Research Journal of Chemical and Environmental Sciences
Res J. Chem. Environ. Sci. Vol 2 [6] December 2014: 60-64
Online ISSN 2321-1040
CODEN: RJCEA2 [USA]

Website: www.aelsindia.com/rjces.htm

RJCES

ORIGINAL ARTICLE

Yield, protein content, nutrient content and uptake of chickpea (*Cicer arietinum* L.) as influenced by graded levels of fertilizers and bio-fertilizers

Dinesh Kumar, Arvadiya, L. K., Kumawat, A. K., Desai, K. L. And Patel, T. U.
Department of Agronomy, N.M. College of Agriculture, Navsari Agricultural University, Navsari-396450, India
Email: dk.agro1991@gmail.com

ABSTRACT
A field study was undertaken during winter (rabi) season of 2013-2014 to explore the effect of graded levels of fertilizers and bio-fertilizers on yield of chickpea, protein content in chickpea seeds and nutrient uptake by the crop. Significantly higher seed and stover yields (1854, 2722 kg ha^{-1}, respectively) were recorded with application of fertilizer @ 100% RDF (25:50:00, kg N:P:K ha^{-1}). Remarkable improvements in protein content, nutrient content as well as their uptake were also observed with the treatment of 100% RDF. Various treatments of bio-fertilizers also produced significant variation on yield, protein content and nutrient content and uptake by crop. The crop sown with Rhizobium and PSB both as seed treatment (B_4) showed significant improvement in seed yield (1824 kg ha^{-1}) and stover yields (2709 kg ha^{-1}) but remained at par with Rhizobium as seed treatment + PSB as soil application (B_2) and Rhizobium as seed treatment + VAM as soil application (B_3). Considerable improvement in nutrient content and uptake was also noticed under Rhizobium and PSB both as seed treatment (B4). Significantly higher protein content in chickpea seeds was recorded with Rhizobium and PSB both as seed treatment (B_4), but it remained at par with Rhizobium as seed treatment + PSB as soil application (B_2) and Rhizobium as seed treatment + VAM as soil application (B_3).
Keywords: *Bio-fertilizers, Chickpea, RDF (Recommended dose of fertilizers), Rhizobium, Protein*

Received 21.08.2014 Accepted 17.10.2014

INTRODUCTION

India is the largest producer and importer of the leguminous crops [1]. Amongst the leguminous crops, Chickpea occupies an important position due to its nutritious value (17-23% protein) in large vegetarian population of the country [2]. According to Akhtar and Siddiqui, [3] during last decade the production of chickpea have declined. In India, it occupies about 9.18 million hectare area with production of 8.22 million tonnes and an average productivity of 900 kg ha^{-1} [4]. In spite of the importance of this crop in our daily diet and in agricultural production, productivity of this crop is very low in India. The low production of this crop is due to improper use of fertilizers and least importance given to bio-fertilizers such as *Rhizobium*, PSB and VAM fungi. The increasing demand for production of crops and food for such a vast population has led to an interest and necessity for the use of bio-fertilizers for the betterment of these crops and even for the health of the soil. Biofertilizers can be a very good complimentary to fertilizers. Fertilizers like nitrogen and phosphorus are the most important elements as well as expensive inputs in crop production. An adequate supply of chemical fertilizers is closely associated with growth and development of plant. *Rhizobium* inoculation can increase the grain yield of pulse crops to the tune of 10 to 15 per cent [5]. Phosphate solubilizing bacteria (PSB) have the consistent capacity to increase the availability of phosphates to plants by mineralizing organic phosphorus compounds. Additional inoculation with selected VAM strains, which are available as commercial products, often yields better growth promotion than indigenous VAM fungi populations [6].

MATERIALS AND METHODS

The present study was conducted throughout *rabi* season of 2013-14 at the College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari to study the effect of graded levels of fertilizers and bio-fertilizers on growth and yield of chickpea (*Cicer arietinum* L.). Soil of the experimental field was clayey in texture and showed low, medium and high rating for available nitrogen (197 kg ha^{-1}),

