

Original Research Article

Effect of spacing and biofertilizer on growth and yield of Greengram (*Vigna radiata*)

ABSTRACT

The present investigation entitled “Effect of spacing and biofertilizer on growth and yield of greengram (*Vigna radiata*)”, was conducted during *Kharif* season of 2022 at the Crop Research Farm of the Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj. The experiment with nine treatments and three replications was laid down in factorial randomized block design. The results showed that pre-harvest observations like plant height (42.04 cm), dry weight (6.79 g), number of branches (6.18) of plant were higher in T3 i.e. Application of Rhizobium and PSB along with the spacing of 30x10 cm. Number of nodules per plant (6.62) was higher in treatment 2 i.e. Application of PSB along with the spacing of 30x10 cm and the value of the treatment. Post-harvest data indicated that number of pods/plant (23.74), number of seeds/pod (7.72), test weight (41.30 g), seed yield (1.69 t/ha), biological yield (5.61 t/ha), stover yield (3.83 t/ha) and harvest index (33.37%) were higher in treatment 3 i.e. Application of Rhizobium and PSB along with the spacing of 30x10 cm. The maximum cost of production and gross return was recorded higher under treatment 3 i.e. Application of Rhizobium and PSB along with the spacing of 30x10 cm is INR. 36500/ha and INR. 88500/ha, respectively. The net return (INR. 12500/ha) and B:C Ratio (2:4) was recorded higher under treatment 3 i.e. Application of Rhizobium and PSB along with the spacing of 30x10 cm.

Key words:- Spacing, biofertilizers, growth, yield, economics, greengram

INTRODUCTION

Green gram generally called as moong bean and it belongs to the family *leguminaceae*. In India, it is one of the most important pulse crop. It alone accounts for 65% of its world acreage and 54% of production and it is grown on about 3.50 mha in our country mainly in the state of Rajasthan, Maharashtra, Andhra Pradesh, Karnataka, Orissa and Bihar. (CITE). From 1964-65 it has continuously increased its area, production and productivity from 0.50 mt to 1.81 mt. In India, it is mainly utilized in making *dal* and also for curries, soup, sweets and snacks. The sprouts are rich in thiamine, niacin and ascorbic acid, thus moongbean sprouts are increasingly becoming popular in certain vegetarian diets (Anonymous, 2016). Mungbean contributes 14% in total pulse area and 7% in total pulse production

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Comment [AC2]: The abstract presented is only limited to presenting part of the methodology and results. It does not present the research problem or justification. There is no obvious objective of the study. The results are presented in a very descriptive and disorganized way. At the end of this item, the impact at a biological, agronomic and economic level of the results found must be presented.

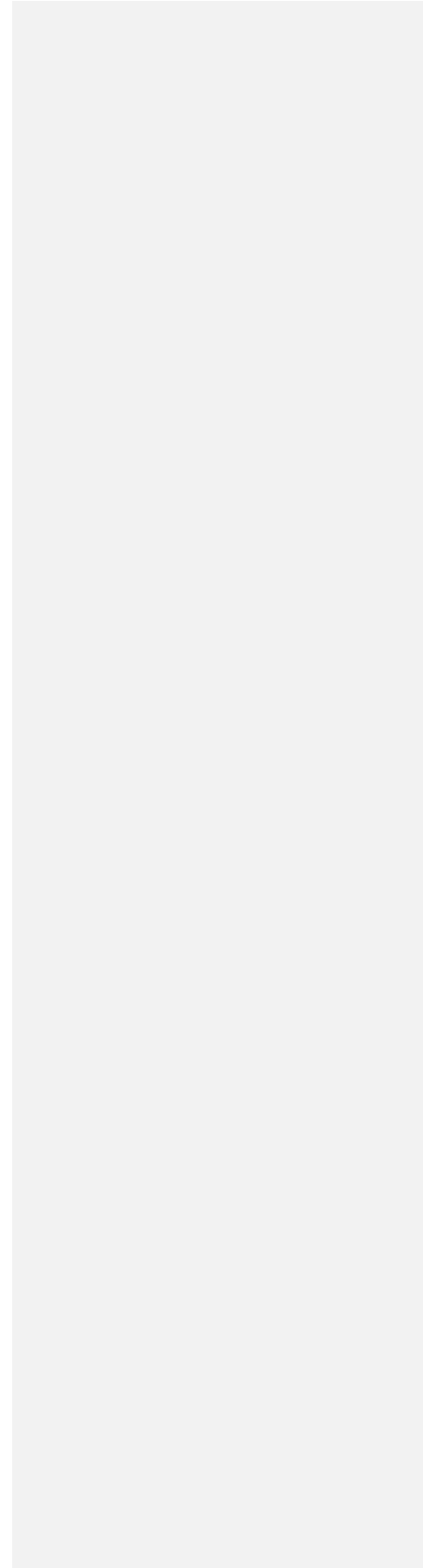
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in India. The low productivity of mung bean may be due to nutritional deficiency in soil and

