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Effect of integrated nutrient management on productivity, soil fertility and economics of chickpea (*Cicer arietinum* Linn.) varieties in vertisols

B.S. Meena* and Baldev Ram

Maharana Pratap University of Agriculture and Technology, Udaipur, Krishi Vigyan Kendra, Kota-324001 (Rajasthan)
**e-mail: bsmeena1970@yahoo.in, baldev.ram@gmail.com*

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ABSTRACT

A field experiment was conducted during winter (*rabi*) seasons of 2010-11 and 2011-12 at farmer's field of Nayagoan, Kota, Rajasthan to evaluate performance of 5 chickpea varieties (GNG 469, GNG 663, RSG 973, RSG 888 and Dahod yellow) and 9 nutrient management practices (T_1:No application of NP (Control), T_2:NP (20:22 kg/ha as farmer practice), T_3: NP (20:17.2 kg/ha as RDF), T_4:RDF+25 kg K/ha, T_5:RDF+25 kg K+20 kg S/ha, T_6:RDF+25 kg K+20 kg S+5 kg Zn/ha, T_7:RDF+25 kg K+20 kg S+5 kg Zn/ha+2 % urea spray at 70 DAS,T_8:RDF+25 kg K+20 kg S+5 kg Zn/ha+*Rhizobium* (RZ) +*Phosphate solubilizing* bacteria (PSB) + 2 % urea spray at 70 DAS and T_9:RDF+25 kg K+20 kg S+5 kg Zn/ha + RZ + PSB + 5 tons FYM/ha + 2 % urea spray at 70 DAS) on productivity, soil fertility and economics in vertisols of irrigated situation. Application of RDF + 25 kg K + 20 kg S + 5 kg Zn/ha along with seed inoculation with *rhizobium* + PSB + 2 % urea spray at 70 DAS recorded significantly higher plant height (69.50cm), branches/plant (7.30), pods/plant (80.82), seed index (20.50g), seed yield (2.62 t/ha), net return (Rs. 47,684/ha) and benefit: cost ratio 3.69 over control, RDF, farmer practices and RDF+ 25 K kg/ha. However, treatment RDF + 25 kg K + 20 kg S + 5 kg Zn/ha + *rhizobium* + PSB + 5 t FYM/ha + 2% urea spray at 70 DAS significantly recorded higher available organic carbon (0.65 %), nitrogen (312 kg/ha), phosphorus (12.7 kg/ha), potassium (413 kg/ha), sulphur (20.2 kg/ha) and zinc (1.37 kg/ha) contents in the soil over rest of the treatments. Among the genotypes, 'RSG 973'recorded highest pods/ plant (85.20), seeds/pod (1.50), seed yield (2.51 t/ha), net return(47,428/ha) and B: C ratio (4.07) remained on par with 'RSG 888' and 'GNG 469' over 'Dahod yellow' and 'GNG 663'.

Keywords: Biofertilizer, chickpea, inorganic fertilizer, seed yield, soil fertility, vertisol.

Chickpea is the major grain legume crop of India, grown over 8.56 million ha area with a production of 7.35 million tonnes (FAO, 2009). It is mainly grown under rainfed situations but in south east part of Rajasthan it is grown under irrigated conditions after harvest of soybean without considering improved varieties. Chickpea also plays a major role in biological nitrogen fixation thereby contributing to crop rotation and sustaining soil productivity, nevertheless, its average productivity in India is low (859 kg/ ha), but in Rajasthan (1013 kg/ha) is slightly higher against a world average of 1000 kg/ha (FAO, 2011). However, major reason contributes for poor performance of chickpea in vertisols is improper fertilizers management and use of existing genotypes. The lack of suitable variety/plant type for prevailing agro-climatic conditions is a major constraint to harness the better yield. Adoptions of improved varieties have been reported by various workers for better growth and yield (Bharadwaj *et al.,* 2010).

Imbalance use of chemical fertilizers not only lower productivity but also adversely affects soil health by decreasing soil organic carbon, microbial flora and hardening of soil. The integrated nutrient management ensures higher productivity, minimizes expenditure on costly fertilizer inputs, improves physical properties of soil, efficiency of added nutrients and at the same time ensures good soil health (Ramesh and Singh, 2010). Combined application of chemical fertilizers, organic manures and biofertilizers improved chickpea productivity. But the information on nutrient management practices of chickpea in Vertisol of irrigated condition is very meager. Hence, a study was undertaken to evaluate performance of chickpea varieties for inorganic fertilizers, organic manure and biofertilizers on productivity, soil fertility and economics in vertisols of irrigated situation.