phosphorus (30 kg ha^{-1}) and potassium (369 kg ha^{-1}), respectively. The soil was found slightly alkaline (pH 7.8) with normal electrical conductivity (0.36 dSm^{-1}).The experiment was conducted in factorial randomized block design with total 12 treatment combination consisting of 3 levels of fertilizers viz.,100% RDF (F_1), 75% RDF (F_2) and 50% RDF (F_3) and 4 levels of bio-fertilizers viz.,Control (no bio-fertilizer) (B1), Rhizobium as seed treatment and PSB as soil application (B_2), Rhizobium as seed treatment and VAM as soil application (B_3), and Rhizobium and PSB both as seed treatment (B_4) with 3 replications. The seeds were drilled 5-8 cm deep in previously opened furrows on 25th October, 2013. After harvesting the produce of each net plot was trashed and cleaned separately and the seed yield was recorded in kilograms per net plot and converted into kg ha^{-1} after subjected to sun drying upto constant weight. Representative samples of seeds were taken from each treatment and dried in oven at 65°C temperature for 24 hours and powdered by mechanical grinder. Then the nitrogen content of seed was determined by micro kjheldahl's method [7]. Protein content of seed was determined by multiplying nitrogen percentage with 6.25. Representative sample from crop was taken separately from each plot for estimation of N, P and K content. The samples were oven dried at 60ºC for 24 hrs, powdered by mechanical grinder and analyzed for respective nutrient content using following procedures.

Sr. No.	Particular	Procedure used	Reference
1.	Nitrogen (%)	Modified Kjeldahl's Method	[7]
2.	Phosphorus (%)	Vanadomolybdo phosphoric acid yellow colour method	[7]
3.	Potash (%)	Flame photometric method	[7]

The uptakes of nutrients were calculated by using the following formula:

$$\text{Uptake of nutrient (Kg ha}^{-1}\text{)} = \frac{\text{Nutrient content (\%) of the seed/stover X Seed/stover yield (kg ha}^{-1}\text{)}}{100}$$

Inoculation of bio-fertilizers

Rhizobium and PSB cultures (liqiud form) purchased from biofertilizer unit, NAU, Navsari while VAM (powder form) purchased from Kissan agro services, Navsari were used for this experiment. The viability count and microbial load of microorganisms used in this experiment are shown in Table 1.

Table 1. Viability count and microbial load of microorganisms used in the study

Bio-fertilizers	Viability count	Microbial load
Rhizobium	1 x 10^8 CFU/ml	1 x 10^8 Cells/ml
PSB	1 x 10^8 CFU/ml	1 x 10^8 Cells/ml
VAM	1.8 x 10^4 IP/g	1.8 x 10^4 IP/g

CFU/ml: Colony Forming Units per 1 ml of liquid culture, IP/g: Infective Propagules per gram

Seed treatments of Bio-fertilizers for treatments B_2, B_3 and B_4 were applied to seeds prior to sowing. Jaggery was prepared by dissolving 100 g of sugar in 1000 ml of water; the solution was boiled and then cooled. The *rhizobium* and PSB inoculants (@ 20 g per kg seed) were then mixed with the sugar solution separately (for treatments B_2 and B_3) or in combination (for treatment B_4). Thereafter, the seeds were mixed with the respective bio-fertilizer treatments, taking care that all the seeds were equally coated with the bio-fertilizer slurry. Bio-fertilizer coated seeds were spread on a polythene sheet and allowed to dry in the shade. Then seeds were drilled 5-8 cm deep in previously opened furrows. For the soil application of bio-fertilizers (for treatments B_2 and B_3) required quantity of PSB culture @ 15 ml and VAM @ 90 g for the experimental area was thoroughly mixed with 1.2 kg sand each and uniformly applied in furrows as per treatments before sowing.

Statistical analysis

The statistical analysis of data recorded for different characters during the course of investigation was carried out through the procedure appropriate to the Factorial Randomized Block Design of the experiment as described by Panse and Sukhatme, [12]. The significance of difference was tested by 'F' test. Five per cent level of significance was used to test the significance of results. The critical differences were calculated when the differences among treatments were found significant in 'F' test.

RESULT AND DISCUSSION

Grain yield, stover yield and protein content

Effect of fertilizer levels

The data presented in Table 2 indicates that the seed yield, stover yield and protein content in chickpea seeds was recorded significant. Significantly maximum grain yield of 1854 kg ha^{-1} was obtained under 100% RDF against 1736 and 1473 kg ha^{-1} at 75% RDF and 50% RDF, respectively. Straw yield was recorded significantly maximum with the application of 100% RDF (2722 kg ha^{-1}). Almost similar findings were also reported by Sharma and Abrol [8], Ali *et al*. [9], Thenua and Sharma [10] and Uddin *et al*. [11]. Higher fertilizer level (100% RDF) also significantly influenced the protein content (20.78 %) in chickpea seeds. Similar promotive effects of fertilizer levels on protein content have also been reported by Uddin *et al.* [11].

