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Effect of Nitrogen, *Rhizobium a*nd PSB on Chickpea (*Cicer arietinum*)-Growth and Nodulation

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ABSTRACT

The study was carried out at instructional farm, Narendra Deva University of Agriculture and Technology, Narendra Nagar, Kumarganj, Faizabad (U.P.) during two consecutive *rabi* season of 2011-12 and 2012-13 to determine the effect of microbial inoculants (uninoculation control, *Rhizobium* CAT-4059, *Rhizobium* CAT-5078, PSB) and nitrogen levels (0, 10, 20, 30 kg ha^{-1}) on growth and nodulation of chickpea (*Cicer arietinum*). Nitrogen application had significant effect on the plant height and nodulation such as number of nodules, fresh weight of nodules and dry weight of nodules during both the years. Inoculation of *Rhizobium* strain CAT-5078 had also significant effect on the plant height, number of nodules, fresh weight of nodules and dry weight of nodules during first year 2011-2012 as well as in 2012-2013.

Key words *Chickpea, nitrogen, PSB, nodulation*

Pulses play a pivotal role and occupy a unique position in Indian agriculture by virtue of their inherent capacity to grow on marginal lands and provide protein rich diet to the vegetarian mass of the country, consumption of pulses alongwith cereals increases biological value of protein consumed. Amongst the leguminous crops, chickpea (*Cicer arietinum* L.) occupy an important position due to its nutritive values (17 to 23% protein) in large vegetarian population of the country (Ali and Kumar, 2006).

Rhizobium is a soil bacteria, which has a close association with the root of higher plants. The inoculation with efficient strain of the rhizobia has been an added significance in effecting the economy of nitrogen fixation and affected by the nitrogen status of plant. The establishment of legume *Rhizobium* symbiosis is a complex process involving biochemical properties of both the bacteria and host plant. There is an interaction of a particular legume spp. with it respective *Rhizobium* symbionts. The inoculation of *Rhizobium* had significant positive effects on number and weight of effective nodules of chickpea (Akdag and Duzdemir, 2001).

Phosphorus sulubilizing bacteria has been proved as the cheapest source of phosphorus particularly in legumes that enhance the availability of phosphorus and productivity of crops. PSB possess the ability to bring springly insoluble inorganic or organic phosphates into soluble form by secreting organic acids. Some other microorganisms that are associated with the roots of crop plants and play an important role in mobilization and immobilization of phosphorus are known as phosphate solubilizing microorganisms (PSM) (Tilak, 1991; Tilak, *et al.,* 2005).

MATERIALS AND METHODS

The study was carried out at Instructional Farm, Narendra Deva University of Agriculture and Technology, Narendra Nagar, Kumarganj, Faizabad (U.P.) during two consecutive *rabi* seasons of 2011-2012 and 2012-2013. Culture of chickpea *Rhizobium* (strain CAT 4059 and CAT 5078) were used as seed treatment at the time of seeds sowing. The application of PSB at the time of sowing was done in furrows at the rate of 2 kg ha^{-1}. The study was conducted in RBD design with 3 replications. Plot size was 4.0 x 2.4 m. In order to eliminate the contamination, inoculation treatments (with and without) were randomly applied to main plots and nitrogen doses (control, 10, 20 and 30 kg N ha^{-1}) as urea were randomly applied to the subplots before sowing. The seeds was sown by hand with 30 cm row spacing in second week of November in both years (11 November, 2011 and 10 November, 2012). Five plants were selected randomly from each plot for counting of nodules. Plants were dig out with the help of *khurpi* alongwith adhered soil was removed from plants by washing. Nodule number counted and mean value of five plants were calculated as the number of nodules per plant. Fresh and dry weight of nodules were recorded and expressed in mg. For dry weight, nodules were dried in oven at 60 ^{0}C for 2 days and dry weight of nodules was expressed on per plant basis (mean of five plants per plot). Observations was recorded after 30 and 45 DAS. The plant height was taken from base of the plant (ground level) upto the last pair of leaves in cm. The height of the plants was recorded at 30 and 60 days after sowing.

RESULTS AND DISCUSSION

The data presented in Table 1 revealed that the application of 20 kg N ha^{-1} recorded significantly more number, fresh and dry weight of nodules plant^{-1} at 30 and 45 DAS during first year 2011-12 as well as in second year. The lowest number, fresh and dry weight of nodules

Table 1. Effect of nitrogen levels and microbial inoculants on growth and nodulation of chickpea

