International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2016): 79.57 | Impact Factor (2015): 6.391

Effect of Inoculant and Phosphorus on Growth and Yield of Chickpea *(Cicerarietinum*L*)*

Pratibha Sharma[1], Girish Pandey[2], Dheeraj Mishra[3]

[1]Research Scholar, School of Agriculture ITM University Gwalior

[2]Department of Soil Science, School of Agriculture ITM University Gwalior

[3]Department of Extension Education, School of Agriculture ITM University Gwalior

Abstract: ***Chickpea is an important and rich source of legume protein which is commonly used among vegetarian diets. Present study was carried out during the year 2014-15 to elucidate the effect of inoculant and phosphorus on growth, yield and of chickpea variety. Results revealed that inoculation with Rhizobium and P_5 (75 kg P_2O_5 ha^{-1}) was found significantly best for growth characters i.e. plant height, number of branches $plant^{-1}$, canopy of plant, number of nodules and yieldcharacters i.e. Number of pods $plant^{-1}$, pod length, pod yield $plot^{-1}$, pod yield $hectare^{-1}$and test weight. Maximum grain yield $plot^{-1}$ and grain yield ha^{-1} was recorded in seed inoculated with Rhizobium.This increase in yield occurred due to an increase in growth and development of chickpea crop with inoculation and phosphorus application.***

Keywords: Chickpea, inoculation, phosphorus, growth, yield.

1. Introduction

Chickpea (*Cicerarietinum*L.) is one of the most important pulse crop and belongs to the family Leguminaceae. Because of high protein content, it is considered as an economical source of quality vegetable protein in human diet. It is grown especially in dry and rain-fed areas of the Indian subcontinents. There are two types of Chickpea, the large seeded more or less rounded, pale cream color are the Kabuli types which constitutes 15% of production and smaller seeded of irregular shapes with various color are deshi types.

India ranks first in the world in respect to the area of cultivation of chickpea. It is cultivated in about 8.22 million ha (m ha) with an average annual production of 7.70 million tones (mt) and productivity was 925 kg ha^{-1} (Anonymous, 2013). Madhya Pradesh, Uttar Pradesh, Rajasthan, Maharashtra, Karnataka, Bihar, Andhra Pradesh, Chhattisgarh, Haryana, West Bengal are the major chickpea growing states in India. Among these states Madhya Pradesh is a leading state in India in terms of pulse production. State scenario of chickpea in the year 2013-14 was 35.25 lakh /ha. area and production, productivity was 47.59 m t / ha and 1350 kg /ha respectively.(Agriculture farmers Development Paper, Bhopal, M.P. 2013-14).

Nutritionally, it is very rich in about 21.1 % protein, 65.5 % carbohydrates, and good amount of fat. It is rich in about 0.76% of amino acids. Besides, it is rich source ofCa, Fe and vitamin – C and B (at green stage).It also contains a good amount of malic acid and citric acid which are very useful for stomach ailments and blood purification.

Being a leguminous crop it form a symbiotic association with bacteria of the genus *Rhizobium* which fix atmospheric nitrogen in soil and their by, enrich the soil fertility. Inoculation of legume seed with *Rhizobium* and phosphatic fertilizer increase the vigorous root growth, no. of active nodules, enrich the soil fertility and yield of the crop.

Chickpea being a leguminous crop, major part of nitrogen requirement can be met through inbuilt mechanism of atmospheric nitrogen. Besides nitrogen, phosphorus is the second most important plant nutrient and classed as a major plant nutrient. Nutritional imbalance and poor nodulation appears to be distinct ones, which can be effective in a single crop season. Growers have wrong notion that chickpea being a legume crop, doesn't need any nutrition and usually grow it on marginal land, without applying fertilizers. Application of phosphorus to legume crops improves grain yields considerably (Hussain 1983). Grain yield of chickpea was increased significantly with *Rhizobium* and phosphorus (Raut and Kohire 1991). The phosphorus requirement is greater for healthy crop growth with efficient root system and profuse nodulation.

Phosphorus also plays an important role in decreasing the adverse effect of excess nitrogen in increasing the no. of active nodules, rate of nitrogen fixation and yield of the chickpea. It also plays a key role in pod filling and ultimately enhances the grain yield (Gupta *et al* 1996). Therefore, phosphatic fertilizer with *Rhizobium* inoculation is a boon for enriching soil fertility efficient plant growth.