Effect if bio-fertilizers

As indicated in Table 2 the bio-fertilizer treatments affected grain yield, stover yield and protein content. Significantly higher values for seed yield, stover yield and protein content were observed with the application of *Rhizobium* and PSB both as seed treatment (B_4). Treatment B_4 was statistically equivalent to *Rhizobium* as seed treatment and PSB as soil application (B_2) and *Rhizobium* as seed treatment and VAM as soil application (B_3). The magnitude of increase in seed yield and stover yield kg ha^{-1} under B_4, B_3 and B_2 were 28.27 and 24.44 %, 23.35 and 19.20 % and 23.00 and 18.24%, respectively, over B_1 (No bio-fertilizer). Similar trends of results were also found in case of seed protein content in chickpea seeds. Significantly maximum protein content (21.04%) was recorded with the treatment B_4 (*Rhizobium* and PSB both as seed treatment) but it remained on par with treatment B_2 (*Rhizobium* as seed treatment and PSB as soil application) and B_3 (*Rhizobium* as seed treatment and VAM as soil application). The present results match other findings that confirm the enhancement of seed and stover yields and improvement in protein content due to application of bio-fertilizers [13, 14, 15, 16, 17, 11].

Table 2. Effect of fertilizer levels and bio-fertilizers on yield and protein content of chickpea

Treatments	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Protein content percent
Fertilizer levels			
F_1	1854	2722	20.78
F_2	1736	2520	19.68
F_3	1473	2299	19.47
S.Em. ±	39.30	66.58	0.31
C.D. at 5%	115.28	195.29	0.92
Bio-fertilizers			
B_1	1422	2177	18.43
B_2	1749	2574	20.25
B_3	1754	2595	20.18
B_4	1824	2709	21.04
S.Em. ±	45.38	76.88	0.36
C.D. at 5%	133.11	225.51	1.07

F_1 : 100% RDF, F_2 : 75% RDF, F_3 : 50% RDF, B_1 : Control (no bio-fertilizer), B_2 : *Rhizobium* as seed treatment + PSB as soil application, B_3 : *Rhizobium* as seed treatment + VAM as soil application, B_4 : *Rhizobium* and PSB both as seed treatment.

N, P and K content and uptake in chickpea seeds and stover

Effect of fertilizer levels

Data presented in Table 3 revealed that fertilizer levels significantly affected the N, P, K content as well as their uptake by chickpea seeds and stover. Treatment 100% RDF resulted in the highest values for the N, P, K content and their uptake by chickpea seeds and stover both. Thus 100% RDF proved to be the optimum fertilizer level surpassing the 50% RDF by 6.75% in N content in seeds, by 33.33% in N content in stover, by 31.03% in P content in seeds, by 29.41% in P content in stover, by 18.84% in K content in seed, by 16.26% in K content in stover, by 33.61% in N uptake by chickpea seeds, by 57.68 % in N uptake by chickpea stover, by 61.81% in P uptake in seeds, by 47.66% in P uptake by stover, by 47.25% in K uptake by seeds and by 36.10% in K uptake by chickpea stover. The present findings are in agreement with those reported by, Shivakumar *et al.* [18], Patel *et al*. [19], Sharma and Abrol [8], Thenua and Sharma [10] and Uddin *et al.* [11].

Effect of bio-fertilizers

Data regarding to N, P, K content and their uptake in chickpea seeds as well as stover as influenced by bio-fertilizer treatments are presented in Table 3. The effect of bio-fertilizer treatments was significant in N, P, K content and their uptake in chickpea seeds and stover. Significantly maximum values for all the N, P, K content and uptake by both chickpea seeds and stover were recorded with the treatment B_4 (*Rhizobium*

and PSB both as seed treatment) but it remained on par with treatment B_2 (*Rhizobium* as seed treatment and PSB as soil application) and B_3 (*Rhizobium* as seed treatment and VAM as soil application) except in case of N uptake in chickpea stover and P uptake in chickpea seeds which found significantly maximum in treatment B_4 (*Rhizobium* and PSB both as seed treatment) over all the remaining treatments. Almost similar results were also reported by Thenua and Sharma [10], Gangwar and Dubey [20] and Uddin *et al.* [11].

