 Original Research Article

EFFECT OF SPACING AND BIOFERTILIZERS ON GROWTH AND YIELD OF CHICKPEA

ABSTRACT

The field experiment titled **"Effect of spacing and biofertilizers on growth and yield of Chickpea"** was conducted during *rabi* 2022, at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of the experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 6.9), low in organic carbon (0.32%), available N (283.93 kg/ha), available P (18.3 kg/ha) and available K (223.5 kg/ha). The experiment was laid out in Randomized Block Design with ten treatments *viz.* T_1: Spacing 20cmx15cm + Uninoculated, T_2: Spacing 20cmx15cm + Rhizobium, T_3: Spacing 20cmx15cm + PSB, T_4: Spacing 30cmx10cm + Uninoculated, T_5: Spacing 30cmx10cm + Rhizobium, T_6: Spacing 30cmx10cm + PSB, T_7: Spacing 40cmx10cm + Uninoculated, T_8: Spacing 40cmx10cm + Rhizobium, T_9: Spacing 40cmx10cm + PSB and T_{10}: Control: 100% RDF each replicated thrice. The results of the experiment obtained that application of Rhizobium (20g/kg seeds) along with the Spacing 30cmx10cm significantly increased the growth parameters *viz.* plant height (46.79 cm), number of nodules (31.93/plant), plant dry weight (22.11 g/plant) and yield parameters *viz.* number of pods per plant (36.80), seed index (22.15 g), seed yield (3.44 t/ha) and stover yield (4.28 t/ha). This treatment also showed its positive effect on economics *viz*. gross returns (1,71,834 INR/ha), net returns (1,24,486 INR/ha), B:C (2.63).

Keywords: Biofertilizers, Chickpea, Economics, Growth parameters, Spacing, Yield parameters

1. INTRODUCTION

Chickpea (*Cicer arietinum* (L.)), also known as Bengal gram is the most significant rabi season pulse crop grown in India. It accounts for around 30% of total acreage and 38% of total production under pulses. Around the world, 15% of the land used for growing different pulses is dedicated to Chickpea. With almost 10 million hectares under cultivation, it is the third pulse crop, fifth legume, and fifteenth grain crop in the world. As a leguminous crop, Chickpeas have root nodules that, with the aid of N-fixing bacteria (Rhizobium sp.), fix and use atmospheric nitrogen, enhancing the soil fertility.

Biofertilizers have the potential to significantly improve crop output and soil health. In addition to preserving soil fertility, biofertilizers a low-cost renewable energy source, are essential for decreasing the use of inorganic fertilizers and boosting crop output (Govindrajan *et. al.,* 2001). When combined with chemical fertilizers and organic manures, biofertilizers increase crop productivity and optimize nutrient usage (Mahajan *et. al.,* 2003). Biofertilizers can be applied either via seed treatment or soil application. Seed treatment with biofertilizers also helps to control soil borne pathogenic infection and lowers the risk of host susceptibility to diseases. It also increased the soil available nutrients as well as uptake of nutrients by crop plants.

In order to achieve the highest crop yield, the ideal spacing for every crop entails maintaining a healthy, homogenous plant stand. Plants per unit area have a direct impact on crop growth and output. Improper plant population is one of the key causes of low yield in Chickpea. Crop yield is frequently negatively impacted by too low and excessive plant population after a certain point. In order to maximize the rate of photosynthesis, aeration and light penetration into the plant canopy proper plant spacing in the field is to be opted. Keeping all the facts into consideration the present study entitled "Effect of spacing and biofertilizers on growth and yield of Chickpea" was undertaken with the objectives such as to find out the influence of spacing and biofertilizers on growth and yield of chickpea and also to study the economics of different treatment combinations.

2. MATERIAL AND METHODS

The experiment was carried out during *rabi* 2022 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj.The soil was sandy loam in texture, medium in available nitrogen (283.93 kg/ha), available phosphorous (18.3 kg/ha) available potassium (223.5 kg/ha). The experiment was laid out in Randomized Block Design with ten treatments *viz.* T_1: Spacing 20cmx15cm + Uninoculated, T_2: Spacing 20cmx15cm + Rhizobium, T_3: Spacing 20cmx15cm + PSB, T_4: Spacing 30cmx10cm + Uninoculated, T_5: Spacing 30cmx10cm + Rhizobium, T_6: Spacing 30cmx10cm + PSB, T_7: Spacing 40cmx10cm + Uninoculated, T_8: Spacing 40cmx10cm + Rhizobium, T_9: Spacing 40cmx10cm + PSB and T_{10}: Control: 100% RDF each replicated thrice. All the agronomic practices with respect to the crop were carried out at different stages of the crop growth. The growth parameters were recorded at different intervals of crop growth and yield attributes were recorded at the time of harvest and statistically analyzed using ANOVA technique (Gomez and Gomez 1984).

3. RESULTS AND DISCUSSIONS

Effect on growth attributes

3.1 Plant height (cm)

The observations related to growth parameters were Presented in Table 1. Results revealed that significantly higher plant height (46.79 cm) was recorded with the application of Rhizobium (20g/kg seeds) along with the Spacing 30cmx10cm and the lowest plant height (39.95cm) was recorded with adoption of Spacing 20cmx15cm and when the seeds were left uninoculated.

