Sanjeev Sharma *et al*, International Journal of Advances in Agricultural Science and Technology,
Vol.6 Issue.11, November-2019, pg. 18-24 **ISSN: 2348-1358**
Impact Factor: 6.057
NAAS Rating: 3.77

Combined Effect of Rhizobium, Phosphorus Solubilizing Bacteria and Azotobacter Inoculation on Nodulation, Nutrient Uptake and Yield of Chickpea Under Amended Alkali Soil

Sanjeev Sharma; R.K. Pathak; Hanuman Prasad Pandey
Department of Soil Science and Agricultural Chemistry
C.S. Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh – 208002
Email: hanuman16794@gmail.com

ABSTRACT: A field experiment on chickpea (*Cicer arietinum*) was conducted for three consecutive years to study and evaluate the effect of symbiotic N_2 fixing bacteria (Rhizobia) with and without symbiotic N_2 fixer (Azotobacter) and P solubilizing bacteria an chickpea grain yield, crude protein content, N, P uptake as also changes in chemical characteristics of amended alkali soil. The treatment comprised of 8 treatments i.e. T_1 control with no inoculation T_2, Azotobacter inoculation T_3 P.S.B. inoculation, T_4 Rhizobia, inoculation, T_5 Rhizobium +PSB, T_6 Rhizobium + Azotobacter T_7 Azotobacter + PSB, T_8 Rhizobium + PSB+ Azotobacter. Three years observation clearly revealed significantly high nodulation and grain yield were recorded in combined inoculation treatment (Rhizobium +PSB+ Azotobacter). Even seed inoculation with Rhizobium and PSB alone, could significantly increase the nodule dry weight plant^{-1} and grain yield of chickpea. Similar observations were recorded in terms of crude protein and uptake of nutrients (N and P). Combined inoculation of chickpea seeds not only increased crop yield significantly but improved soil property in term of pH_s ECe dsm^{-1}) and ESP.

INTRODUCTION

Chickpea (*Cicer arietinum*) is commonly known as gram. Chickpea occupies about 35% of area under pulses and contribute about 50% of total pulse production in India. The area and production of chickpea in Uttar Pradesh are 5.25 lakh hectare and 3.98 lakh tonnes respectively. Chickpea productivity in Uttar Pradesh is about 75 6.51 Kgha^{-1}. Concerted effort made towards reclaiming sodic soil in Uttar Pradesh has made possible to put additional area which was hitherto to barren, under cultivation and growing crops. Soil, which was originally sodic in nature (PHs9.5, Ece 8.6 dsm^{-1}, ESP 62.5) was reclaimed by introducing standard technique, developed by Central Soil Salinity Research Institute, Karnal,

Haryana improving soil characteristics with pHs 8.1, ECe 1.8 dsm^{-1}, ESP 18.5. Meager information is available on combined effect of Rhizobium, phosphorus solubilizing bacteria (PSB) and Azotobacter inoculation in chickpea and their utility in enriching the soil N and P status. Keeping above in view the present investigation was undertaken to evaluate the effect of symbiotic N-fixer (Rhizobium) together with N_2 fixer (Azotobacter) and P solublizer on chickpea grain yield, crude protein content, N and P uptake.

MATERIAL AND METHOD

Field trial was conducted on the farm located at K.V.K. Thariyaon Fatehpur. The soil (amended) of the experimental field was sandy loam with pHs 7.9, ECe 1.5 dsm^{-1}, ESP 18.5, organic carbon 3.29 kg^{-1} and available NPK 157, 16 and 134 $kgha^{-1}$ respectively. The experiment was laid out in a randomized block design with eight treatments and replicated thrice. The treatments comprised of T_1 control, T_2, T_3 and T_4 Azotobacter, P.S.B. and Rhizobium respectively; T5 Rhizobium + PSB; T6 Rhizobium + Azotobacter; T7 Azotobacter + P.S.B. T_8 Rhizobium + PSB + Azotobacter seed inoculation. Observations on nodulation at 40 days after sowing and on grain yield at the harvest were recorded. The grain and straw samples were analysed for N content and P content by method prescribed by Koening and Johnson (1942). Crude protein in grain was calculated by % N in grains multiplied with 6.25. Soil available N.P.K. and other parameters were determined by procedure prescribed by Jackson (1973).

RESULTS AND DISCUSSION

Treatment effects on nodulation and grain yield of chickpea are presented in table 1 which clearly revealed beneficial effect of inoculation over no inoculation. Critical examination of the data revealed that seed inoculation with Rhizobium and PSB alone could significantly increase nodule dry weight per plant from 18 to 23 and 45 (mg $plant^{-1}$) and average grain yield of chickpea to 19% and 13% respectively over control (no inoculation). Even inoculation of seed with Azotobacter helped in improving mean grain yield

significantly over control. As regards combined effect, the inoculation of seed with Rhizobium + PSB + Azotobacter influenced maximum nodulation and grain yield increase with mean value of 55 (dry wt mg plant^{-1}) and 1570 kgha^{-1} respectively over control. Beneficial effect of combined inoculation on nodulation and grain yield of chickpea may be due to enhanced P availability and biological nitrogen fixation on account of synergetic effect of Azotobacter and Rhizobium and PSB (Gupta et al. 1998; Sanoreia and Rawat 1981).