CONCLUSION

Present study clearly demonstrated that application of 100% RDF affected positively seed yield, stover yield, protein content and N, P, K content and their uptake by chickpea seeds as well as stover. Inoculation of different bio-fertilizers like *Rhizobium*, PSB and VAM fungi either as seed treatment or soil application exhibited positive influence on yield, quality and nutrient concentration and their uptake by chickpea seeds and stover.

Table 3. Effect of fertilizer levels and bio-fertilizers on N, P, K content and uptake in chickpea seeds and stover

Treatments	N content (%)		P_2O_5 content (%)		K_2O content (%)		N uptake (kg ha^{-1})		P uptake (kg ha^{-1})		K uptake (kg ha^{-1})	
	Seeds	Stover	Seeds	Stover	Seeds	Stover	Seeds	Stover	Seeds	Stover	Seeds	Stover
Fertilizer levels												
F_1	3.32	1.32	0.76	0.22	0.82	1.43	61.97	36.22	14.11	6.01	15.30	39.02
F_2	3.14	1.17	0.69	0.19	0.74	1.30	54.82	29.85	12.09	5.04	13.01	33.02
F_3	3.11	0.99	0.58	0.17	0.69	1.23	46.38	22.97	8.72	4.07	10.39	28.67
S.Em. ±	0.05	0.03	0.02	0.008	0.02	0.04	1.78	1.13	0.45	0.23	0.54	1.37
C.D. at 5%	0.14	0.10	0.06	0.02	0.05	0.11	5.23	3.32	1.34	0.67	1.59	4.04
Bio-fertilizers												
B_1	2.95	1.01	0.61	0.17	0.70	1.22	42.24	22.27	8.86	3.86	10.16	26.87
B_2	3.24	1.17	0.67	0.20	0.75	1.32	56.75	30.36	11.91	5.15	13.35	34.14
B_3	3.23	1.18	0.68	0.20	0.75	1.33	56.94	31.04	12.11	5.24	13.34	34.64
B_4	3.36	1.27	0.74	0.21	0.80	1.41	61.62	35.05	13.68	5.90	14.74	38.62
S.Em. ±	0.06	0.04	0.03	0.009	0.02	0.04	2.06	1.30	0.52	0.26	0.62	1.59
C.D. at 5%	0.17	0.11	0.08	0.02	0.06	0.12	6.04	3.83	1.55	0.78	1.83	4.66

F_1 : 100% RDF, F_2 : 75% RDF, F_3 : 50% RDF, B_1 : Control (no bio-fertilizer), B_2 : Rhizobium as seed treatment + PSB as soil application, B_3 : Rhizobium as seed treatment + VAM as soil application, B_4 : Rhizobium and PSB both as seed treatment.

ACKNOWLEDGEMENT

This research was supported by Department of Agronomy, N.M. College of Agriculture, Navsari Agricultural University, Navsari and carried out under the direct supervision of Dr. L. K. Arvadiya, Associate professor (Agronomy), NAU, Navsari. The auther is thankful to his major advisor Dr. L. K. Arvadiya, his friends A K Kumawat, Sandeep budaniya and Satyapal choudhary, didi Manju Mohanlal Yadav, and Dept. of Agronomy, NMCA, NAU, Navsari for their kind help and support.

