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EFFECT OF *RHIZOBIUM* AND PHOSPHATE SOLUBILIZING BACTERIA ON GROWTH AND YIELD OF DIFFERENT CHICKPEA (*CICER ARIETINUM* L.) CULTIVAR UNDER ORGANIC PRACTICES

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***Key word**: Chickpea (Cicer arietinum* L.), *Biofertilizer Rhizobium and PSB, Germination percentage*

Abstract– A field experiment was conducted during the rabi season of 2021-22, at instructional cum research farm of Indira Gandhi Krishi Vishwa Vidyalaya, Raipur (C.G.) to study the "Effect of *Rhizobium* and Phosphate Solubilizing Bacteria on growth and yield of different chickpea (*Cicer arietinum* L.) cultivar under organic practices." In this experiment total eleven cultivar was used and all the cultivar chickpea were treated with liquid biofertilizer *Rhizobium* and PSB with three replications in the randomized block design. In this experiment result was found that the best variety response in biofertilizer application. Among all the treatment varieties T9 Vijay and T11 JG-14, in this trial these are the two varieties which performed very well at different stage of the crop growth. T9 (Vijay) it performed best in various characters like germination percentage at 91.91%, 50% flowering at 51 days, root length (20:40:20 kg/ha NPK+*Rhizobium* and PSB) recorded a significant maximum root length of 15.97 cm, grain yield (1423.76 Kg/ha), and straw yield (1730.32 kg/ha) and plant height 45.20 cm, number of nodules (57.33), performance in characters like no. of pods per plant, 54.29 pods.

INTRODUCTION

Chickpea (*Cicer arietinum* L.) was first domesticated in the Middle East and belongs to the Fabaceae family. In India, Australia, Pakistan, Turkey, Myanmar, and Ethiopia, it is widely grown. The most important and popular winter season pulse crop in India is Bengal gramme (*Cicer arietinum* L.), also known as "gramme" or "chickpea." Chickpea (*Cicer arietinum* L.) is one of India's most important grain legume crops, accounting for about 29.7% of the country's total pulse production and 41.6% of total pulse production. It is the world's third most widely grown grain legume, tolerant of a wide range of climates. Chickpeas are a potentially valuable crop because their seed protein content, which can reach up to 30%, is higher than that of most other grain legumes. Chickpeas are grown in the drier parts of the country because they grow best there. Madhya Pradesh (21.87 percent), Maharashtra (22.89 percent), Andhra Pradesh (4.92 percent), and Rajasthan are the states that produce chickpeas in India (23.44 percent). Karnataka (7.26 percent), Uttar Pradesh (7.50 percent), Gujarat (5.62 percent), and Chhattisgarh (ninth) are the states with the highest percentages. In 2019-20, Chhattisgarh's chickpea area, production, and productivity were 3.35 lakh hectares, 3.32 lakh tonnes, and 990 kg per hectare, respectively (C.G. Govt., 2021). It was grown on 101.71 ha in India in 2019–20, yielding a total of 113.51 lakh tonnes and an average productivity of 1116 kg per hectare (Sharma *et al*., 2020).

Biofertilizers have emerged as a promising part of agriculture's integrated nutrient supply system. Our entire agricultural system is dependent on microbial activities in many ways, and there appears to be a huge potential for using microorganisms to boost crop production. Environmentally friendly microbiological fertilizers nitrogen-fixing, phosphate-solubilizing, and plant growth-promoting microorganisms are the most common biofertilizers. Biofertilizers have increase crop yield by 15-20% and enrich soil with nitrogen through biological nitrogen fixation. Phosphate solubilizing

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bacteria (PSB) (*Pseudomonas striata*) and *Rhizobium* sp. (*Bradyrhizobium japonicum*) are two examples. *Rhizobium* is the most common and oldest biofertilizer. In leguminous crops, *Rhizobium* has the ability to fix atmospheric nitrogen.with the help of the nitrogenase enzyme in nodules in the roots of legumes. The amount of nitrogen fixed by *Rhizobium* is directly proportional to the number and size of nodules. Rhizobia species are required for various crops. In leguminous crops, *Rhizobium* can fix 50200 gm (50.20 kg) of nitrogen per hectare. chickpea has been grown in India for so long, a population of nature rhizobia has grown in our soils, and the variable response to chickpea inoculation in terms of forming only 5 to 10% nodules on chickpea grown in soils with a high population to nodulation, dry matter production, and grain yield could possibly be described as a strong competition between inoculated strains and native chickpea rhizobia in our soil. PSB (phosphate solubilizing bacteria) secrete organic and inorganic acids that convert insoluble phosphates into soluble forms that plants can use. Chickpeas require more phosphorus than other legumes due to their high energy requirements for protein synthesis and N_2-fixation.