Maximum uptake of nutrients and increases in crude protein content as presented in table 2 was recorded in combined inoculation of treatment (Rhizobium + PSB+ Azotobacter). N. uptake in the combined inoculation treatment increased to 85.2 kgha^{-1} and P uptake increased to 9 kgha^{-1} from 57 kgha^{-1} and 3.5 kgha^{-1} respectively which was closely followed by Rhizobium + PSB the value being 83.0 and 8.0 kgha^{-1} in order. Similar observations were recorded with regard to crude protein content. Rhizobium + PSB and Azotobacter inoculation recorded highest value of 20.80% followed with Rhizobium + PSB (20.60%) as against 18.60% under control. Observation clearly indicate that Rhizobium inoculation together with PSB increased the nodulation and N2 fixation as also the availability of phosphorus to the crop which resulted in the increased N and P uptake as also crude protein in chickpea seeds. The results are corroborated with the findings of Gupta et al. (1998), Singh et al. (2014) and Sharma et al. (2015).

Available N and P content recorded after harvest of three cropping seasons, as shown in table 2 clearly revealed that maximum available N and P content in soil was recorded under combined inoculation treatment (Rhizobium + PSB + Azotobacter). Under combined inoculation treatment the available N (Kgha^{-1}) and P (Kgha^{-1}) showed increased value to the order of 180.4 Kgha^{-1} and 25.8 Kgha^{-1} respectively as against 135.0 Kgha^{-1} and 20.1 Kgha^{-1} respectively in control. Results further indicated that available N and available P content was observed to significantly higher in all treatments over control. Increased available N and P content is soil after three cropping season, may be due to synergetic effect of combined inoculation (Rhizobium + Azotobacter + PSB) on enhanced N fixation, P solubilization

resulting to increased N and P availability in the soil and to the crop. Increase in available N in soil due to Rhizobium and Azotobacter inoculation and enhanced available P in the soil due to phosphorus solubilizing bacteria has been reported by Pandey and Singh (2001) and Sarawagi et al. (1999).

Data presented in table 2 regarding chemical characteristics recorded after three cropping seasons clearly show the beneficial effect of increased cropping biomass as a consequence of combined inoculation of chickpea seeds. Maximum drop in pH, EG and ESP values were observed crop under combined inoculation treatment showing on are average drop from 8.1, 1.9 and 17.8 to 7.7, 1.0 and 13.0 respectively.

Table 1: Effect of Treatments on nodulation and grain yield of chickpea.

Treatments		Nodule dry wt. (mg plant^{-1}) at 40 Days of sowing	Grain yield (Kgha^{-1})	Increase in yield over control (%)	Increase in over control (Kgha^{-1})
		Mean of three crops	Mean of three crops		
T_1	Control (no inoculation)	18	1208		
T_2	Azotobacter	23	1320	9.1	111
T_3	Rhizobium	45	1440	19.0	231
T_4	P.S.B.	28	1370	13.4	162
T_5	Azotobacter +PSB	52	1550	28.3	342
T_6	Rhizobium + Azotobacter	45	1460	20.8	252
T_7	Azotobacter+ PSB	27	1455	20.4	247
T_8	Rhizobium +PSB+ Azotobacter	55	1570	29.0	362
	CD (P=0.05)	5.0	135		
	CV(%)	11.3	5.0		

Table 2: Effect of Treatments on crude protein, N, P uptake in soil and soil characteristics

		Mean crude protein in seed (%)	Mean uptake ($Kgha^{-1}$)		Available N in soil after three season ($Kgha^{-1}$)	Available P in soil after three season ($Kgha^{-1}$)	pHs	ECe (dsm^{-1})	ESP
			N	P					
T_1	Control (no inoculation)	18.60	57.0	3.50	135.0	20.1	8.1	1.9	17.8
T_2	Azotobacter	19.20	65.1	4.80	150.3	21.1	8.0	1.8	15.9
T_3	Rhizobium	19.70	74.1	5.98	163.4	21.0	8.0	1.9	16.0
T_4	P.S.B.	19.05	67.2	6.50	153.0	24.9	8.1	1.8	16.2
T_5	Rhizobium +PSB	20.60	83.0	8.0	166.0	25.0	7.8	1.1	15.0
T_6	Rhizobium + Azotobacter	20.40	76.7	6.20	173.5	20.5	7.8	1.0	14.0
T_7	Azotobacter+ PSB	20.05	74.3	7.50	159.9	25.2	7.9	1.0	13.0
T_8	Rhizobium +PSB+ Azotobacter	20.80	85.2	9.0	180.4	25.8	7.7	1.0	13.0
	CD (P=0.05)	1.10	5.10	0.68	4.8	2.8			
	CV(%)	3.2	3.70	5.90	1.9	10.0			

REFERENCES

[1]. Gupta, S.C., Namdeo, S.L. and Paliwal, K.K. (1998). Proceeding of 3rd European Conference on grain legumes, vallodilid pp 418-419

[2]. Jackson, M.L. (1973). Soil chemical analysis, Prentice Hall of India, Pvt. Ltd., New Delhi.

[3]. Koeing, R.A. and Johnson, C.R. (1942). Colorimetric determination of biological material. Industrial and Engineering Chemistry (Analytical edition) 14, 155-164.

[4]. Pandey, M. and Singh S. (2001). Annals of Soil and Plant Research, 3, 107-110.

[5]. Sharma, V.K. Pandey, R.N. Sharma, B.M. (2015). Indian Journal of Environmental Biology, 36: 241-247.

[6]. Singh, V.V. and Singh S.K. (2018). Indian Journal of Ecology 41(2) 282-285.