The significantly higher plant height was might be due to plants get sufficient space under optimal spacing for light, air and nutrition for better growth and development. Results were similar to (Arun *et. al.,* 2022). Further, Rhizobium and PSB inoculated plants improved photosynthetic efficiency which might have increased the growth. Similar findings were reported by (Abisha *et. al.,* 2022). The biofertilizer inoculation improved the availability of nitrogen, phosphorus and all other major nutrients for enhanced vegetative growth which resulted in increase in plant height in Chickpea. Similar results were obtained by (Rabieyan *et. al.*, 2012).

Number of nodules per plant

During 60 DAS, Significantly maximum number of nodules per plant (31.93) was recorded with the application of Rhizobium (20g/kg seeds) along with the Spacing 30cmx10cm. However, the minimum number of nodules per plant (24.93) was observed in Control.

Rhizobium inoculation resulted in a significant and maximum number of nodules per plant, and the nitrogenase enzyme availability contributed to the rise in nodules per plant of

Chickpea. Results were similar to (Sathvik *et. al.*, 2022). The optimal row spacing also had a significant impact on nodulation due to accumulation of plant nutritions at the rooting zones. This is in accordance with the early findings of (Khan *et. al.*, 2010)

Plant dry weight (g)

The significantly highest plant dry weight (22.113 g/plant) was recorded with application of Rhizobium (20g/kg seeds) along with the Spacing 30cmx10cm. However, application of PSB (20g/kg seeds) along with the Spacing 30cmx10cm and application of Rhizobium (20g/kg seeds) along with the Spacing 40cmx10cm was found to be statistically at par.

The continuous increase in the dry matter with progressing growth phases was shown to be greater with closer spacing, which maybe because of the higher plant population and nutrients accumulating per unit area than compared to broader spacing. This is in accordance with findings of (Varshitha *et. al.*, 2022). Rhizobium and PSB inoculation enhances the availability of nutrients like N and P. Increased nutritional availability led to increase in physiological processes, which in turn improved growth characters and dry matter output. (Singh *et. al.*, 2018). The dry weight increased steadily with advancing growth stages and was found to be maximum at harvest. It was recorded to be highest with spacing 30cmx10cm, which could be due to optimum plant population and accumulation of nutrients per unit area. (Sathyamoorthi *et. al.*, 2008).

Effect on yield attributes

Number of pods per plant

The data showed that the number of pods per plant (36.80) was significantly higher with application of Rhizobium (20g/kg seeds) along with the Spacing 30cmx10cm. However, application of PSB (20g/kg seeds) along with the Spacing 20cmx15cm (36.67) and adoption of Spacing 30cmx10cm along with Uninoculated seeds (35.20) was found to be statistically at par.

Number of seeds per pod

The data revealed that application of Rhizobium (20g/kg seeds) along with the spacing 40cmx10cm recorded maximum number of seeds per pod (1.35), which was found to be significant. However, application of Rhizobium (20g/kg seeds) along with the Spacing 30cmx10cm (1.29) and application of PSB (20g/kg seeds) along with the Spacing 40cmx10cm (1.33) was found to be statistically at par.

Seed index (g)

The data showed that there was no significant difference among the treatments. However, highest seed index (22.15 g) was recorded with application of Rhizobium (20g/kg seeds) along with the Spacing 30cmx10cm and the lowest seed index (19.52) was observed in Control.

Seed inoculation with Rhizobium and PSB significantly enhanced the quantity of pods per plant and seeds per pod. This could be as a result of seed treatment with Rhizobium increasing the root nodulation through improved root development and enhanced nutrient availability. As a result, better flowering, fruiting and pod formation was observed. This is in accordance to findings of (Das *et. al.*, 2013). When sufficient amount of Nitrogen, Phosphorus and all other major nutrients provided to plants, they increase the growth attributes which as a result increases number of pods per plant, number of seeds per pod and seed index. Results are in conformity with (Yadav *et. al.*, 2021)

Effect on yield

Seed yield

The data showed that seed yield (3.44 t/ha) was significantly higher with application of Rhizobium (20g/kg seeds) along with the Spacing 30cmx10cm. However, application of PSB (20g/kg seeds) along with the Spacing 20cmx15cm + PSB (3.17 t/ha), adoption of Spacing 30cmx10cm along with Uninoculated seeds (2.95 t/ha) and application of PSB (20g/kg seeds) along with the Spacing 30cmx10cm (3.06 t/ha) was found to be statistically at par.

Stover yield

The application of Rhizobium (20g/kg seeds) along with the Spacing 30cmx10cm recorded significantly higher stover yield (4.28 t/ha). However, application of PSB (20g/kg seeds) along with the Spacing 20cmx15cm (4.05 t/ha), adoption of Spacing 30cmx10cm along with Uninoculated seeds (3.75 t/ha) and application of PSB (20g/kg seeds) along with the Spacing 30cmx10cm (4.28 t/ha) was found to be statistically at par.