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imbalanced external fertilization (Awomi *et al.*, 2012). Pulses play a very important role not only for humans but also for animal feed and their dried straw is used as hay. In pulses, mungbean is a vital crop (Khattak *et al.*, 2004). This warm season legume is native of India and is still grown on a large acreage due to all regions it is called as goldengram in international publications. There are many constraints like appropriate varieties and inter-row spacing are the most important, which contribute yield and yield attributes of mungbean (Ismail and Hall, 2000, Khan *et al.*, 2001). Green gram crop has compensatory behavior in respect of biofertilizer to economic yield. Biofertilizers are apparently environment friendly, low cost, non-bulky agricultural inputs which could play a significant role in plant nutrition as a supplementary and complementary factor to mineral nutrition. *Rhizobium* population in the soil depends on the presence of legume crops in the field. In absence of legumes, the population decreases. Artificial seed inoculation is often needed to restore the population of effective strain of the *Rhizobium* near the rhizosphere to hasten N-fixation. [CITE](#)

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The strain of *Bradyrhizobium japonicum* species is specific to legume crop (Dorle *et al.*, 2015). Biofertilizers being essential components of organic farming play a vital role in maintaining long term soil fertility and sustainability by fixing atmospheric di-nitrogen, (N = N) mobilizing fixed macro and micro nutrients or convert insoluble P in the soil into forms available to plants, thereby increase their efficiency and availability. Under *Rhizobium* inoculation, plants synthesize more photosynthesis and enhances the protein content in grain and nodulation in plants. Increase nodulation in legumes, helps in promoting free-living nitrogen fixing bacteria. The use of phosphate solubilizing bacteria (PSB) as inoculants simultaneously increases uptake by the plant and crop yield. Strains from the genera *Pseudomonas*, *Bacillus* and *Rhizobium* are among the most powerful phosphate solubilizers. Biofertilizers are the preparations which contain living cells of efficient strains of various microorganisms that enhance uptake of nutrients by their interaction in the rhizosphere when applied through soil or seed treatment. There are various types of Biofertilizers like *Rhizobium*, *Azospirillum*, *Azotobacter*, Blue green algae and *Azolla*. Biofertilizers add nutrients in soil through the natural processes of nitrogen fixation, solubilizing phosphorus, and stimulating plant growth through the synthesis of growth promoting substances. Biofertilizers play an important role in the plant growth as well as they bring down the cost of chemical fertilizers.

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MATERIALS AND METHODS

The present investigation was conducted during the *Kharif season* 2022, at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj (U.P.) to study the effect of **Effect of spacing and biofertilizer on growth and yield of greengram (*Vigna radiata*)** which is located at 25° 39' 42" N latitude, 81° 67' 56" E longitude and 98 m altitude above the mean sea level (MSL). This area is situated on the right side of the Yamuna River by the side of Prayagraj-Rewa road about 12 km from the city. The soil of the experimental field constituting a part of central Gangetic alluvial is neutral and deep. Pre-sowing soil samples were taken from 5 different places with a depth of 15 cm with the help of a auger. The composite samples were used for the chemical and mechanical analysis.

Comment [AC5]: The introduction presents a lot of information without bibliographic references and those they do have are very old. This item should be better organized starting with the generalities of the species, economic, nutritional, human health importance, etc. Subsequently, the research problem that justifies carrying out this study must be described. The background studies of the research must be organized according to its international, national and regional context and demonstrate its articulation with this study. Finish the introduction with the general objective of the research and its impact at a biological, agronomic and economic level.

