Trends in Biosciences 7(5): 396-399, 2014

Effect of Nitrogen, *Rhizobium* and PSB on Chickpea (*Cicer arietinum*)- Yield and Quality

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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 (*Rhizobium* CAT 4059, *Rhizobium* CAT 5078, PSB) and nitrogen levels (0, 10, 20, 30 kg ha^{-1}) on yield and quality of chickpea (*Cicer arietinum* L.). Nitrogen application had significant effect on the seed yield, straw yield, nitrogen content and protein content in grain and straw during both the years. Inoculation of *Rhizobium* strain CAT 5078 had also significant effect on the seed yield, straw yield, nitrogen and protein content in grain and straw during both the years. The highest seed and straw yield was obtained with 20 kg N ha^{-1} + inoculation of *Rhizobium* CAT 5078 during 2011-2012 and in 2012-2013. The highest nitrogen content in grain was obtained under treatment 30 kg N ha^{-1} + inoculation of *Rhizobium* CAT 5078 during 2011-2012 as well as in 2012-2013.

Key words *Chickpea, nitrogen, rhizobium, PSB, yield, quality*

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 along with 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).

Nitrogen, being a major constituents of protein and chlorophyll must be adequately and timely supplied to the crop. Although pulses are capable of extracting nutrients from soils and fixing atmospheric nitrogen yet they need a small basal dose of nitrogen fertilizer for quick and better start. *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 seed inoculation with *Rhizobium* increased nodule plant^{-1} by 16-65 per cent of chickpea (Tippannavar and Desai, 1992).

Phosphorus solubilizing bacteria (PSB) can solubilize and mineralize P from inorganic and organic pools of total soil P and may be used as inoculants to increase P-availability to plants (Illmer, *et al.,* 1995; Whitelaw, *et al.,* 1999) and also have the capacity to increase the growth and yield of crop plants (Gupta and Namdeo, 1997; Ozgonen, *et al.,* 1999) besides reducing disease severity (Weller, 1988; Siddiqui and Mahmood, 1999).

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* season 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). Seed yield and straw yield were determined after harvest. For protein analysis, five other randomly and physiologically matured plants were selected from subplot. The dried seed and straw powder was analysed for their protein contents following the procedure of modified micro Kjeldahl's methods as suggested by Jackson, 1973. Per cent protein content in grain and straw with a factor of 6.25 (AOAC, 1970).

Table 1. Effect of nitrogen levels and microbial inoculants on seed yield and straw yield of chickpea

Treatment	Seed yield (q ha^{-1})										Straw yield (q ha^{-1})									
	2011-12					2012-13					2011-12					2012-13				
	M_0	M_1	M_2	M_3	Mean	M_0	M_1	M_2	M_3	Mean	M_0	M_1	M_2	M_3	Mean	M_0	M_1	M_2	M_3	Mean
N_0	13.35	16.17	18.78	17.70	16.50	13.62	16.49	19.16	18.05	16.83	19.23	23.55	28.35	27.66	24.70	19.42	23.79	28.63	27.94	24.94
N_{10}	17.74	21.08	24.73	23.28	21.71	18.09	21.50	25.22	23.74	22.14	25.83	30.69	37.64	37.63	32.95	26.09	31.00	38.02	38.00	33.28
N_{20}	18.97	21.57	31.20	25.49	24.31	19.35	22.00	31.83	26.00	24.79	26.15	32.18	51.75	39.43	37.38	26.42	32.50	52.26	39.82	37.75
N_{30}	20.32	23.02	29.07	25.05	24.36	20.73	23.48	29.65	25.55	24.85	27.82	36.09	44.32	46.74	38.75	28.10	36.46	44.77	47.21	39.13
Mean	17.59	20.46	25.95	22.88		17.95	20.87	26.47	23.34		24.76	30.63	40.52	37.86		25.01	30.94	40.92	38.24	
	M	N		M ×N		M	N		M×N		M	N		M×N		M	N		M×N	
SEm±	0.40	0.40		0.79		0.39	0.39		0.80		0.87	0.87		1.74		0.86	0.86		1.71	
CD at 5%	1.15	1.15		2.21		1.14	1.14		2.28		2.52	2.52		5.03		2.45	2.45		4.95	

RESULTS AND DISCUSSION

Seed and straw yield:

