Effect of phosphorus fertilization and PSB inoculation on growth attributes and root nodulation of chickpea

Abstract:

A field experiment was conducted at Research Farm, JNKVV-College of Agriculture, Tikamgarh (Madhya Pradesh) during *rabi*season 2019-20 to assess the effect of phosphorus fertilization and PSB inoculation on growth attributes and root nodulation of chickpea.Results revealed thatthe vegetative growth parameters were, in general, enhanced very fast between 30 to 90 days thereafter the rise was normally very slow up to the crop maturity stage. Thus, at harvest stage, plant height ranged from 49.5 to 67.9 cm and branches 9.40 to 13.0 plant^{-1} under various treatments.

Amongst the all treatments, 50 kg P_2O_5 + PSB + 2% DAP foliar spray resulted in significantly higher number of root nodules plant^{-1}and fresh and dry weight of root nodules plant^{-1}at 30, 45, 60, and 75 DAS followed by 25 kg P_2O_5 + PSB + 2% DAP spray before flowering stage. Similarly, the same treatments also enhanced the fresh and dry matter production per plant up to the maximum extent, being significantly higher to the single applied P levels or with each of PSB and DAP spray.

Keywords:Phosphorus fertilization, PSB, growth attributes, root nodulation, chickpea

Introduction:

Chickpea (*Cicerarietinum* L.) is the predominant pulse crop of India.Being a legume it responds well to phosphorus fertilization. Phosphorus is an essential plant nutrient both as a part of several key plant structure compounds and as a catalysis in the conversion of numerous key biochemical reactions in plants. Some specific growth factors that have been associated with phosphorus are stimulated root development, increased stalk and stem strength, improved flower formation and seed production, more uniform and earlier crop maturity, increased nitrogen N- fixing capacity of legumes, improvements in crop quality and increased resistance to plant diseases (Khatik*et al.,*2004, Dwivedi *et al.,*2019).

Most of the phosphorus present in the soil unavailable to the plants. Efficiency of soil applied phosphatic fertilizer is a round 10-25 % as these are converted readily to less available forms by the process P- fixation(Singh *et al.,*2017). Amelioration of phosphorus deficiency by application of costly phosphorus fertilizer is not viable portion to many resource poor farmers. The use of phosphate solubilizing bacteria (PSB) has opened the new vistas of phosphorus nutrition (Tagore *et al.,*2013). Phosphate solubilizing bacteria (PSB) play an important role in enhancing phosphorus availability to plants by lowering soil pH and microbial production of organic acid and mineralization of organic phosphorus (Chauhan and Raghav 2020). Considering these facts, this study was carried out to assess effect of phosphorus fertilization and PSB inoculation on growth attributes and root nodulation of chickpea.

Materials & Methods:

A field experiment was conducted at JNKVV, Research Farm, College of Agriculture, Tikamgarh (24° 43' N latitude and 78^{0}49' E longitude at an altitude of 358 m above sea level) Madhya Pradesh during *rabi* 2019-20 to assess effect of phosphorus fertilization and PSB inoculation on growth attributes and root nodulation of chickpea. The soil of the experimental field was clay loam having pH 7.20, electrical conductivity 0.26 dsm^{-1}, organic carbon 0.62 %, available N, P_2O_5 and K_2O 233, 16.7 and 497 kg ha^{-1}, respectively. Nine treatments (T_1-Control, T_2-50 kg $P_2O_5ha^{-1}$, T_3-25 kg $P_2O_5ha^{-1}$, T_4--50 kg P_2O_5 +PSB (5 g kg^{-1} seed),T_5-25 kg P_2O_5+PSB (5 g kg^{-1} seed),T_6-50 kg P_2O_5+ 2% DAP spray before flowering stage,T_7-25 kg P_2O_5+2% DAP spray before flowering stage,T_8-50 kg P_2O_5 +PSB + 2% DAP spray before flowering stage and T_9-25 kg P_2O_5 +PSB + 2% DAP spray before flowering stage) were replicated thrice in randomized block design. The chickpea var. JG 12 was sown @ 80 kg seed ha^{-1} in rows 30 cm apart on 17 November 2019. A uniform dose of 20 kg N and 20 kg K_2O ha^{-1} was applied in all the treatments through urea and MoP, respectively. The P levels, PSB and 2% DAP foliar spray were applied as per treatments. The chickpea was grown as per recommended package of practices. The crop was harvested on 14 March 2020. The periodical observations at 30, 60, 90 DASand harvest stage of growth parameters (Plant height, Plant population, Number of branches $plant^{-1}$, Total fresh and dry weight g $plant^{-1}$)and root nodulation growthat 30, 45, 60 and 75 DAS were recorded.