MATERIALS AND METHODS

A field experiment was conducted during the *rabi* season of 2021-22 to study the "Effect of *Rhizobium* and Phosphate Solubilizing Bacteria on growth and Yield of different Chickpea (*Cicer arietinum* L.) Cultivar under organic practices." at Instructional cum research farm College of Agriculture IGKV Raipur (C.G.). All the cultivar of chickpea variety was treated with liquid biofertilizer inoculants *Rhizobium* and PSB in the chickpea crop variety-Vaibhav, JG-226, Jaki, RG2009-01, RG2009-16, RG2003-28, Vishal, JG-16, Vijay, Daftari, JG-14. A total of 10 treatments with 3 replicates were taken for field experiments. Randomly block design (RBD) was planned to evaluate the performance of all chickpea cultivars. Other details are given in Table 1.

All the recommended cultural practices and plant protection measures were followed throughout the experimental periods. The height of plant, number of branches effective nodules, dry matter, test weight, pod per plant, yield and yield contributing characters were recorded from all plots at pertinent stages of chickpea cultivar were statistically analyzed using (ANOVA) for randomized block design RBD.

Table 1. Details of Experimental plan and Treatments

Layout Design	Randomized Block Design (RBD)
Treatment	11
Replication	03
Total no of plot	33
Production condition	Irrigated Timely sown
Sowing method	Line sowing
Plot size	Gross: 9.3 m×3 m = 27.9m^2
Total plot area	613.8 sqm
Date of Sowing	11/12/2021
Date of harvesting	01/04/2022

RESULTS AND DISCUSSION

Result of the experiments revealed that seed treatment with *Rhizobium* and PSB significantly increased the growth characters germination percentage, plant height, day to 50% flowering, and days to maturity in different cultivars of chickpea.

During investigation, the combination of *Rhizobium* + PSB with N-20, P-40, and K-20 gave a maximum percent germination 91.91%, the variety of T9 Vijay, gave maximum plant height at 60 and 90 DAS, 35.13 cm and 45.20 cm, the variety of T9 Vijay, Within variety better performance was given by Vijay, which has given better in Number of nodules per plant (57.33), Fresh weight of nodules in g per plant (1.38), Dry weight of nodules in g per plant (0.26), grain yield (1423.76 kg/ha) and straw yield (1730.32 kg/ha), respectively. Similarly, JG-14 has also shown its better performance in plant height (cm in 43.07 90 DAS), number of grain per pod (50.58) and grain yield (1396.88 kg/ha), respectively. and 94.33 days for day of maturity in the variety of T9 Vijay. The best performance variety T9 Vijay and T11 JG-14 was observed in treated plot *Rhizobium* + PSB with N-20 P-40 and K-20 kg/ha. This finding was supported by Joshi *et al*. (2021), Roy *et al.* (2015), Kaushik Mohanta and Shikha Singh (2021) and Yadav *et al.* (2017).

The number of pods increases significantly. is shown in Table 4. The highest number of pods was recorded in treatment T9 (Vijay) (54.29 pods per plant) followed by T11 (JG-14) (50.58 pods per plant) and the minimum was recorded in inoculated treatment T10 (Daftari) (42.32 pods per plant). The effect of seed inoculation on number of pods was found significantly. The significant number of pods (54.29 pods per plant) was counted with T9 (Vijay) Rhizobium + PSB, followed by T11 (JG-14) (50.58) and T8 (JG-16) (49.64) pod per plant respectively

over T10 Daftari (42.32) pod per plant. Kumar *et al.* (2014), Yadav *et al. (*2015) and Yadav *et al.* (2021).

The maximum test weight (24.03 g) was recorded with the variety of T3 (Jaki) and the minimum test weight (18.17g) was recorded under T6 (RG2003-28). in the case of all chickpea cultivar along with Rhizobium and PSB compare were at par only T3 was showed significant variation (Yadav *et al.* (2021), Kumar *et al.* (2014).

The highest grain yield was recorded in T9 (Vijay)(1423.76 kg/ha) The lowest grain yield was 1003.58 kg/ha associated with T_{10} (Daftari). Among the seed treated with *Rhizobium* and PSB recorded the maximum grain yield (1423.76 kg ha^{-1}), which was significantly higher over T1 (Vaibhav), T5 (RG2009-16) and T6(RG2003-28) respectively rest of the treatments. This was also supported by Hari sankar *et al.* (2020) and Katiyar *et al.* (2020).

Straw yield varied from 1268.05 to 1730.32 kg ha^{-1} under different chickpea cultivars. The maximum straw yield (1730.32 kg ha^{-1}) was the observed in the variety of T9 (Vijay) followed by The treatment T5 (RG2009-16) 1423.34 kg ha^{-1} and T8 (JG-16) 1663.16 kg ha^{-1} straw yield significantly higher over T10 (Daftari) 1268.05 kg ha^{-1} and rest of the treatment at par with T10 (Daftari) cultivar of chickpea. This was also supported by Katiyar *et al*. (2020).

CONCLUSION

Performance of liquid biofertilizer (Rhizobium and PSB) applied seed treatment was recorded in T9

Table 2. Effect of *Rhizobium* and PSB inoculation on germination percentage, plant height (cm), number of branches and Day to 50% flowering at different stages in chickpea.