Materials and Methods

The field experiment was conducted during winter (*rabi*) seasons of 2010-11 and 2011-12 to test the suitability of chickpea varieties for integrated nutrient management practices at farmer's field of Nayagoan, Kota, Rajasthan under Technology Demonstration for Harnessing Pulse Productivity Project. The experiment was laid out in different fields during both the years. The demonstrated soil was clay loam in texture with pH ranging from 7.9 to 8.2, poor in organic carbon 0.48 to 0.51% and in available N (275 to 279 kg N/ha), medium in available phosphorus (11.5 to 15.0 kg P/ ha), high in available K (373 to 369 kg K/ha), zinc (1.20 to 1.18 mg) and low in sulphur (14.5 to 14.7 kg S/ ha). The experiment was laid out in split plot design with 3 replications. Main-plots treatments consisted of 5 chickpea varieties, *viz.* 'GNG 469', 'GNG 663', 'RSG 973', 'RSG 888' and 'Dahod yellow' (Farmer's practice). Sub-plots treatments comprised of 9 integrated nutrient management practices, *viz.* T_1:No application of NP (Control), T_2:NP (20:22 kg/ha as farmer practice), T_3:NP (20:17.2 kg/ha as RDF), T_4:RDF+25 kg K/ha, T_5:RDF+25 kg K+20 kg S/ha, T_6:RDF+25 kg K+20 kg S+5 kg Zn/ha, T_7:RDF+25 kg K+20 kg S+5 kg Zn/ha+2% urea spray at 70 DAS, T_8:RDF+25 kg K+20 kg S+5 kg Zn/ha+Rhizobium (RZ) +Phosphate solubilizing bacteria (PSB) + 2% urea spray at 70 DAS and T9:RDF+25 kg K+20 kg S+5 kg Zn/ha + RZ + PSB + 5 tons FYM/ha + 2% urea spray at 70 DAS in different combinations. The recommended dose of N and P was 20:17.2 kg/ ha. These fertilizers were given through in the form of urea, DAP, muriate of potash, bentonite sulphur and zinc sulphate, respectively. All the fertilizers were applied as basal at the time of sowing.

Farmyard manure containing 0.5, 0.2 and 0.4% of N, P and K was incorporated and mixed well in the soil 15 days prior to sowing of the crop. Biofertilizers (*viz. Rhizobium* and *PSB*) in readymade liquid form were used through seed inoculation as per treatment. The rate of seed inoculation of each was 250 ml/ha and mixed with required quantity of seeds before sowing. The chickpea was sown in second week of November during both the years at 30 cm row to row and 10 cm plant to plant spacing using 80 kg seed/ha. 2% urea spray was done at 70 DAS. Pre-emergence application of pendimethalin 1.0 kg/ha was done after sowing with the help of a knapsack sprayer fitted with flat fan nozzle with a spray volume of 600 liters/ha. There was no rainfall during 2011-12, however during 2010-11 25.5 mm rainfall received in the third week of December. Irrigation was given to the crop as and when necessary by sprinkler system. The crop was harvested at maturity variety wise. Initial and post harvest soil samples after 2 years were collected from 0-15 cm depth, dried processed and analyzed for oxidizable organic carbon, N, P, K, S and Zn using standard procedure. The crop was raised adopting standard package of practices for the zone V.

Results and Discussion

Growth, yield attributes and yield

All the genotypes recorded marked variation in days taken to 50% flowering, maturity, plant height, branches/plant, pods/ plant, seeds/pod and seed index (Table 1). Among the genotypes, 'GNG 469' recorded significantly higher values of plant height, branches/plant and seed index than 'Dahod yellow' and 'GNG 663' but remained on par with 'RSG 973' and 'RSG 888' except in seed index, which was recorded highest seed index (22.1 g)

Table 1. Effect of integrated nutrient management practices on yield attributes and yields of chickpea varieties (Mean of 2 years)