The data presented in Table 1 revealed that the application 30 kg N ha^{-1} being *at par* with 20 kg N ha^{-1} recorded significantly more grain and straw yield during first year 2011-2012 as well as in second year 2012-2013. Increase in grain yield due to increasing levels of nitrogen have also been reported by Solaiman, *et al.,* 2007 and Abdalla, *et al.,* 2013. The increase in straw yield is associated with more plant height per plant. The inoculation of *Rhizobium* CAT 5078 recorded significant more grain and straw yield as compared to rest of the microbial inoculants and uninoculated control during first year 2011-2012 as well as in second year 2012-2013. The increase in yields with microbial inoculation of *Rhizobium* CAT-5078 were mainly due to increase in all growth and yield attributing characters *viz*., plant height, branches plant^{-1}, pod plant^{-1}, 1000 seed weight which ultimately resulted in significant increase in grain and straw yield. The results are in close conformity with those of Abdalla, *et al.,* 2011, Gupta, 2006 and Barhate, *et al.,* 2004. The application of 20 kg N ha^{-1} and inoculation of *Rhizobium* CAT 5078 *at par* with application of 30 kg N ha^{-1} and inoculation of *Rhizobium* CAT 5078 gave the higher grain yield which was significantly greater than rest of combinations during first year (2011-2012) as well as in second year (2012-2013). Application of 20 kg N ha^{-1} and inoculation of *Rhizobium* CAT 5078 being *at par* with application of 30 kg N ha^{-1} and inoculation of PSB gave the highest straw yield which was significantly greater than rest of combinations during first year but in second year application of 20 kg N ha^{-1} and inoculation of *Rhizobium* CAT-5078 gave higher straw yield which was significantly greater then rest of combinations. Similar results also observed by Ali, *et al.,* 2011 in chickpea.

Quality:

The data presented in Table 2.1 and 2.2 revealed that use of 30 kg N ha^{-1} registered significantly more nitrogen content in grain and straw as well as protein content in grain and straw during first year as well as in second year. Similar results observed by Venkatesh and Basu, 2011, Solaiman, *et al.,* 2007. The inoculation of *Rhizobium* CAT-5078 registered significantly more nitrogen content in grain and straw as well as protein content in grain and straw

Table 2.1 Effect of microbial inoculants and nitrogen levels on nitrogen content in grain

Treatment	Nitrogen content in grain									
	2011-12					2012-13				
	M_0	M_1	M_2	M_3	Mean	M_0	M_1	M_2	M_3	Mean
N_0	2.77	2.85	2.88	2.82	2.83	2.78	2.92	2.97	2.83	2.88
N_{10}	2.80	2.86	3.02	2.90	2.89	2.80	2.95	3.03	2.91	2.93
N_{20}	2.86	2.90	3.19	2.93	2.97	2.80	2.94	3.26	3.01	3.03
N_{30}	2.92	2.96	3.42	2.93	3.06	2.97	3.22	3.47	3.06	3.18
Mean	2.84	2.89	3.13	2.89		2.86	3.01	3.18	2.95	
	M	N		M ×N		M	N		M×N	
SEm±	0.01	0.01		0.03		0.01	0.01		0.03	
CD at 5%	0.04	0.04		0.09		0.04	0.04		0.09	

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

Table 2.2. Effect of nitrogen levels and microbial inoculants on quality parameters

S.No.	Treatment	N content in Straw (%)		Protein content			
				Grain (%)		Straw (%)	
		2011-2012	2012-2013	2011-12	2012-2013	2011-12	2012-2013
A. Nitrogen levels (kg ha^{-1})							
1	Control	0.61	0.64	17.69	17.98	3.79	3.98
2	10	0.62	0.67	18.11	18.28	3.90	4.17
3	20	0.66	0.69	18.56	18.91	4.12	4.32
4	30	0.71	0.73	19.12	19.87	4.42	4.55
	SEm±	0.007	0.007	0.171	0.146	0.044	0.042
	CD at 5%	0.020	0.019	0.493	0.423	0.126	0.121
B. Microbial inoculants							
1	Un-inoculation	0.57	0.62	17.74	17.86	3.57	3.87
2	CAT-4059	0.65	0.67	18.12	18.82	4.05	4.20
3	CAT-5078	0.77	0.79	19.53	19.90	4.79	4.91
4	PSB	0.61	0.65	18.10	18.46	3.81	4.04
	SEm±	0.007	0.007	0.171	0.146	0.044	0.042
	CD at 5%	0.020	0.019	0.493	0.428	0.126	0.121
C. Interaction M × N		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

during first year as well as in second year. The results confirmed with the observation of Abdalla, *et al.,* 2013 Akhtar and Siddiqui, 2007. The interaction effect of nitrogen and microbial inoculants on nitrogen content in straw, protein content in grain and straw did not reach to the level of significance during first year 2011-2012 as well as in second year (2012-2013) but nitrogen content in grain was perceptible during both the years. Application of 30 kg N ha^{-1} + inoculation of *Rhizobium* CAT-5078 gave the higher nitrogen content in grain which was significantly greater than rest of combinations during first year as well as in second year.

Nitrogen 30 kg ha^{-1} which produced higher seed yield, straw yield and quality components of chickpea. Also, improvement in seed yield, straw yield and quality component in inoculated treated plot with rhizobia inoculation, which is important for atmospheric nitrogen fixation. Thus, it may be concluded that seed inoculation with *Rhizobium* gave highest values related to yield and quality component of chickpea.

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Recieved on 07-01-2014 *Accepted on 28-01-2014*