The soil was sandy loam in texture, low inorganic carbon and medium in available nitrogen, phosphorus and low in potassium. The experiment was laid out with randomized block design consisting 9 treatments

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combination which are as follows: T₁: Rhizobium+75% RDF+ 25x10cm, T₂:PSB + 75%RDF+ 25 x 10cm, T₃: (Rhizobium + PSB) + 100% RDF+25 x 10cm, T₄:Rhizobium + 75%RDF+30x10cm, T₅:PSB+75%RDF+30x10cm, T₆: (Rhizobium+PSB) +100%RDF+30x10cm, T₇:Rhizobium+75%RDF+40x10cm, T₈:PSB+75%RDF+40 x10cm and T₉: (Rhizobium+PSB)+100%RDF+40x10cm, each replicated thrice. Treatments were randomly arranged in each replication, divided into ~~twenty seven~~ twenty-seven plots. A net plot size of 3m x 3m = 9m² was kept. Sowing date was on 23-07-2022 by hand. The observations on growth, yield and yield attributes and economics viz., viz., Plant height (cm), Plant dry weight (g/plant), Branches/plant (No.), Nodules/plant (No.), Pods/plant (No.), Seeds/pod (No.), Test weight (g), Seedyield (kg/ha), Stover yield (t/ha), Biological yield (t/ha), Harvest index (%), Cost of cultivation (INR/ha), Gross return (INR/ha), Net return (INR/ha) and Benefit:cost ratio (B:C). The data recorded for different characteristics were subjected to statistical analysis by adopting the method of analysis of variance (ANOVA) as described by **Gomez and Gomez (1984)**.

Comment [AC6]: Include these treatments in a table.

RESULTS AND DISCUSSION

The response of spacing and biofertilizer on growth attributes of *kharif* green gram. Data pertaining to growth parameters at harvest 60 DAS of green gram there was a significant influence on plant height (cm), dry weight (g), number of branches per plant, and number of nodules per plant at 60 DAS as seen in table 1. At 60 DAS, there was a significant difference between the treatments and higher plant height (42.04 cm) was recorded along with the application of Rhizobium and PSB along with the spacing of 25x10cm. However, treatment Rhizobium and PSB along with the spacing of 25x10cm (42.04 cm) was recorded statistically at par with the treatment of Rhizobium along with spacing of 40x10cm. At 60 DAS, there was a significant difference between the treatments and higher dry weight (6.69 g) was recorded with the application of Rhizobium and PSB along with the spacing of 25x10cm. However, treatment Rhizobium and PSB along with the spacing of 25x10cm (6.69 g) was recorded statistically at par with the treatment of PSB along with the spacing of 30x10cm. Dry weight was significantly more with treatment of recommended dose of fertilizer (25: 50N:P₂O₅ kg/ha) in the findings of **Singh et al. (2016)**. At 60 DAS, there was a significant difference found between the treatments and higher number of branches per plant (5.42) was recorded with the application of Rhizobium and PSB along with the spacing of 25x10cm. However, treatment Rhizobium and PSB along with the spacing of 25x10cm (5.42) was recorded statistically at par with the treatment of PSB along with the spacing of 25x10cm.

Comment [AC7]: The results should be written in a more scientific way. Organize the methodology by subtitles. Location: present the agronomical characteristics of the site in which the work was developed. Plant material: Describe the main morphological characteristics of the variety or varieties used, justify their selection. Experimental design: Here clearly describe the design used, the experimental units, the repetitions, the treatments, including a detailed description of how the variables were measured and at what phenological stage. Include statistical analyses and software used.

The number of branches is a genetically controlled factor so it differed significantly among three factors under study. The inter-row spacing affected the branches, which might be due to better availability of light, moisture nutrients, etc. in case of varying spacing. These results are in agreement with those of **Kokani et al. (2015)** who stated significant differences for this character among inter row spacing. At 60 DAS, there was a significant difference between the treatments and higher number of nodules per plant (6.62) was recorded with the application of Rhizobium and PSB along with the spacing of 30x10cm. However, treatment Rhizobium and PSB along with the spacing of 30x10cm (6.62) was recorded statistically at par

with the treatment of PSB along with the spacing of 40x10cm. The yield and yield attributes recorded at harvest is presented in Table 2. The data show that there was a

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significant effect of different treatments on the pods/plant (no.), seeds/pod (no.), test weight (g), seed yield (kg/ha), stover yield (t/ha), biological yield (t/ha) and harvest index (%) of green gram. At

harvest, there was significant difference between the treatments and higher number of pods/plant (23.74) was recorded with Rhizobium and PSB along with the spacing of 25x10cm. However, treatment Rhizobium and PSB along with the spacing of 25x10cm (23.74) was recorded statistically at par with the treatment of Rhizobium along with the spacing 30x10cm. At harvest, there was significant difference between the treatments and higher number of seeds/pods (7.72) was recorded in treatment of Rhizobium and PSB along with the spacing of 25x10cm. However, treatment Rhizobium and PSB along with the spacing of 25x10cm (7.72) was recorded statistically at par with the treatment of PSB along with the spacing of 25x10cm. Maximum number of seeds/pod (7.80) was found to be maximum in treatment combination with 30x10 cm along with 40kg/ha of phosphorus as compared to rest of the treatments which is beneficial for Green gram production in the findings of **Rashmitha et al. (2021)**.