Treatment	Days to 50% flowering	Days to maturity	Plant height (cm)	Branches/ plants	Pods/ plant	Seeds/ pod	Seed index (g)	Seed yield (t/ha)	Straw yield (t/ha)
Varieties									
'GNG 469'	80	142	69.50	7.80	79.10	1.00	22.10	2.42	3.02
'GNG 663'	75	140	66.20	6.90	65.24	1.30	15.20	2.24	3.15
'RSG 973'	75	137	67.70	7.50	85.20	1.50	18.50	2.51	3.13
'RSG 888'	75	137	67.40	7.60	83.50	1.75	17.80	2.49	3.02
'Dahod yellow'(Farmer's practice)	70	120	57.82	4.90	55.40	1.10	15.90	1.85	2.84
SEm ±	0.70	0.69	0.72	0.15	0.80	0.08	0.28	0.34	0.46
CD (P = 0.05)	2.27	2.24	2.34	0.49	2.60	0.26	0.90	1.11	1.49
Nutrient management practices									
No NP(Control)	68	118	55.50	4.86	55.49	1.15	14.85	1.65	2.73
NP(20:22 kg/ha as farmer practice)	69	130	66.80	7.00	68.50	1.20	17.30	2.27	2.99
NP(20:17.2 kg/ha as RDF)	68	131	66.70	6.52	69.30	1.22	17.15	2.27	3.01
RDF+25kg K/ha	70	130	66.90	6.50	70.20	1.27	17.29	2.32	2.95
RDF+25 kg K+20kg S/ha	70	132	68.30	6.85	72.30	1.26	18.40	2.33	3.10
RDF+25 kg K+20kg S+5kg Zn/ha	69	132	67.70	6.90	74.28	1.30	18.30	2.35	3.12
RDF+25kg K+20kg S+5kg Zn/ha+2% urea spray at 70DAS	70	132	68.80	7.00	78.20	1.30	19.00	2.47	3.02
RDF+25 kg K+20kg S+5kg Zn/ha+RZ+ PSB+ 2%urea spray at 70DAS	73	135	69.50	7.30	80.22	1.34	20.50	2.62	3.21
RDF+25 kg K+20kg S+5kg Zn/ha+RZ+ PSB +5tFYM/ha+2%urea spray at 70DAS	73	135	68.90	7.45	82.50	1.35	21.00	2.63	3.32
SEm ±	0.97	1.23	1.04	0.25	1.04	0.11	0.39	0.48	0.63
CD (P = 0.05)	2.70	3.41	2.87	0.68	2.89	NS	1.09	1.34	1.74

RDF-Recocmmended dose of fertilizer; RZ-*Rhizobium*, PSB-*Phosphate solubilizing bacteria*,FYM-Farmyard manure

Table 2. Economics of chickpea varieties and soil fertility as influenced by integrated nutrient management practice (Mean of 2 years)

Treatment	Cost of cultivation ($x10^3$ Rs/ha)	Gross returns ($x10^3$ Rs/ha)	Net returns ($x10^3$ Rs/ha)	Benefit: cost ratio	Soil organic carbon (%)	Soil available nutrient status (kg/ha) N	P	K	S	Zn (mg/kg)
Varieties										
'GNG 469'	15.4	59.6	45.2	3.93	0.51	307	10.20	415	15.30	1.22
'GNG 663'	15.4	56.1	40.6	3.63	0.52	302	10.30	410	14.30	1.34
'RSG 973'	15.4	62.9	47.4	4.07	0.51	304	11.00	412	14.41	1.34
'RSG 888'	15.4	62.4	46.9	4.04	0.50	301	10.30	415	15.45	1.32
'Dahod yellow'(Farmer's practice)	15.4	46.9	31.4	3.04	0.52	305	10.35	417	14.35	1.28
SEm ±	-	-	704	0.12	0.03	2.91	0.22	1.86	0.35	0.06
CD (P = 0.05)	-	-	2,216	0.37	NS	NS	0.77	6.08	NS	NS
Nutrient management practices										
No NP(Control)	14.2	41.9	27.7	2.94	0.48	265	9.20	375	14.30	1.18
NP(20:22 kg/ha as farmer practice)	15.9	57.0	41.1	3.57	0.53	277	10.70	389	14.80	1.22
NP(20:17.2 kg/ha as RDF)	15.7	56.9	41.2	3.62	0.54	275	10.40	385	14.42	1.24
RDF+25kg K/ha	15.9	58.3	42.4	3.66	0.53	276	10.60	397	14.32	1.26
RDF+25 kg K+20kg S/ha	16.7	58.4	41.7	3.50	0.55	280	9.40	395	18.20	1.24
RDF+25 kg K+20kg S+5kg Zn/ha	17.4	58.1	40.8	3.35	0.55	279	9.50	402	17.70	1.33
RDF+25kg K+20kg S+5kg Zn/ha+2% urea spray at 70DAS	17.5	61.8	44.2	3.52	0.57	279	10.70	403	18.15	1.33
RDF+25 kg K+20kg S+5kg Zn/ha+RZ+ PSB+ 2%urea spray at 70DAS	17.7	65.4	47.7	3.69	0.57	308	10.90	406	18.31	1.32
RDF+25 kg K+20kg S+5kg Zn/ha+RZ+ PSB +5t FYM/ha+2%urea spray at70DAS	18.7	66.2	47.5	3.54	0.65	312	12.70	413	20.20	1.37
SEm ±	-	-	610	0.12	0.05	2.12	0.29	2.58	0.45	0.07
CD (P= 0.05)	-	-	1,690	0.33	0.16	5.86	0.79	7.15	1.24	0.20