2. Materials and Methods

The experiment regarding the effect of rhizobium and different levels of phosphorus on growth, yield and quality of chickpea crop was conducted at the experimental farm,School of Agriculture, ITM University Gwalior during 2013-14 on soil having pH 7.8, organic matter 0.26, nitrogen210.0 ppm phosphorus12.6 ppm and 425 ppm potassium. The treatments were allocated in a randomized block design with factorial concept with three replicates having net plot size of 2.4 m X 4 m. Chickpea variety JG-74 was used for experiment. The experiment consists of the

treatments viz., without rhizobium and with rhizobium and phosphorus levels of 0 kg, 15 kg, 30 kg, 45 kg, 60 kg and 75 kg P_2O_5 ha^{-1}

Seeds were inoculated before planting by adding rhizobium solution 10 ml and mixed to wet all seeds until all seeds were coated. Sowing date was at 16 November. The irrigation was every ten days. Planting space were 30 X 12 cm

Five randomly selected plants were uprooted at 50 % flowering stage from each plot to record active nodule. At harvest, data were collected on seed yield $gplant^{-1}$, number of grains pod^{-1},seeds number $plant^{-1}$ as average of five randomly selected plants. Data on days to maturity, plant height, number. The collected data was analyzed by using statistical,

3. Result

The present investigation entitled "Effect of Rhizobium and phosphorus on growth of chickpea *(Cicerarietinum.*L*)"* elucidate the various aspects such asdetermine the effect of conjunctive use of Rhizobium and phosphorus on growth of chickpea. Results indicate that seed inoculation with *Rhizobium* found non-significant effect on plant population and different doses of phosphorus were also found non-significant at 15 DAS and at harvest in table 4.1.At 15 DAS, the plants raised from seed inoculated with *Rhizobium* showed significantly maximum plant height (9.86 cm) compare to non-inoculated (8.89 cm). The differences in plant height among various phosphorus levels were also significant but, the interactions between inoculated seed and phosphorus fertilizer were found to be non-significant. Maximum plant height was recorded in P_5 (9.91 cm) followed by P_4 (9.49 cm), P_3 (9.25 cm) and P_1 (9.30 cm), while, minimum plant height was recorded in P_0 (9.09 cm) followed by P_2 (9.20 cm).

Table-4.2 reveals that inoculation had significant effect on plant height at 30 DAS and the effect of phosphorus application on plant height was also found to be significant. Significantly, maximum plant height (16.84 cm) was attained by treatment P_5 where phosphorus was applied at the rate of 75 kg P_2O_5 ha^{-1}. It was followed by P_4 treatment (60 kg P_2O_5 ha^{-1}) and P_4 treatment (45 kg P_2O_5 ha^{-1}). Minimum plant height was observed in treatment P_1 (0 kg P_2O_5 ha^{-1}).

At 45 DAS, the plants raised from seed inoculated with *Rhizobium* showed significantly maximum plant height (22.01 cm) compare to non-inoculated (19.94 cm). The differences in plant height among various phosphorus levels were also significant but, the interactions between inoculated seed and phosphorus fertilizer were found to be non-significant. Maximum plant height was recorded in P_5 (23.66 cm) followed by P_4 (20.97 cm), P_1 (20.55 cm) and P_3 (20.44 cm), while, minimum plant height was recorded in P_0 (19.86 cm) followed by P_2 (20.34 cm).

It is evident from Table 4.2 that the both factors application level of phosphorus and Rhizobium influenced maximum plant height significantly at 60 DAS while, interaction of both factors (P x R) was not significantly effective for maximum plant height. Among the level of phosphorus, the maximum plant height 30.70 cm was recorded in P_5 (75 kg P_2O_5 ha^{-1}) followed by P_4 (28.31 cm), while, minimum plant height was recorded in P_0 (26.80 cm) which was found at par with P_2 (27.46 cm), P_1 (27.60 cm) and P_3 (20.44 cm). Among the Rhizobium, maximum height was recorded in seed inoculated with *Rhizobium* (39.30 cm) compare to non-inoculated (26.91 cm).

The data in Table 4.3 indicate that inoculation by Rhizobium had a pronounced effect on number of branches per plant (2.27 branches $plant^{-1}$) as compared to non-inoculated treatments (2.21 branches $plant^{-1}$). Similarly phosphorus levels number of branches per plant. Among the phosphorus doses, phosphorus level @ 75 kg P_2O_5 ha^{-1} was found maximum branches per plant (2.35 branches $plant^{-1}$) followed by P_4 (2.27 branches $plant^{-1}$), P_1 (2.23 branches $plant^{-1}$) and P_3 (2.22 branches $plant^{-1}$), while, minimum number of branches was recorded in P_0 (2.18 branches $plant^{-1}$) followed by P_2 (2.21 branches $plant^{-1}$).

The data depicted in Table 4.3 reveals that the both factors application level of phosphorus and Rhizobium influenced canopy of plantsignificantly, interaction of both factors (P x R) was not significantly effective for maximum canopy of plant. Among the level of phosphorus, the maximum canopy of plant45.98 cm was recorded in P_5 (75 kg P_2O_5 ha^{-1}) followed by P_4 (44.12 cm), while, minimum canopy of plantwas recorded in P_0 (40.37 cm) which was found at par with P_1 (41.77 cm), P_2 (41.95 cm) and P_3 (42.24 cm). Among the Rhizobium, maximum canopy of plantwas recorded in seed inoculated with Rhizobium (44.97 cm) compare to non-inoculated (40.51 cm).

