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 the *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 andthree replications was laid down in factorial randomized block design. The results showedthat pre harvest observations like plant height (42.04cm), 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 treatment2 i.e. Application of PSB along with the spacing of 30x10 cm and the value of the treatment. Post-harvest data indicated that the number of pods/plant (23.74), number ofseeds/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. Applicationof 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 spacingof 30x10 cm.

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

INTRODUCTION

Green gram generally called as mung 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 its production and it is grown on about 3.50 mha in our country mainly in the states of Rajasthan, Maharashtra, Andhra Pradesh, Karnataka, Orissa and Bihar. From 1964-65 it has continuously increased its area, production and productivity from

0.50 mt to1.81mt. 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 moong bean sprouts are increasingly becoming popular in certain vegetarian diets **(Anonymous, 2016).** In India, the mung bean accounts for 7% of all production of pulses and 14% of all cultivated pulse area. Mung bean yield issues could be brought on by poor soil nutrient levels and 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, mung bean is a vital crop **(Khattak *et al*., 2004).** This warm season legume is a native of India and is still grown on a large acreage due to all regions.It is called golden gram 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 mung bean **(Ismail and Hall, 2000,Khan *et al*., 2001**). Greengram crop exhibits compensatory behavior in terms of biofertilizer to economic yield. Biofertilizers appear to be environmentally friendly, low-cost, non-bulky agricultural inputs that could play an important part in plant nutrition as a supplementary and complimentary element to mineral nutrition. The presence of legume crops in the field influences the population of Rhizobium in the soil. In the lack of legumes, the population declines. Artificial seed inoculation is frequently required to restore the population of efficient Rhizobium strains near the rhizosphere and accelerate N-fixation. Bradyrhizobium japonicum species is restricted to legume crops (Dorle et al., 2015). Biofertilizers, which are essential components of organic farming, play an important role in long-term soil fertility and sustainability by fixing atmospheric di-nitrogen, (N = N) mobilizing fixed macro and micronutrients or converting insoluble P in the soil into forms available to plants, thereby increasing their efficiency and availability. Under *Rhizobium* inoculation, plants synthesize more photosynthesis and enhance the protein content in grain and nodulation in plants. Increased nodulation in legumes promotes the growth of free-living nitrogen-fixing bacteria. The use of phosphate solubilizing bacteria (PSB) as inoculants boosts both plant absorption and crop production. Strains from the genera *Pseudomonas*, *Bacillus* and *Rhizobium* are among the most powerful phosphate solubilizers. Biofertilizers are preparations that contain living cells of efficient strains of various microorganisms that enhance the 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 supply nutrients to soil through natural processes such as nitrogen fixation, phosphorus solubilization, and plant growth stimulation via the manufacture of growth-promoting chemicals. Biofertilizers enhance plant growth and reduce the expense of chemical fertilizers.

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^{o} 39' 42''N latitude, 81^{o} 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 an auger. The chemical and mechanical analyses were performed on the composite samples. The soil had a sandy loam texture, was low in organic carbon, medium in available nitrogen, phosphorous, and potassium, and was low in potassium [Paul and Dawson, 2022]. The experiment was laid out with randomized block design consisting of 9 treatment combination which are as follows: $T_{1:}$ Rhizobium+75% RDF+ 25x10cm, $T_{2:}$PSB + 75% RDF+ 25 x 10cm, $T_{3:}$ (Rhizobium + PSB) + 100% RDF+25 x 10cm, $T_{4:}$Rhizobium + 75% RDF +30 x10 cm, $T_{5:}$PSB + 75%RDF+ 30 x10 cm, $T_{6:}$ (Rhizobium + PSB) +100%RDF+30 x10 cm, $T_{7:}$Rhizobium + 75% RDF+ 40 x 10cm, $T_{8:}$PSB +75% RDF+ 40 x 10cm and $T_{9:}$(Rhizobium+ PSB)+100%RDF+40x10cm, each replicated thrice. Treatments were randomly arranged in each replication, divided into twenty seven plots. A net plot size of 3 m x 3 m=9m^2 was kept. The 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), Seed yield (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).**