over rest of the genotypes. However, 'Dahod yellow' genotype also recorded significant reduction in days to 50% flowering and maturity days than rest of the genotypes. Whereas, highest significant pods/plant, seed and straw yield was recorded in 'RSG 973' remained on par with 'RSG 888' and 'GNG 469' except in pods/ plant was significant over 'GNG 469'. Among all the genotypes, 'RSG 888' recorded significantly higher seeds/pod over rest of the genotypes except 'RSG 973'. Whereas, genotypes 'GNG 469', 'GNG 663', 'RSG 973' and 'RSG 888' being on par in term of straw yield but significantly superior over 'Dahod yellow.' This could be attributed to genetically variations existing among the chickpea cultivars.

Further, there was significant reduction in days to 50% flowering and days to maturity due to no fertilization over application of chemical fertilizers, organic manures and biofertilizers. (Table1). Application of N_{20} $P_{17.2}$ kg/ha as RDF + 25 kg K + 20 kg S + 5 kg Zn /ha along with seed inoculation with *rhizobium* + *PSB* + 2% urea spray at 70 DAS recorded significantly higher plant height, branches/plant, pods/plant, seed index, seed yield and straw yield remained on par with treatment RDF + 25 kg K + 20 kg S + 5 kg Zn/ha + *rhizobium* + *PSB* + 5 t FYM/ha + 2% urea spray at 70 DAS over control, RDF, farmer practices and RDF + 25 kg K/ha. However, treatments RDF+25 kg K+20 kg S/ha, RDF+25 kg K+20 kg S+5 kg Zn/ha and RDF+25 kg K+20 kg S+5 kg Zn/ha+2% urea spray at 70 DAS remained statistically at par with each other but significantly superior over control. Treatment RDF+25 kg K+20 kg S+5 kg Zn/ha+*Rhizobium* (RZ) +Phosphate solubilizing bacteria (PSB)+2% urea spray at 70 DAS also significantly increased seed and straw yields to the tune of 58.9 and 75.8% over control (no fertilization). This could be attributed to the ability of the *rhizobium* to fix atmospheric nitrogen in symbiotic association with legumes and ability of PSB culture species Bacillus megatherium to bring sparingly soluble/ insoluble inorganic and/or organic phosphates into soluble forms by secreting organic acids and its synergistic with rhizobium (Singh *et al.*, 2005). Similar findings were also reported by Singh and Chauhan (2005).

Economic returns

The genotype 'RSG 973' fetched significantly higher net return (Rs. 47400/ha) and B:C ratio (4.07) which was significantly higher 'Dahod yellow' (Rs. 31400/ha & 3.04) and 'GNG 663' (Rs. 40600/ha & 3.63), respectively (Table 2). However, genotypes 'RSG 888' and 'GNG 469' remained statistically on par with genotype 'RSG 973' but significantly superior in net return and B: C ratio over 'Dahod yellow 'and 'GNG 663' in net return only. This might be due to increased in different parameters of growth and yield components which ultimately resulted in higher yield. These results are in accordance with the results obtained by Kaprekar *et al.* (2003) in gram.

The economic analysis of different treatments indicated that net returns and benefit: cost ratio was influenced by various treatment effects. Application of inorganic fertilizers (i.e. 20 kg N + 17.2 kg P + 25 kg K + 20 kg S + 5 kg Zn/ha) along with seed inoculations of *rhizobium* + *PSB* and 2% urea spray at 70 DAS fetched maximum and significantly higher net return Rs. 47,684/ha and benefit: cost ratio 3.69 remained statistically at par with RDF + 25 kg K + 20 kg S + 5 kg Zn/ha + rhizobium + PSB + 5 t FYM/ha + 2% urea spray at 70 DAS over rest of fertility levels and control. It was registered increase of 72.4 and 25.5% over control. The combined effect of inorganic fertilizers, farm yard manure, biofertilizers and foliar nutrition of urea played very significant role due to their synergistic effect and enhanced the partitioning of photosynthates in vegetative and reproductive parts goes simultaneously in the later growth phases. The incremental increase in yield attributes and yield ultimately gave higher net returns and benefit: cost ratio. The results confirm the findings Jat and Ahlawat (2004).