S. No.	Treatments	Plant height (cm)				Number of nodules plant^{-1}				Fresh weight of nodules plant^{-1}				Dry weight of root nodules plant^{-1}			
		30 DAS		60 DAS		30 DAS		45 DAS		30 DAS		45 DAS		30 DAS		45 DAS	
		2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
A. Nitrogen levels (kg ha^{-1})																	
1	Control	11.58	12.16	17.87	18.40	9.00	10.00	12.72	13.75	198.00	220.89	304.58	329.43	45.41	52.64	64.24	71.72
2	10	12.15	12.76	18.45	19.00	9.67	10.58	14.50	15.42	212.86	235.62	349.47	378.58	49.04	56.75	67.55	80.25
3	20	12.83	13.56	19.28	19.85	11.17	12.25	17.17	17.83	245.16	272.23	425.45	450.17	56.20	65.22	86.13	82.78
4	30	13.31	13.97	19.99	20.58	9.83	10.83	15.08	16.08	216.46	239.78	361.97	401.83	50.43	57.26	75.98	82.54
	SEm±	0.17	0.20	0.27	0.25	0.25	0.24	0.28	0.24	5.46	5.40	7.36	7.18	1.315	1.376	2.863	1.543
	CD at 5%	0.50	0.57	0.78	0.73	0.72	0.71	0.80	0.70	15.78	15.59	21.24	20.74	3.799	3.973	8.270	4.458
B. Microbial inoculants																	
1	Un-inoculation	11.80	12.39	17.98	18.50	7.42	8.50	13.25	13.90	163.49	188.25	318.01	332.13	37.34	45.03	66.98	71.39
2	CAT-4059	12.41	13.03	18.63	19.18	8.25	9.33	14.52	15.42	182.38	206.94	348.48	370.93	42.36	50.48	73.67	79.71
3	CAT-5078	13.21	13.87	19.76	20.34	12.67	13.50	16.58	17.50	277.67	299.09	407.44	440.04	64.33	71.18	83.48	91.42
4	PSB	12.46	13.16	19.23	19.81	11.333	12.33	15.17	16.25	248.94	274.23	367.53	414.92	57.06	65.18	69.78	84.78
	SEm±	0.17	0.20	0.27	0.25	0.25	0.24	0.28	0.24	5.46	5.40	7.36	7.18	1.315	1.376	2.863	1.543
	CD at 5%	0.50	0.57	0.78	0.73	0.72	0.71	0.80	0.70	15.78	15.59	21.24	20.74	3.799	3.973	8.270	4.458
C. Interaction M × N		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS		NS	NS	NS

N_0- 0 kg N ha^{-1}, N_{10}- 10 kg N ha^{-1}, N_{20}- 20 kg N ha^{-1}, N_{30}- 30 kg N ha^{-1}

M_0- Uninoculated (Control), M_1- *Rhizobium* CAT-4059, M_2- *Rhizobium* CAT-5078, M_3- PSB

was recorded in control treatment. The number, fresh and dry weight of root nodules increased upto 20 kg N ha^{-1} and then decreased at 30 kg N ha^{-1}. These findings are close conformity to the findings of David and Khan, 2001 and Bhuiya, *et al.,* 1979. Higher nitrogen doses retarded the nodulation probably because of reduction in cell sap as a result of increased nitrogen concentration in the soil. The plant height increased with increasing levels of nitrogen and significantly higher plant height was recorded by 30 kg N ha^{-1} as compared to control but it was *at par* with 20 kg N ha^{-1} at 30 and 60 DAS for crop growth during first year as well as second year. Nitrogen application increases the synthesis of carbohydrates by affecting the photosynthetic structure of plants. The increased production of photosynthates leads to increase energy for metabolic process, which in turn resulted into faster increase in plant height. This might be the possible reason for more increase in plant height under higher doses of nitrogen. The results are in close conformity with these of Rathi and Singh, 1976, Kumar and Pandey, 1962.

The inoculation of *Rhizobium* CAT 5078 increased number, fresh and dry weight of nodules plant^{-1} significantly over rest microbial inoculants and uninoculated control at 30 and 45 DAS during first year 2011-2012 and in second year 2012-2013. the inoculation of *Rhizobium* CAT 5078 significantly increased the number, fresh and dry weight of nodules plant^{-1} mainly due to the fact that the nitrogenase enzyme present in the bacteria gets introduced through infection causes nodules formation and its development which is a complex process where bacteria enters in root through root hair and the epidermal cell of the root (Chaudhary, *et al.,* 2005, Bhuiyan, *et al.,* 2008, Akhtar and Siddiqui, 2009). The inoculation of *Rhizobium* CAT 5078 recorded significantly increased plant height over rest microbial treatments and inoculated at 30 and 60 DAS during both the years. The results are in close conformity with those of Singh and Prasad, 2008, and Abdalla, *et al.,* 2011. This was mainly due to fact that the better availability of nitrogen to various plant parts.

The interaction effect of nitrogen and microbial inoculants on number, fresh, dry weight of root nodules at 30 and 45 DAS and plant height at 30 and 60 DAS during first year 2011-2012 as well as 2012-2013 was found non-significant.

Nitrogen, 20 kg ha^{-1} which produced higher nodulation whereas 30 kg N ha^{-1} which produced higher plant height of chickpea. Also, improvement in plant height and nodulation in inoculated plot with rhizobial inoculation, which is important for atmospheric nitrogen fixation. Thus, it may be concluded that seed inoculation with Rhizobia gave highest value related to plant height, number, fresh weight and dry weight of nodules.

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