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Effect of integrated nutrient management on growth, yield and economics of chickpea (*Cicer arietinum* L.)

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Abstract
A field experiment entitled "Integrated nutrient management in Chickpea (*Cicer arietinum* L.)" was carried out during *rabi* season of 2017-18 on calcareous clayey soil at Junagadh. The experiment was laid out comprising ten treatments in randomised block design with three replications. The experimental results revealed that significantly higher values of growth parameters *viz.*, plant height, number of branches per plant, number and dry weight of root nodules, dry matter production and yield attribute *viz*., pods per plant along with higher seed yield (2228 kg/ha) and stover yield (3436 kg/ha) and net return (Rs.68141/ha) were recorded significantly higher under the treatment RDF + VAM + *Rhizobium* + PSB + KMB (soil application). Whereas, the highest B:C ratio (2.81) was realized with the application of 75% RDF + VAM + *Rhizobium* + PSB + KMB (soil application).

Keywords: Chickpea, integrated, growth, yield, rhizobium, PSB, KMB and VAM

1. Introduction
Chickpea (*Cicer arietinum* L.) is most important pulse crop of India in terms of both area and production. In India, chickpea accounts for about 45% of total pulses production in the country. Similar to the case of other pulses, India is the major producing country for over 75% of total production in the world. India is producing 16.47 million tons of pulses from an area of 25.26 million hectare, which is one of the largest pulses producing countries in the world. The yield levels of chickpea have been generally low which might be attributed to its major cultivation under rainfed conditions with less/ imbalance use of fertilizers, limited seed inoculation (10% approximately) with *rhizobium* and phosphorus solubilizing bacterial cultures (Sharma and Gupta, 2005) [7] and also due to its susceptibility to wilt, insect, pest and diseases. Among bio-fertilizers *Rhizobium* inoculation is cheapest, easiest and safest method of supplying nitrogen to legumes through well-known symbiotic nitrogen fixation process. It increases the yield and improves the quality of legumes, also adds substantial amount of residual nitrogen in soil for subsequent crops. *Rhizobium* inoculation can increase the grain yield of pulse crops to the tune of 10 to 15 percent (Ali and Chandra, 1985) [1]. Inoculation of appropriate strain enhances nodule formation resulting better nitrogen fixation. Phosphate solubilizing bacteria (PSB) have the consistent capacity to increase the availability of phosphates to plants by mineralizing organic phosphorus compounds. It solubilizes insoluble inorganic phosphorus compounds by exerting organic acids, which is the primary mechanism of solubilizing of insoluble inorganic phosphates. Besides organic acids, production of chelating substances, mineral acids, siderophores and proton extrusion mechanism are also involved. Potassium mobilizing bacteria (KMB) can transform the insoluble potassium to soluble forms by acidification, chelation, exchange reactions and polymeric substances formation. There is, therefore an urgent need to integrate the inorganic and biofertilizers in proper combination. The present study was undertaken to see the effect of integrated nutrient management on growth, yield, quality and economics of chickpea.

2. Materials and Methods
The field experiment entitled "Integrated nutrient management in Chickpea (*Cicer arietinum* L.)" was conducted during *rabi* season of the year 2017-18. The experiment was conducted on a clayey soil which was slightly alkaline in reaction with pH 7.67 and EC 0.52 dS/m, low in available nitrogen (245.20 kg/ha), medium in available phosphorus (35.10 kg/ha) and available

