Bio-fertilizer on seed yield/ha of Black gram.



Number of branches per plant: (i) At 60 DAS T_5 recorded the highest branches per plant (3.76) which was significantly different from other and the lowest observation under this category was recorded at T_1 i.e., 3.10. (ii) At harvest T_5 recorded the highest branches per plant (4.80) which was significantly different from other and the lowest observation was recorded at T_1 i.e., 3.60

Length of the pod (cm): The highest length of the pod was recorded at T_5 treatment i.e, 10.60cm which was significantly different from the rest of the treatment and the lowest pod length was recorded at T_1 treatment i.e., 8.60cm.

Number of seed per pod: The highest number of seeds per pod was found in T_5 (8.42). The lowest number of seeds per pod was recorded at T_1 (6.17).

Number of pods per plant: The highest Number of pods per plant was found in T_5 (28.60). The lowest number of Number of pods per plant was recorded at T_1 (25.42).

Seed yield: The highest Number of pods per plant was found in T_5 (980 kg/ha). The lowest number of Number of pods per plant was recorded at T_1 (736kg/ha).

On the basis of the results obtained from the present investigations, following conclusions may be drawn. (i) Among all the intercropping treatments T_5 treatment was found to be superior in all the characters. (ii) For getting maximum yield advantage, treatment T_5 was found to be most suitable variety among different selected varieties of Black gram. (iii) Total grain yield per unit area was greatly influenced by the various treatments and hence competition was less significant in terms of total yield. (iv) As the findings are based on the one year experiments, further research is required on the same field.

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