Treatment	Variety	Germination percentage (%)	Plant height (in cm)				Days to 50% flowering
			30 DAS	45 DAS	60 DAS	90 DAS	
T1	VAIBHAV	87.87	14.33	23.73	34.13	42	53.33
T2	JG-226	86.86	13.07	21.93	32.87	39.8	56.33
T3	JAKI	86.85	13.93	22.4	33.33	42.2	54.67
T4	RG2009-01	88.88	14.47	23.8	34.4	40.53	52.33
T5	RG2009-16	85.85	13.87	22.33	33.2	40.27	55.33
T6	RG2003-28	86.86	14.27	23.47	33.67	40.67	54.33
T7	VISHAL	87.87	14.07	23.07	33.2	44.73	53.67
T8	JG-16	89.89	14.47	24.33	34.4	42.4	52
T9	VIJAY	91.91	16.67	25.2	35.13	45.2	51.33
T10	DAFTARI	85.52	12.93	20.2	31.87	35.87	56.67
T11	JG-14	90.9	15.13	24.73	34.87	43.07	51.67
SEm±	1.35		0.62	0.53	0.9	1.08	
CD at 5%	3.98	NS	1.83	1.57	2.65	3.18	

Table 3. Effects of bio-fertilizer on number and weight of nodule of chickpea cultivar.

Treatment	Variety	Number of nodules per plant			Fresh weight of nodules per plant (g)			Dry weight of nodules per plant (g)		
		30 DAS	45 DAS	60 DAS	30 DAS	45DAS	60DAS	30 DAS	45DAS	60DAS
T1	VAIBHAV	16.4	42	53.33	0.25	0.81	1.25	0.05	0.18	0.21
T2	JG-226	15	37	43	0.21	0.6	0.78	0.03	0.13	0.18
T3	JAKI	15.93	38	49.33	0.21	0.65	0.88	0.04	0.13	0.19
T4	RG2009-01	17.47	44	54.33	0.26	0.83	1.27	0.06	0.21	0.22
T5	RG2009-16	15.5	37.67	46.67	0.21	0.6	0.86	0.04	0.13	0.18
T6	RG2003-28	16.4	39.67	52.33	0.22	0.78	0.94	0.05	0.17	0.2
T7	VISHAL	16.4	38.33	50.33	0.23	0.66	0.92	0.04	0.14	0.19
T8	JG-16	17.53	45.67	55.33	0.26	0.87	1.29	0.08	0.22	0.23
T9	VIJAY	17.73	52	57.33	0.36	1.03	1.38	0.11	0.23	0.26
T10	DAFTARI	14.87	36	41.33	0.2	0.54	0.62	0.03	0.12	0.17
T11	JG-14	17.6	50	56.33	0.31	0.94	1.3	0.09	0.22	0.24
SEm±		1.12	1.34		0.02	0.03		0.004	0.005	
CD at 5%	NS	3.31	3.97	NS	0.06	0.08	NS	0.01	0.01	

Table 4. Effect of *Rhizobium* and PSB inoculation on Day to maturity, number of pod, Test weight (g), seed yield and straw yield kg/ha at different stages in chickpea.

Treatment	Variety	Days to Maturity	No. of pods per plant	100 Seed Weight (g)	Seed Yield (Kg/ha)	Straw Yield (Kg/ha)
T1	VAIBHAV	96.67	45.78	19.2	1195.93	1512.32
T2	JG-226	99.33	42.84	20.2	1052.86	1303.1
T3	JAKI	98.33	44.39	24.03	1152.92	1430.88
T4	RG2009-01	96	48.43	20.43	1310.74	1506.08
T5	RG2009-16	98.67	44.14	18.97	1132.01	1423.34
T6	RG2003-28	98	45.22	18.17	1166.36	1577.71
T7	VISHAL	97	44.54	21.53	1161.88	1476.82
T8	JG-16	95	49.64	18.27	1363.01	1663.16
T9	VIJAY	94.33	54.29	18.77	1423.76	1730.32
T10	DAFTARI	99.67	42.32	19.23	1003.58	1268.05
T11	JG-14	94.67	50.58	20.5	1396.88	1679.29
SEm±	0.95	2.22	0.71	53.04	94.51	
CD at 5%	2.8	6.54	2.1	156.48	278.82	

Vijay, germination percentage, plant height, number of branches, number of nodule, fresh and dry weight of nodule, 50% flowering, day to maturity, grain yield, and straw yield. Then, in T9 Vijay more attributing characters variety was recorded, which performed well in number of pod per plant, grain yield, and straw yield. Rhizobium + PSB was found most effective for growth and development of chickpea compared to other seed inoculations. Finally concluded that the treatment T9 (Vijay) and T11(JG-14) was better performance in the field trail as compared to cultivar of chickpea as well as all over chickpea cultivar.

These results are preliminary and will require more testing to provide more consistent results, to confirm the result at farmer field. Different methods and doses of liquid biofertilizer are needed to confirm the results. Prominent *Rhizobium* and PSB strains can be used as biofertilizers being compared to this biofertilizer.

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