The sufficient plant population with optimum spacing may have led to higher growth and development along with better utilization of production inputs, which resulted in the maximum yield. The results were similar to (Arun *et. al*., 2022).

With the use of biofertilizers for seed treatment, factors that contribute to growth and yield increased. This was primarily because there was more N and P available, which led to well developed roots with higher capacity for nitrogen fixation, which improved plant growth and development and also improved photosynthate diversion in sink. Similar results found by (Kumari *et. al*., 2022) and (Meena *et. al.*, 2006)

Harvest index

The harvest index was recorded to be non- significant. However, the highest harvest index (44.18%) was obtained with the adoption of Spacing 40cmx10cm along with Uninoculated seeds.While the lowest harvest index (41.97%) was recorded with the application of PSB (20g/kg seeds) along with the Spacing 30cmx10cm.

Economics

The maximum gross return (1,71,834), net return (1,24,486) and B:C ratio (2.63) was recorded with the application of Rhizobium (20g/kg seeds) along with the Spacing 30cmx10cm.

CONCLUSION

From the experimental research, it is concluded that the application of Rhizobium (20g/kg seeds) along with the Spacing 30cmx10cm was found to be more desirable in terms of growth and yield attributing parameters viz., seed yield and stover yield. It also fetched maximum gross return, net return and benefit-cost ratio as compared to the rest of the treatments.

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Table 1. Effect of spacing and biofertilizers on growth parameters of Chickpea.

S. No.	Treatments	Plant height (cm)	Number of nodules/plant	Plant dry weight(g/plant)
1.	Spacing 20cmx15cm + Uninoculated	39.95	25.87	13.397
2.	Spacing 20cmx15cm + Rhizobium	41.87	25.73	20.417
3.	Spacing 20cmx15cm + PSB	40.83	28.20	16.353
4.	Spacing 30cmx10cm + Uninoculated	43.76	28.67	14.660
5.	Spacing 30cmx10cm + Rhizobium	46.79	31.93	22.113
6.	Spacing 30cmx10cm + PSB	45.02	30.13	20.757
7.	Spacing 40cmx10cm + Uninoculated	41.81	27.93	13.120
8.	Spacing 40cmx10cm + Rhizobium	43.61	27.40	20.667
9.	Spacing 40cmx10cm + PSB	42.46	26.60	19.003
10.	Control (RDF- NPK: 20:60:20 kg/ha)	40.68	24.93	14.417
	SEm(±)	0.49	0.52	0.65
	CD (P=0.05)	1.46	1.55	1.94

Table 2. Effect of spacing and biofertilizers on yield attributes and yield of Chickpea.

S. No.	Treatments	Pods/plant	Seeds/pod	Seed yield (t/ha)	Stover yield (t/ha)
1.	Spacing 20cmx15cm + Uninoculated	34.80	1.13	2.71	3.46
2.	Spacing 20cmx15cm + Rhizobium	35.13	1.25	2.94	3.76
3.	Spacing 20cmx15cm + PSB	36.67	1.21	3.17	4.05
4.	Spacing 30cmx10cm + Uninoculated	35.20	1.25	2.95	3.75
5.	Spacing 30cmx10cm + Rhizobium	36.80	1.29	3.44	4.41
6.	Spacing 30cmx10cm + PSB	34.13	1.29	3.06	4.28
7.	Spacing 40cmx10cm + Uninoculated	34.20	1.22	2.22	2.80
8.	Spacing 40cmx10cm + Rhizobium	34.73	1.35	2.36	3.00
9.	Spacing 40cmx10cm + PSB	33.20	1.33	2.25	2.85
10.	Control (RDF- NPK: 20:60:20 kg/ha)	35.27	1.22	2.72	3.47
	SEm(±)	0.58	0.03	0.20	0.29
	CD (P=0.05)	1.72	0.10	0.85	0.85

Table 3. Effect of spacing and biofertilizers on economics of Chickpea

S. No.	Treatments	Cost of cultivation (INR/ha)	Gross returns (INR/ha)	Net returns (INR/ha)	B:C
1.	Spacing 20cmx15cm + Uninoculated	47,148	1,35,667	89,519	1.88
2.	Spacing 20cmx15cm + Rhizobium	47,348	1,47,000	99,652	2.10
3.	Spacing 20cmx15cm + PSB	47,328	1,58,500	1,11,172	2.35
4.	Spacing 30cmx10cm + Uninoculated	47,148	1,47,334	1,00,186	2.12
5.	Spacing 30cmx10cm + Rhizobium	47,348	1,71,834	1,24,486	2.63
6.	Spacing 30cmx10cm + PSB	47,328	1,53,167	1,05,839	2.24
7.	Spacing 40cmx10cm + Uninoculated	47,148	1,10,834	63,686	1.35
8.	Spacing 40cmx10cm + Rhizobium	47,348	1,18,000	70,652	1.49
9.	Spacing 40cmx10cm + PSB	47,328	1,12,500	65,172	1.38
10.	Control (RDF- NPK: 20:60:20 kg/ha)	47,148	1,36,000	88,852	1.88

* Data was not subjected to statistical analysis.