Result and Discussion

Growth parameters

A linear increase in plant height was observed with advancement in the age of chickpea (Table 1). Among the different treatments the plants height and number of branches plant^{-1} were significantly higher in T_8, (50 kg P_2O_5 +PSB + 2% DAP spray before flowering stage) followed by T_9, (25 kg P_2O_5 +PSB + 2% DAP spray before flowering stage) at 30, 60, 90 DAS tomaturity stage. The vegetative growth parameters were, in general, enhanced very fast between 30 to 90 days thereafter the rise was normally very slow up to the crop maturity stage. At harvest stage, plant height ranged from 49.5 to 67.9 cm and branches were 9.40 to 13.0 plant^{-1}under various applied treatments. The lowest plant height was found in control plot than T_3 (25 kg P_2O_5) the similar trend was found in number of branches plant^{-1}.

The increase in growth parameters due to treatments T_8, T_9 and T_6 treatments may be owing to increased supply of N and P availability to crop plants. That is why seed inoculation with competitive and efficient phosphorus solubilizing bacteria at sowing is the recommended agronomic practice for pulse production technology. The similar findings was observed by Tiwari *et al.* (2012), Kumar *et al.* (2019), Chauhan and Raghav, (2020).The positive effect of phosphorus solubilizing bacteria (PSB) and plant growth promoting rhizobacteria (PGPR) on legume *Rhizobium* symbiosis is well documented in early events of nodulation. PSB has been found to have a positive effect on nodulation and N_2 fixing efficiency of *Rhizobium* in legumes (Singh *et al.,*2017, Chalchissa, C. and Chala, M., 2020).

Root nodulation

The data on number of nodules plant^{-1} (Table 2) indicated the significant differences among various treatments. Treatment T_8, (50 kg P_2O_5 +PSB + 2% DAP spray before flowering stage) registered significantly the highest (36.8) number of nodules plant^{-1} followed by T_9, (25 kg P_2O_5 +PSB + 2% DAP spray before flowering stage) produced significantly higher number of nodules. Control plot registered significantly lowest (32.7) number of nodules than all the treatments.This may be because of the increased naturally occurring nitrogen – fixing bacteria as well as applied

phosphate solubilizing bacteria in the root-zone thereby the sufficient supply of N and P nutrients to the growing plant for their plant growth (Gupta, 2006, Tagore *et al.* 2013, Kumar *et al.* 2019, Chauhan and Raghav,(2020).

The increase in number of nodules and their fresh and dry weight plant^{-1} with increasing levels of phosphorus alone and along with phosphorus solubilizing agents and through foliar spray may be attributed to adequate supply of phosphorus to the plant roots specially at nodules formation and the association of P with microbial population and its activity. These results are in conformity with those observed byTiwari *et al.* (2012), Chalchissa, C. and Chala, M.(2020).

Fresh and dry matter plant^{-1}

The fresh and dry matter production g plant^{-1} at 30, 60, 90 DAS and at harvest stages were influenced significantly due to different treatments (Table3). The treatments $T_{8,}$ T_9 and T_6 enhanced the fresh and dry matter production per plant up to the maximum extent, being significantly higher to the single applied P levels or with each of PSB and DAP spray.The increase in fresh and dry matter production plant^{-1} due to applied P levels and PSB inoculation has also been reported byRaj*et al.* (2014), Chalchissa, C. and Chala, M. (2020),).

Conclusion

In general, the growth parameters (plants height and number of branches plant^{-1}) were increased by nearly two to three fold in all the treatments with the successive growth and development stages i.e., from 30, 60, 90 days up to maturity. The vegetative growth parameters were, in general, enhanced very fast between 30 to 90 days thereafter the rise was normally very slow up to the crop maturity stage. Amongst the all treatments, 50 kg P_2O_5 + PSB + 2% DAP foliar spray resulted in significantly higher number of root nodules plant^{-1}and fresh and dry weight of root nodules plant^{-1}at 30, 45, 60, and 75 DAS followed by 25 kg P_2O_5 + PSB + 2% DAP spray before flowering stage. Similarly the same treatments also enhanced the fresh and dry matter production per plant up to the maximum extent, being significantly higher to the single applied P levels or with each of PSB and DAP spray.

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Table 1: Plant growth attributes of chickpea as influenced by P levels, foliar spray of P and PSB inoculation

Treatments	Plant height in cm (DAS)				No.branches plant^{-1} (DAS)			
	30	60	90	At harvest	30	60	90	At harvest
Control	15.2	27.6	48.5	49.5	4.24	6.56	8.45	9.40
50 kg P_2O_5ha^{-1}	17.7	32.6	56.8	57.9	6.64	8.89	9.80	11.7
25 kg P_2O_5ha^{-1}	16.9	31.2	52.3	53.4	5.44	7.76	9.00	10.4
50 kg P_2O_5+PSB (5 g kg^{-1} seed)	18.7	35.4	63.2	64.3	6.82	8.43	10.8	11.8
25 kg P_2O_5+PSB (5 g kg^{-1} seed)	17.8	32.0	61.7	61.9	5.68	7.37	9.40	10.5
50 kg P_2O_5+ 2% DAP spray (before flowering stage)	18.3	32.7	64.7	64.9	5.94	8.86	11.3	12.8
25 kg P_2O_5+2% DAP spray (before flowering stage)	18.0	31.8	63.2	63.4	5.78	7.98	10.4	11.5
50 kg P_2O_5+PSB + 2% DAP spray (before flowering stage)	19.4	37.5	67.3	67.9	6.98	9.38	11.7	13.0
25 kg P_2O_5+PSB + 2% DAP spray (before flowering stage)	18.2	36.2	64.8	66.3	6.88	8.92	11.0	12.7
S.Em±	0.95	0.22	0.20	0.19	0.19	0.17	0.12	0.15
CD (P=0.05)	NS	0.65	2.59	0.57	0.58	0.50	0.37	0.46