At harvest, there was significant difference between the treatments and highest test weight (41.30g) was recorded with the treatment of Rhizobium and PSB along with the spacing of 25x10cm. However, treatment Rhizobium and PSB along with the spacing of 25x10cm (41.30g) was recorded statistically at par with the treatment of PSB along with the spacing 30x10cm. Test weight was higher in application of 60 kg P and 45 kg/ha S in green gram in the findings of **Neeraj et al. (2015)**. At harvest, there was significant difference between the treatments and higher number of grain yield (1.69 t/ha) was recorded

in treatment of Rhizobium and PSB along with the spacing of 25x10cm. However, treatment Rhizobium and PSB along with the spacing of 25x10cm (1.69t/ha) was recorded statistically at par with the treatment of PSB along with the spacing of 25x10cm. Application of 60kg/ha P₂O₅ recorded grain yield (8q/ha) and phosphorus (0.365%), sulphur (0.253%) and protein content of grain (22.64%) as compared to lower levels. Application of Sulphur @ 40kg/ha recorded grain yield (7.92t/ha) and phosphorus (0.295%), sulphur (0.281%) and protein content (21.79%). Inoculation of green gram seeds with phosphorus solubilizing bacteria recorded slightly higher grain yield (7.49 t/ha) as compared to no inoculation (7.39 t/ha) were reported by **Mir et al. (2013)**. Combined application of P and S had significant effects to stover yield of black gram. The optimum stover yield (39.20 g/pod) were recorded with combined application of 60 mg/kg soil and 30 mg/kg soil, respectively which was statistically at par with combined application of 80 mg/kg soil and 40 mg/kg soil were reported by **Tamang et al. (2017)**.

The data on biological yield was recorded highest (5.61 t/ha) with Rhizobium and PSB along with the spacing of 25x10cm which found a significant difference between the treatments. However, treatment Rhizobium and PSB along with the spacing of 25x10cm was recorded statistically at par with the treatment of Rhizobium along with the spacing 40x10cm. There was a significant difference between the treatments and data on stover yield (3.83q/ha) was recorded higher with PSB along with the spacing of 25x10cm and Rhizobium and PSB along with the spacing of 25x10cm. However, treatment PSB along with the spacing of 25x10cm and Rhizobium and PSB along with the spacing of 25x10cm (3.83q/ha) was

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recorded statistically at par with the treatment PSB along with the spacing of 30x10cm. There was significant difference between the treatments and the higher harvest index (33.37%) was recorded with Rhizobium and PSB along with the spacing of 25x10cm. However, treatment Rhizobium and PSB along with the spacing of 25x10cm (33.37%) was recorded statistically at par with the treatment Rhizobium along with the spacing 25x10cm. Observations on economics of treatments viz., total cost of cultivation, gross return, net return, and benefit cost ratio was calculated and has been presented in Table 3. The maximum cost of production i.e. INR. 36500/ha was recorded under treatment of Rhizobium and PSB along with the spacing of 25x10cm whereas minimum INR. 34100/ha was recorded in control with Rhizobium along with the spacing of 30x10cm. The maximum gross return i.e. INR.125000/ha was found in treatment of Rhizobium and PSB along with the spacing of 25x10cm and lowest i.e. INR.104390/ha was found in treatment of Rhizobium along with the spacing of 25x10cm. The maximum net return i.e. INR.88500/ha was recorded under treatment Rhizobium and PSB along with the spacing of 25x10cm whereas minimum i.e. INR.70955/ha recorded in Rhizobium along with the spacing of 30x10cm. Higher B:C Ratio i.e. 2:4 was recorded treatment of Rhizobium and PSB along with the spacing of 25x10cm meanwhile minimum B:C Ratio i.e. 2:1 recorded in control of Rhizobium along with the spacing of 30x10cm.

CONCLUSION

It is concluded that for obtaining highest growth and yield and yield attributes in Greengram during *khariif* season, application of treatment 3 i.e. Application of Rhizobium and PSB along with the spacing of 25x10cm recorded Plantheight(cm), Number of branches per plant, Dry weight(g) per plant, Number of nodules/plant, Test weight(gm), Seed yield (t/ha), Stover yield (kg/ha), Biological yield (kg/ha) and Harvest index (%). It has also recorded the maximum gross return, net return and benefit cost ratio.