REFERENCES

1. Shakya, M. S.: Patel, M .M. and Singh, V. B. 2008. Knowledge level of chickpea growers about chickpea production technology. *Indian Res. J Ext. Edu*. **8**: 65-68
2. Ali, M. and Kumar, S. (2006). Pulse production in India. Yojana, Sept. pp. 13-15.
3. Akhtar, M. A. and Siddiqui, Z. A.(2009). Effects of phosphate solubilising microorganisms and *Rhizobium sp.* On the growth, nodulation, yield and root rot disease complex of chickpea under field condition. *African Journal of Biotechnology*. **8** (15): 3489-3496.
4. Anonymous, (2013). Statistical year book, India 2013. Ministry of statistics and programme implementation. http://www. http://mospi.nic.in/Mospi_New/upload/SYB2013/index1.html
5. Ali, M. and Chandra, S. (1985). Rhizobium inoculation of pulse crop. *Indian Farming*, **35** (5) : 22-25.
6. Salami, A.; Olusola, O. and Nnenna, I. 2005. An investigation of the impact of *Glomus clarum* (mycorrhiza) on the growth of tomato (*Lycopersicum esculentum* Mill.) on both sterilized and non-sterilized soils. *Archives of Agron. and Soil Sci*., **51**, 579-588.
7. . Jackson, M. L. (1967). "Soil Chemical Analysis". Prentice Hall of India, New Delhi, pp. 183-192.
8. Sharma, V. and Abrol, V. 2007. Effect of phosphorus and zinc application on yield and uptake of P and Zn by chickpea under rainfed conditions. *Journal of Food Legumes*, **20** (1) : 49-51.
9. Ali, A.; Ali, Z.; Iqbal, J.; Nadeem, M. A.; Akhtar, N.; Akram, H. M. and Sattar, A. (2010). Impact of nitrogen and phosphorus on seed yield of chickpea. *J. Agric. Res.*, **48** (3) : 335-343.
10. Thenua, O. V. S. and Sharma, R. K. 2011. Effect of phosphorus, sulphur and phosphate solubilizing bacteria on productivity and nutrient uptake of chickpea (*Cicer arietinum* L.). *Ann. Agric. Res. New Series*, **32** (3 & 4) : 116-119.

11. Uddin, M.; Hussain, S.; Khan, M. M. A.; Hashmi, N.; Idress, M.; Naeem, M. and Dar, T. A. 2014. Use of N and P biofertilizer reduces inorganic phosphorus application and increases nutrient uptake, yield and seed quality of chickpea. *Turk J. Agric. For*, **38** : 47-54.
12. Panse, V. G. and Sukhatme, P. V. 1967. Statistical methods for Agricultural workers, ICAR, New Delhi, pp. 187-197.
13. Giri, N. and Joshi, N. C. (2010). Growth and yield response of chickpea (*Cicer arietinum* L.) to seed inoculation with *Rhizobium sp. Nature and Science*, 2010;8(9).
14. Mohammadi, K.; Ghalavand, A. and Aghaalikhani, M. (2010). Effect of organic matter and biofertilizers on chickpea quality and biological nitrogen fixation. *World Academy of Science, Engineering and Technology*, **44** : 966-971.
15. Rabieyan, Z.; Yarnia, M. and Kazemi-e-Arbat, H. 2011. Effects of bio-fertilizer on yield and yield components of chickpea (*Cicer arietinum* L.) under different irrigation levels. *Australian J. of Basic and Applied Sci*., **5** (12) : 3139-3145.
16. Maya, C.; Roopa, B.; Makari, H. K. and Nagraj, K. (2012). The synergistic effect of VAM fungi with Rhizobium on the growth and yield of *Cicer arietinum* L*. Online International Interdisciplinary Research Journal*, {Bi-Monthly}, Volume-II, Issue-I, Jan-Feb2012.
17. Abdalla, A. S.; Abdelgani, M. E. and Osman, A. G. (2013). Effects of biological and mineral fertilization on yield, chemical composition and physical characteristics of chickpea (*Cicer arietinum* L.) seeds. *Pakistan J. of Nutrition,* **12** (1) : 01-07
18. Shivakumar, B. G.; Balloli. S. S. and Saraf, C. S. 2004. Effect of sources and levels of phosphorus with and without seed inoculation on the performance of rainfed chickpea (*Cicer arietinum* L.). *Ann. Agric. Res*. New Series, **25** (2) : 320-326
19. Patel, D.; Arvadia, M. K. and Patel, A. J. (2007). Effect of integrated nutrient management on growth, yield and nutrient uptake by chickpea on Vertisol of South Gujarat. *Journal of Food Legumes*, **20** (1) : 113-114.
20. Gangwar, S. and Dubey, M. 2012. Effect on N and P uptake by chickpea (*Cicer arietinum* L.) as influenced by micronutrients and bio-fertilizers. *Legume Res*., **35** (2) : 164-168.

CITE THIS ARTICLE
Dinesh Kumar, Arvadiya, L. K., Kumawat, A. K., Desai, K. L. And Patel, T. U.Yield, protein content, nutrient content and uptake of chickpea (*Cicer arietinum* L.) as influenced by graded levels of fertilizers and bio-fertilizers. Res. J. Chem. Env. Sci. Vol 2 [6] December 2014. 60-64