Table 2: Fresh and dry weight g plant^{-1}of chickpea as influenced by P levels, foliar spray of P and PSB inoculation

Treatments	Fresh weight g plant^{-1} (DAS)				Dry Weight g plant^{-1} (DAS)			
	30	60	90	At harvest	30	60	90	At harvest
Control	16.2	43.5	80.7	121.0	4.97	11.8	21.5	40.9
50 kg P_2O_5ha^{-1}	18.0	46.5	83.5	127.2	5.60	12.8	23.2	43.5
25 kg P_2O_5ha^{-1}	17.4	45.6	82.3	125.0	5.19	12.2	22.1	42.1
50 kg P_2O_5+PSB (5 g kg^{-1} seed)	18.4	57.8	87.2	131.1	6.06	13.9	24.1	44.4
25 kg P_2O_5+PSB (5 g kg^{-1} seed)	18.3	57.3	84.0	127.4	5.65	14.3	23.2	42.6
50 kg P_2O_5+ 2% DAP spray (before flowering stage)	20.0	60.6	95.9	139.5	6.17	15.7	26.2	47.0
25 kg P_2O_5+2% DAP spray (before flowering stage)	19.6	56.4	89.0	134.7	5.83	14.7	25.4	45.0
50 kg P_2O_5+PSB + 2% DAP spray (before flowering stage)	21.9	61.9	100.7	146.9	7.08	16.4	27.6	53.2
25 kg P_2O_5+PSB + 2% DAP spray (before flowering stage)	21.1	60.9	100.0	144.7	6.83	15.8	27.1	51.6
S.Em±	**0.39**	**0.88**	**0.48**	**0.60**	**0.30**	**0.51**	**0.39**	**0.58**
CD (P=0.05)	**1.18**	**2.64**	**1.43**	**1.80**	**0.91**	**1.53**	**1.16**	**1.74**

Table 3: Root nodulation of chickpea as influenced by P levels, foliar spray of P and PSB inoculation

Treatments	No. root–nodules plant^{-1} (DAS)				Fresh Weight root–nodules g plant^{-1} (DAS)				Dry Weight root–nodules g plant^{-1} (DAS)			
	30	**45**	**60**	**75**	**30**	**45**	**60**	**75**	**30**	**45**	**60**	**75**
Control	14.8	21.0	32.7	29.5	0.187	0.422	0.578	0.503	0.036	0.081	0.112	0.097
50 kg P_2O_5ha^{-1}	16.4	22.6	34.2	30.9	0.217	0.488	0.669	0.582	0.042	0.094	0.130	0.113
25 kg P_2O_5ha^{-1}	15.7	21.9	33.6	30.3	0.201	0.453	0.622	0.541	0.039	0.088	0.121	0.105
50 kg P_2O_5+PSB (5 g kg^{-1} seed)	16.6	22.7	34.4	31.0	0.234	0.527	0.721	0.628	0.045	0.102	0.140	0.121
25 kg P_2O_5+PSB (5 g kg^{-1} seed)	16.9	23.0	34.70	31.4	0.220	0.496	0.681	0.592	0.042	0.096	0.132	0.114
50 kg P_2O_5+ 2% DAP spray (before flowering stage)	18.1	24.2	35.9	32.6	0.255	0.574	0.785	0.684	0.049	0.111	0.152	0.132
25 kg P_2O_5+2% DAP spray (before flowering stage)	17.6	23.7	35.4	31.1	0.233	0.523	0.715	0.623	0.045	0.101	0.138	0.120
50 kg P_2O_5+PSB + 2% DAP spray (before flowering stage)	19.0	25.2	36.8	33.5	0.294	0.664	0.911	0.792	0.057	0.128	0.177	0.153
25 kg P_2O_5+PSB + 2% DAP spray (before flowering stage)	18.5	24.7	36.3	33.0	0.293	0.660	0.901	0.786	0.056	0.127	0.175	0.152
S.Em±	**0.31**	**0.29**	**0.30**	**0.57**	**0.003**	**0.007**	**0.014**	**0.009**	**0.001**	**0.002**	**0.003**	**0.002**
CD (P=0.05)	**0.92**	**0.86**	**0.88**	**1.70**	**0.010**	**0.021**	**0.042**	**0.027**	**0.002**	**0.005**	**0.010**	**0.007**