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Comment [AC8]: The discussion of these results in the biological, agronomic and economic sense is not presented. The comparative studies are minimal and those presented are very old and it is not shown how they relate to the results found in this study. The authors are suggested to consult more recent articles that support the findings found in this study, and truly show their impact.

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Table 1: Effect of spacing and biofertilizer on growth parameters of Greengram

S.No.	Treatments	Growth Parameters			
		Plant height (cm) at 60 DAS	Dry weight (g) at 60 DAS	Number of Branches at 60 DAS	Nodules per plant at 60 DAS
1	Rhizobium+75% RDF+ 25 x 10cm	37.88	6.65	4.78	5.52
2	PSB+75% RDF+25 x 10cm	40.27	6.30	5.30	6.09
3	(Rhizobium+ PSB) +100% RDF+25 x 10cm	42.04	6.79	5.42	5.36
4	Rhizobium+ 75% RDF+30 x 10 cm	38.88	6.32	4.74	5.24
5	PSB+75% RDF+30x10cm	41.51	6.69	4.76	5.31
6	(Rhizobium+PSB)+100% RDF+30x10cm	39.63	5.47	4.98	6.62
7	Rhizobium+ 75% RDF+40x 10cm	41.90	6.18	5.07	5.71
8	PSB+75% RDF+40 x 10cm	40.14	6.17	5.01	6.40
9	(Rhizobium+PSB) +100% RDF+40x10cm	40.86	6.31	5.03	6.00
	Ftest	S	S	S	S
	S.Ed(±)	1.05	0.26	0.23	0.45
	CD(P=0.05)	0.52	0.13	0.12	0.22

Comment [AC10]: Improve the presentation of the tables and statistics used.

Table 2: Effect of spacing and biofertilizer on yield and yield attributes of Greengram

S.No.	Treatments	Yield and yield attributes						
		Number of Pods/plant	Number of seeds/pods	Test weight (g)	Seed yield (t/ha)	Biological yield (t/ha)	Stover yield (t/ha)	Harvest index (%)
1	Rhizobium+75% RDF+ 25 x 10cm	18.10	6.71	36.04	1.51	4.68	3.18	32.00
2	PSB+75% RDF+25 x 10cm	19.10	7.51	34.15	1.54	5.37	3.83	28.69
3	(Rhizobium+ PSB) +100% RDF+25 x 10cm	23.74	7.72	41.30	1.69	5.61	3.83	33.37
4	Rhizobium+ 75% RDF+30 x 10 cm	23.62	6.65	35.53	1.27	4.77	3.5	26.67
5	PSB+75% RDF+30x10cm	23.11	6.29	40.09	1.39	4.99	3.81	27.82
6	(Rhizobium+PSB)+100% RDF+30x10cm	22.31	5.48	32.56	1.29	4.8	3.52	26.76
7	Rhizobium+ 75% RDF+40x 10cm	23.54	6.48	30.31	1.41	5.51	4.09	25.75
8	PSB+75% RDF+40 x 10cm	18.43	7.15	36.35	1.42	4.73	3.31	29.94
9	(Rhizobium+PSB) +100% RDF+40x10cm	20.85	5.52	39.17	1.14	4.98	3.54	28.91
	Ftest	S	S	S	S	S	S	S
	S.Ed(±)	0.23	0.42	0.79	0.31	0.21	0.31	2.63
	CD(P=0.05)	0.12	0.21	0.40	0.16	0.11	0.15	1.41

Comment [AC11]: Take into account the previous observations.

Table3:EffectofdifferentlevelsofspacingandbiofertilizeronGreenGram

S.No.	Treatments	Total Cost of Cultivation (INR/ha)	Net Return (INR/ha)	Gross Return (INR/ha)	Benefit Cost Ratio
1	Rhizobium+75%RDF+ 25 x10cm	34130	79725	113855	2.3
2	PSB+75%RDF+25 x 10cm	34130	76780	110910	2.2
3	(Rhizobium+ PSB) +100%RDF+25x10cm	36500	88500	125000	2.4
4	Rhizobium+ 75%RDF+30 x10 cm	34100	70955	105055	2.1
5	PSB+75%RDF+30x10cm	34130	78445	112575	2.3
6	(Rhizobium+PSB)+100%RDF+30x10cm	34130	75055	109190	2.2
7	Rhizobium+ 75%RDF+40x 10cm	34160	78395	112555	2.3
8	PSB+75%RDF+40 x 10cm	35600	76385	111985	2.1
9	(Rhizobium+PSB)+100%RDF+40x10cm	34160	76455	110615	2.2

Comment [AC12]: Take into account the previous observations.