potash (270.70 kg/ha). Ten treatments comprising of T_1 (20-40-00 N-P_2O_5-K_2O kg ha^{-1}), T_2 (VAM soil application), T_3 *(Rhizobium* + PSB + KMB soil application @ 3 l ha^{-1} each), T_4 (Enrich Compost @ 5 t ha^{-1}), T_5 (RDF + VAM), T_6 (VAM + *Rhizobium* + PSB + KMB), T_7 (RDF +VAM + *Rhizobium* + PSB + KMB), T_8 (75% RDF + VAM + *Rhizobium* + PSB + KMB), T_9 (50% RDF + VAM + *Rhizobium* + PSB + KMB) and T_{10} (Enrich Compost @ 5 t ha^{-1} + VAM) were tried under randomized block design with three replications. The improved variety 'Chickpea GG-5' was sown at 45 cm row spacing with seed rate of 60 kg/ha at first week of December. The fertilizer dose of 20-40 kg N-P_2O_5/ha in form of Urea and Diammonium Phosphate and biofertilizers (*Rhizobium*, PSB, KMB and VAM) were applied to the crop just before sowing. Gap filling were carried out at 12-15 DAS to maintain intra-row spacing of 10 cm.

3. Results and Discussion

3.1 Growth parameters

The data pertaining to the effect of different treatments on growth parameters are presented in Table 1. At 30, 60 DAS and at harvest, maximum plant height was recorded under T_7 (RDF +VAM + *Rhizobium* + PSB + KMB) but it was found statistically at par with treatments T_1 (RDF 20-40-00 N-P_2O_5-K_2O kg ha^{-1}), T_5 (RDF + VAM), T_6 (VAM + *Rhizobium* + PSB + KMB), T_8 (75% RDF + VAM + *Rhizobium* + PSB + KMB) and T_9 (50% RDF + VAM + *Rhizobium* + PSB + KMB). At harvest, maximum number of branches per plant was recorded under T_7 (RDF +VAM + *Rhizobium* + PSB + KMB), but it was found statistically at par with treatments T_1 (RDF 20-40-00 N-P_2O_5-K_2O kg ha^{-1}), T_5 (RDF + VAM), T_8 (75% RDF + VAM + *Rhizobium* + PSB + KMB) and T_9 (50% RDF + VAM + *Rhizobium* + PSB + KMB). At 60 DAS, maximum number of root nodules/plant and weight of root nodules/plant was recorded under T_7 (RDF +VAM + *Rhizobium* + PSB + KMB), but it was found statistically at par with treatments T_1 (RDF 20-40-00 N-P_2O_5-K_2O kg ha^{-1}), T_3 *(Rhizobium* + PSB + KMB soil application @ 3 litre ha^{-1} each), T_5 (RDF + VAM), T_6 (VAM + *Rhizobium* + PSB + KMB), T_8 (75% RDF + VAM + *Rhizobium* + PSB + KMB) and T_9 (50% RDF + VAM + *Rhizobium* + PSB + KMB). Significantly, the maximum CGR at 30 DAS-60 DAS and 60 DAS to harvest were recorded with treatment T_7 (RDF +VAM + *Rhizobium* + PSB + KMB), which remained statistically at par with the treatments T_1 (RDF 20-40-00 N-P_2O_5-K_2O kg ha^{-1}), T_5 (RDF + VAM), T_6 (VAM + *Rhizobium* + PSB + KMB), T_8 (75% RDF + VAM + *Rhizobium* + PSB + KMB) and T_9 (50% RDF + VAM + *Rhizobium* + PSB + KMB). While, the minimum plant height, number of branches, number and weight of root nodules and CGR were observed under the treatment T_2 (VAM soil application).

The higher values of growth parameters viz., plant height, number of branches, number and weight of root nodules and CGR were observed under treatment T_7 (RDF +VAM + *Rhizobium* + PSB + KMB). This might be due to adequate supply of N and P under higher level. Moreover, nitrogen being essential constituent of various amino acids and proteins as well as structural constituent of cell, it influences different physiological processes such as cell division and elongation. Phosphorus plays an important role in conversion of solar energy into chemical energy and it has also beneficial effect on root proliferation that increases the absorption of plant nutrients and moisture from soil. *Rhizobium* strain in leguminous crop plays a pivotal role in fixation of atmospheric nitrogen in association with the crop. PSB solubilises the unavailable bound phosphate of the soil and makes them available to plants which increase overall plant growth while VAM increases the phosphorus uptake by the plants. The increase in growth parameter due to the mobilisation of nutrients in the soil by producing organic acids by KMB. These results confirms the findings of Singh and Prasad (2008) [9], Tagore *et al.* (2013) [10] and Meena *et al.* (2016) [5].