Table-4.3 shows that inoculation had significant effect on nodulation and the effect of phosphorus application on number of nodules was also found to be significant. Significantly, maximum nodules (43.76 nodules $plant^{-1}$) was observed in treatment P_5 where phosphorus was applied at the rate of 75 kg P_2O_5 ha^{-1}. It was followed by P_4 treatment (40.38 nodules $plant^{-1}$) and P_1 treatment (37.58 nodules $plant^{-1}$). Minimum number of nodules was observed in treatment P_0 (38.21 nodules $plant^{-1}$).

Table 4.1: Plant population on different treatments

Levels of Phosphorus	Plant population at 15 DAS	Plant population at harvest
	Mean	Mean
P0	236.17	221.00
P1	244.00	228.00
P2	240.00	224.33
P3	240.00	224.33
P4	235.67	220.17
P5	238.67	223.17
	PXR	**PXR**
SEm±	4.61	4.31

Table 4.2: Plant height of chickpea influenced by different level of phosphorus and rhizobium

Levels of phosphorus	Plant height at 15 DAS (cm)	Plant height at 30 DAS (cm)	Plant height at 45 DAS (cm)	Plant height at 60 DAS (cm)
	MEAN	MEAN	MEAN	MEAN
P0	9.09	14.98	19.86	26.80
P1	9.30	15.81	20.55	27.75
P2	9.20	15.65	20.34	27.46
P3	9.25	15.73	20.44	27.60
P4	9.49	16.13	20.97	28.31
P5	9.91	16.84	23.66	30.70
Mean		14.98		
	P x R	**P x R**	**P x R**	**P x R**
	0.17	0.28	0.38	0.51

Table 4.3: Effect of Rhizobium and different level of phosphorus on Number of branches per plant, Canopy (cm) and No. of active nodules per plant of chickpea

Levels of phosphorus	Number of branches per plant	Canopy (cm)	No. of active Nodules per plant
	MEAN	MEAN	MEAN
P0	2.18	40.37	38.21
P1	2.23	41.77	39.58
P2	2.21	41.95	39.17
P3	2.22	42.24	39.37
P4	2.27	44.12	40.38
P5	2.35	45.98	43.76
Mean			38.21
	P x R	**P x R**	**P x R**
	0.040	1.41	0.72

Yield Attributes

Table-4.4 revealed that inoculation had significant effect on number of pods per plant and the effect of different level of phosphorus on number of pods per plant was also found to be significant, but interaction between both the factor was found non-significant. Significantly, maximum number of pods weight was attained by treatment P_5 (47.36 pods plant^{-1}) where phosphorus was applied at the rate of 75 kg P_2O_5 ha^{-1}. It was followed by P_4 treatment (45.45 pods plant^{-1}) and P_3 (43.51 pods plant^{-1}). Minimum number of pods was observed in treatment P_0 (41.59 pods plant^{-1}). Among the Rhizobium, maximum number of podswas recorded in seed inoculated with Rhizobium (46.32 pods plant^{-1}) compare to non-inoculated (41.72 pods plant^{-1}).

It is depicted from Table 4.4that the factor application level of phosphorus influenced length of pod significantly, however Rhizobium and interaction of both factors (P x R) were not significantly effective for length of pod. Significantly, maximum length of pod was recorded in treatment P_5 (1.046 cm) followed by P_4 treatment (1.033 cm) and P_3 (0.995 cm). Minimum length of pod was observed in treatment P_0 (0. 912 cm).

The data presented in Table 4.4 showed that the factor application level of phosphorus influenced number of grains per pod significantly, however Rhizobium and interaction of both factors (P x R) were not significantly effective for number of grains pod^{-1}. Significantly, maximum number of grains pod^{-1} was recorded in treatment P_5 (1.328 grains/pod) which was at par with P_4 treatment (1.311 grains pod^{-1}) and P_3 (1.298 grains pod^{-1}). Minimum number of grains pod^{-1} was observed in treatment P_0 (1.186 grains pod^{-1}).

Table 4.4 revealed that inoculation had significant effect on 1000-seed weight and the effect of phosphorus application on seed weight was also found to be significant. Significantly, maximum 1000-seed weight was attained by treatment P_5 (182.11 g) where phosphorus was applied at the rate of 75 kg P_2O_5 ha^{-1}. It was followed by P_4 treatment (178.13 g) and P_3 (162.16 g). Minimum 1000-seed weight was observed in treatment P_0 (145.47 g). Among the Rhizobium, maximum 1000-seed weight was recorded in seed inoculated with Rhizobium (172.83 g) compare to non-inoculated (151.89 g).