RESULTS AND DISCUSSION

The response of spacing and biofertilizer on growth attributes of *kharif* green gram. Data pertaining growth parameters at harvest 60 DAS of greengram 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 significant difference between the treatments and higher plant height (42.04cm) 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 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:P_2O_5 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. Since the number of branches is a genetically determined factor, it varied significantly among the three factors studied. The inter-row spacing had an effect on the branches, which could be owing to increased availability of light, moisture, nutrients, and so on with variable spacing. These findings are consistent with those of Kokani et al. (2015), who found significant changes in this feature over interrow spacing. At 60 DAS, there was significant difference between the treatments and higher number nodules per plant (6.62) was recorded with the applications 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 shows that there was a 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 greengram. 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. The maximum number of seeds/pod (7.80) was found to be maximum in treatment combination with 30×10 cm along with 40 kg/ha of phosphorus as compared to the rest of the treatments which is beneficial for Greengram production in the findings of **Rashmitha *et al*. (2021).** At harvest, there was significant difference between the treatments and higher 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 greengram in the findings of **Neeraj *e t a l* . (2015).** At harvest, there was significant difference between the treatments and higher number of grain yield (1.69 t/ha) was recorded in the treatment of Rhizobium and PSB along with the spacing of 25x10cm. However,the treatment Rhizobium and PSB along with the spacing of 25x10cm (1.69 t/ha) was recorded statistically at par with the treatment of PSB along with the spacing of 25x10cm. Application of 60kg/ha P_2O_5 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 @ 40 kg/ha recorded grain yield (7.92 t/ha) and phosphorus (0.295%), sulphur (0.281%) and protein content (21.79%). Inoculation of greengram 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 on stover yield of black gram. The optimum stover yield (39.20 g/pod) was 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 as 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, the treatment PSB along with the spacing of 25x10cm and Rhizobium and PSB along with the spacing of 25x10cm (3.83q/ha) were recorded statistically at par with the treatment PSB along with the spacing of 30x10cm. There was a 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 ie. INR.125000/ha was found in treatment of Rhizobium and PSB along with the spacing of 25x10cm and lowest ie. INR.104390/ha was found in treatment of Rhizobium along with the spacing of 25x10cm. The maximum net return ie. INR.88500/ha was recorded under treatment Rhizobium and PSB along with the spacing of 25x10cm whereas minimum ie. INR.70955/ha recorded in Rhizobium along with the spacing of 30x10cm. Higher B:C Ratio ie. 2:4 was recorded treatment of Rhizobium and PSB along with the spacing of 25x10cm meanwhile minimum B:C Ratio ie. 2:1 recorded in control of Rhizobium along with the spacing of 30x10cm.

CONCLUSION

It is concluded that for obtaining the highest growth and yield attributes in Greengram during *kharif* season, application of treatment 3 ie. Application of Rhizobium and PSB along with the spacing of 25x10 cm recorded Plant height (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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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 x10 cm	38.88	6.32	4.74	5.24
5	PSB + 75%RDF+ 30 x10 cm	41.51	6.69	4.76	5.31
6	(Rhizobium + PSB) +100%RDF+30 x10 cm	39.63	5.47	4.98	6.62
7	Rhizobium + 75% RDF+ 40 x 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+40 x 10cm	40.86	6.31	5.03	6.00
	F test	**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**

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 x10 cm	23.62	6.65	35.53	1.27	4.77	3.5	26.67
5	PSB + 75%RDF+ 30 x10 cm	23.11	6.29	40.09	1.39	4.99	3.81	27.82
6	(Rhizobium + PSB) +100%RDF+30 x10 cm	22.31	5.48	32.56	1.29	4.8	3.52	26.76
7	Rhizobium + 75% RDF+ 40 x 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+40 x 10cm	20.85	5.52	39.17	1.14	4.98	3.54	28.91
	F test	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**

Table 3: Effect of different levels of spacing and biofertilizer on Green Gram

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 x 10cm	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+ 30 x10 cm	34130	78445	112575	2.3
6	(Rhizobium + PSB) +100%RDF+30x10 cm	34130	75055	109190	2.2
7	Rhizobium + 75% RDF+ 40 x 10cm	34160	78395	112555	2.3
8	PSB +75% RDF+ 40 x 10cm	35600	76385	111985	2.1
9	(Rhizobium + PSB) +100%RDF+40 x10cm	34160	76455	110615	2.2