3.2 Yield and yield attributes

The yield and yield attributes as influenced by different treatments recorded at harvest is obtainable in Table 2. The enhanced yield and yield attributes were recorded under treatments T_7 (RDF +VAM + *Rhizobium* + PSB + KMB) which remained at par with treatments T_1 (RDF 20-40-00 N-P_2O_5-K_2O kg ha^{-1}), T_5 (RDF + VAM), T_8 (75% RDF + VAM + *Rhizobium* + PSB + KMB) and T_9 (50% RDF + VAM + *Rhizobium* + PSB + KMB). This might be due to better growth of plant in terms of plant height, number of branches, number and weight of root nodules and crop growth rate (Table 4.2 to 4.5) which resulted due to adequate supply of photosynthates for development of sink under integrated nutrient management. The lowest value of yield and yield attributes were observed under the treatment T_2 (VAM soil application). These findings are in close conformity with those reported by Shivakumar *et al*. (2004) [8], Singh and Prasad (2008) [9], Namvar *et al*. (2011) [6] and Thenua and Sharma (2011) [11].

3.3 Economics

The data on economics pertaining to gross returns, total cost of cultivation, net returns and benefit cost ratio (B:C) under different treatments are presented in Table 2. The data revealed that the maximum gross return and net return were realized with treatment T_7 (RDF +VAM + *Rhizobium* + PSB + KMB), followed by the treatments T_8 (75% RDF + VAM + *Rhizobium* + PSB + KMB) and T_9 (50% RDF + VAM + *Rhizobium* + PSB + KMB) while maximum benefit cost ratio (B:C) was obtained with the treatment T_8 (75% RDF + VAM + *Rhizobium* + PSB + KMB) followed by treatments T_7 (RDF +VAM + *Rhizobium* + PSB + KMB) and T_9 (50% RDF + VAM + *Rhizobium* + PSB + KMB). This may be attributed due to significant increase in seed and stover yields (Table 2) under inorganic fertilizers and biofertilizer application with smaller increase in cost of cultivation. These results are conformity with those reported by Chandra (1995) [2], Kasole *et al*. (1995) [4] and Kaprekar *et al.* (2003) [3].

Table 1: Effect of different treatments on growth parameters of chickpea.

Treatments	Plant height (cm) at			No. of branches/plant	No. of root nodules at 60 DAS	Weight of root nodules at 60 DAS (mg)	CGR (g/plant/day)	
	30 DAS	60 DAS	Harvest				30-60 DAS	60 DAS-harvest
T_1	23.77	34.10	43.11	7.12	24	50.28	0.277	0.563
T_2	20.91	30.71	38.55	5.40	20	42.42	0.238	0.443
T_3	22.80	32.68	42.46	6.53	23	49.45	0.271	0.490
T_4	21.22	31.11	39.88	5.91	21	44.58	0.242	0.448
T_5	24.68	34.49	43.60	7.30	24	50.90	0.274	0.580
T_6	23.49	33.56	42.77	6.77	23	49.74	0.268	0.508
T_7	26.52	37.20	45.54	8.42	27	55.64	0.317	0.610
T_8	25.47	36.44	44.89	8.14	26	53.23	0.291	0.604
T_9	25.15	35.61	44.17	7.85	25	52.11	0.278	0.593
T_{10}	21.79	31.62	40.19	6.14	21	45.31	0.257	0.458
S.Em.±	1.03	1.28	1.17	0.50	1.41	2.15	0.015	0.043
C.D. at 5%	3.06	3.81	3.49	1.49	4.19	6.39	0.043	0.128
C.V.%	7.60	6.59	4.80	12.52	10.27	7.56	9.27	14.04

Table 2: Effect of different treatments on yield attributes, yield and economics of chickpea.