The data depicted in Table 4.5 refers that the factor application level of phosphorus and Rhizobium significantly influenced grain yield per plot and grain yield per hectare, however interaction of both factors (P x R) were not significantly effective. Significantly, maximum grain yield plot^{-1} and grain yield ha^{-1} was recorded in treatment P_5 (2.031 kg plot^{-1} and 21.16 q ha^{-1}, respectively) followed by P_4 treatment (1.962 kg plot^{-1} and 20.43 q ha^{-1}, respectively) and P_3 (1.820 kg plot^{-1} and 18.96 q ha^{-1}, respectively). Minimum grain yield plot^{-1} and grain yield ha^{-1} was observed in treatment P_0 (1.603 kg plot^{-1} and 16.70 q ha^{-1}, respectively). Among the Rhizobium, maximum grain yield per plot and grain yield per hectare was recorded in seed inoculated with *Rhizobium* (1.930 kg plot^{-1} and 20.10 q ha^{-1}, respectively) compare to non-inoculated (1.697 kg plot^{-1} and 17.68 q ha^{-1}, respectively).

Table 4.4: Impact of Rhizobium and different levels of phosphorus on yield attributing traits

Level of phosphorus	No of pods plant-1	Length of Pods (cm)	No. of grains pod-1	Test weight
	MEAN	MEAN	MEAN	MEAN
P0	41.59	0.91	1.19	145.58
P1	43.03	0.98	1.25	149.21
P2	43.21	0.99	1.27	156.96
P3	43.51	0.99	1.30	162.12
P4	45.45	1.03	1.31	177.97
P5	47.36	1.05	1.33	182.12
Mean				
	P x R	**P x R**	**P x R**	**P x R**
	1.37	0.033	0.042	9.16

Table 4.5: Impact of Rhizobium and different levels of phosphorus on grain yield

Levels of Phosphorus	Grain yield (kg plot^{-1})	Grain yield (q ha^{-1})
	MEAN	MEAN
P_0	1.60	16.70
P_1	1.70	17.74
P_2	1.76	18.35
P_3	1.82	18.96
P_4	1.96	20.43
P_5	2.03	21.16
		16.70
	P x R	P x R
SEm±	0.11	1.09

4. Conclusion

- On the basis of present investigation, it is concluded that the P_5 (75 kg P_2O_5 ha^{-1}) was found best in terms of growthcharacters.

- P_5 (75 kg P_2O_5 ha^{-1}) along with inoculation of Rhizobium were observed best for different growth parameters i.e. significantly maximum plant height, number of branches $plant^{-1}$, canopy of plant, number of nodules were recorded maximum in the treatment. It was also observed to promote the quality parameters i.e., protein content.
- Maximum grain yield ha^{-1} was recorded in treatment P_5 (21.16 q ha^{-1}) and maximum grain yield $plot^{-1}$ and grain yield ha^{-1} was recorded in seed inoculated with Rhizobium.
- Rhizobium had significant effect on net monetary returns and B:C ratio and the effect of phosphorus application on net monetary returns and B:C ratio was also found to be significant.

References

[1] Anonymous(2013-14),Agriculture Farmers Development Paper,Bhopal, Madhya Pradesh
[2] Ardeshana,R.B.;Modhavadia, M.M.; Khanpara, V.D. and Patel, J.C.(1993) .Response of greengram to nitrogen, phosphorus and Rhizobium inoculation. Indian J.Agron, 38 (3): 490-492.
[3] Akhtar, M.A.and Z.A. Siddiqui.2009. Effects of phosphate solubilising microorganisms and Rhizobium sp. on the growth, nodulation Rhizobium sp. on growth, nodulation, yield and root rot disease complex of chick-pea under field condition. African Journal of Biotechnology.8 (15): 3489-3496.Gupta, S.C. and S.L. Namdeo. (1996). Effect of Rhizobium strains on symbiotic traits and grain yield of chickpea. Indian J. Pulses Res. 9(1): 94-95.
[4] Gupta, S.C. and S.L. Namdeo. (1996). Effect of Rhizobium strains on symbiotic traits and grain yield of chickpea. Indian J. Pulses Res. 9(1): 94-95.
[5] Hussain, A. (1983).Isolation and identification of effective root nodule bacteria for important legumes of Pakistan.Pro, Rep. Dept. of Soil Sci. Univ. of Agric. Faisalabad, Pakistan.
[6] Raut, K.G., Pedgaonkar, S.M. and Katare,R.A.(1992) .Effect of Rhizobium culture treatment on nodulation, growth and yield of gram BDN-9-3.Res.Bult.Marathwada Agric.Univ.,16(2)3