Availability of nutrients in soil

Availability of nutrients after the crop harvest and analyzed in soil that different genotypes of chickpea had no marked variations in organic carbon, nitrogen, sulphur and zinc but significant variations have been analyzed in phosphorus and potassium. The genotype 'RSG 973' have recorded significantly higher available phosphorus and 'Dahod yellow' in potassium

showed their least requirement of phosphorus and potassium compared to the other genotypes. This might be due to have least fertilizer requirement which is left in the soil pool (Table 2). The maximum soil P was recorded with 'RSG 973' and was 7.8% higher over 'GNG 469' and available K was significantly higher in 'Dahod yellow', which 1.7% higher was over 'GNG 663'. The biomass production of these genotypes and subsequently higher nutrients uptake led to relatively lower soil nutrient compared to the genotypes of 'RSG 973' and 'Dahod yellow'.

Application of RDF + 25 kg K + 20 kg S + 5 kg Zn/ha + 5 t FYM/ha + seed inoculated with *rhizobium* + *PSB* + 2% urea spray at 70 DAS (T_9) showed significantly increase in availability of organic carbon (0.65%), nitrogen (312 kg/ha), phosphorus (12.7 kg/ha), potassium (413 kg/ha), sulphur (20.2 kg/ha) and Zinc (1.37 mg/kg) contents in the soil after second year crop harvest over rest of the treatments except in organic carbon, nitrogen and potassium was found at par with RDF+25 kg K+20 kg S+5 kg Zn/ha+*Rhizobium*(RZ) + *Phosphate solubilizing bacteria* (PSB) + 2% urea spray at 70 DAS (T_8). Addition of 5 t FYM/ha in treatment RDF+25 kg K+20 kg S+5 kg Zn/ha + RZ + PSB + 5 tons FYM/ha + 2% urea spray at 70 DAS (T_9) showed the maximum availability of nutrients in the soil might be ascribed to the addition of these nutrients in the soil which remained unutilized after crop harvest and thus improved the status of the soil. Similar findings corroborate the findings given by Bharadwaj and Omanwar, 1994.

Conclusion

Based on two years pooled mean data inferred that the application of 20 kg N + 17.2 kg P + 25 kg K + 20 kg S + 5 kg Zn/ha + seed inoculated with *rhizobium* + PSB and 2% urea spray at 70 DAS with FYM 5 tons/ha or without FYM can improved soil fertility and achieved higher productivity and better economic returns from chickpea variety of 'RSG 973' compared to other treatments of nutrient management practices and genotypes in vertisol of irrigated condition.

References

Bharadwaj,V. and Omanwar, P.K. 1994. Long term effects of continuous rotational cropping and fertilization on crop yields and soil properties-II. Effects on EC, pH, organic matter and available nutrients of soil. *J. Ind. Soc. Soil Sci.* **42** : 387-392.

Bharadwaj, C., Chauhan, S.K., Rajguru, G., Srivastava, R., Satyavathi, C.T., Yadav, S., Rizvi, A.H., Kumar, J. and Solanki, R.K. 2010. Diversity analysis of chickpea (*Cicer arietinum*) cultivars using STMS markers. *Ind. J. Agri. Sci.* **80** : 947-951.

FAO 2009. Food and Agriculture Organization of the United Nations (http://www.fao.org).

FAO 2011. FAOSTAT Production Statistics, Food and Agriculture Organization, Rome. (http://www.fao.org).

Jat, R.S. and Ahalawat, I.P.S. 2004. Effect of vermicompost, biofertilizers and phosphorus on growth, yield and nutrient uptake by gram (*Cicer arietinum*) and their residue effect on fodder maize (*Zea mays*). *Ind. J. Agri. Sci.* **74** : 359-361.

Kaprekar, N., Sasode, D. S. and Patil, A. 2003. Yield, nutrient uptake and economics of gram (*Cicer arietinum*) as influenced by P and S levels and PSB inoculation under irrigated conditions. *Legume Res.* **26** : 125-127.

Ramesh, P., Panwar, N.R. and Singh, A.B. 2010. Crop productivity, soil fertility and economics of soybean (*Glycine max*), chickpea (*Cicer arietinum*) and blond psyllium (*Plantago ovate*) under organic nutrient management practices. *Ind. J. Agri. Sci.* **80** : 965-969.

Singh, K.K., Srinivasarao. CH. and Ali, M. 2005. Root growth, nodulation, grain yield and phosphorus use efficiency of lentil as influenced by phosphorus, irrigation and inoculation. *Communications in Soil Service and Plant Analysis* **36(13&14)**: 1919-1929.

Singh, Y.P. and Chauhan, C.P.S. 2005. Effect of sulphur, phosphorus and rhizobium inoculation on yield, content of micro nutrients and phosphorus utilization of lentil. *Ind. J. Pulses Res.*, **18** : 211-213.