Treatments	Pods per plant	Seed yield (kg/ha)	Stover yield (kg/ha)	Gross returns (₹/ha)	Cost of cultivation (₹/ha)	Net returns (₹/ha)	BCR
T_1	62.20	1944	3176	92956	35936	57020	2.58
T_2	44.25	1630	2537	77879	34465	43414	2.25
T_3	52.46	1813	3024	86723	34760	51963	2.49
T_4	46.70	1656	2650	79157	55992	23165	1.41
T_5	62.68	1966	3290	94047	37069	56978	2.53
T_6	49.33	1759	2957	84152	35893	48259	2.34
T_7	68.21	2228	3436	106434	38293	68141	2.77
T_8	66.63	2180	3418	104169	37070	67099	2.81
T_9	64.26	2067	3381	98839	35916	62923	2.75
T_{10}	47.24	1698	2706	81159	57329	23830	1.42
S.Em.±	2.35	106.59	116.09	-	-	-	-
C.D. at 5%	6.99	316.72	344.94	-	-	-	-
C.V.%	7.23	9.79	6.58	-	-	-	-

Treatment details

T_1 = 20-40-00 N-P_2O_5-K_2O kg ha^{-1}, T_2 = VAM soil application, T_3 = *Rhizobium* + PSB + KMB soil application @ 3 litre ha^{-1} each, T_4 = Enrich Compost @ 5 t ha^{-1}, T_5 = RDF + VAM, T_6 = VAM + *Rhizobium* + PSB + KMB, T_7 = RDF +VAM + *Rhizobium* + PSB + KMB, T_8 = 75% RDF + VAM + *Rhizobium* + PSB + KMB, T_9 = 50% RDF + VAM + *Rhizobium* + PSB + KMB) and T_{10} = Enrich Compost @ 5 t ha^{-1} + VAM.

4. Conclusion

On the basis of the results of the present one year field study, it seems quite logical to concluded that higher production and net returns from chickpea (Gujarat Gram-5) can be obtained by the application of RDF + soil application of VAM @ 0.25 kg/ha + soil application of *Rhizobium* + PSB + KMB @ 3 L/ha each while maximum benefit cost ratio (B:C) can be obtained by the application of 75% RDF + soil application of VAM @ 0.25 kg/ha + soil application of *Rhizobium* + PSB + KMB @ 3 L/ha each on medium black calcareous clayey soil under South Saurashtra Agro-climatic Zone.

5. References

1. Ali M, Chandra S. *Rhizobium* inoculation of pulse crop. Indian Farming. 1985; 35(5):22-25.
2. Chandra R. Response and economics of *Rhizobium*, phosphorus and zinc application in gram in western U.P. plains. Legume Res., 1995; 18(2):103-108.
3. Kaprekar N, Sasode DS, Patil A. Yield, nutrient uptake and economics of gram (*Cicer arietinum* L.) as influenced by P and S levels and PSB inoculation under irrigated conditions. Legume Res. 2003; 26(2):125-127.
4. Kasole KE, Kalke SD, Kareppa SM, Khade KK. Response of chickpea (*Cicer arietinum* L.) to different fertilizer levels, plant population and weed management on cultivors' field in north-eastern part of Kolhapur, Maharastra. Indian J. Agron. 1995; 40(2):217-219.
5. Meena VS, Maurya BR, Verma JP, Meena RS. Potassium solubilizing microorganisms for sustainable agriculture. Springer, 2016.
6. Namvar A, Sharifi RS, Khandan T. Growth analysis and yield of chickpea (*Cicer arietinum* L.) in relation to organic and inorganic nitrogen fertilization. Ekologija. 2011; 57(3):97-108.
7. Sharma HO, Gupta SC. Yield of chickpea under rainfed condition with less/imbalance use of fertilizer with *Rhizobium* and PSB culture. Indian J Pure and Applied Biol. 2005; 20:197-204.
8. Shivakumar BG, Balloli SS, Saraf CS. 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. 2004; 25(2):320-326.
9. Singh R, Prasad K. Effect of vermicompost, *Rhizobium* and DAP on growth, yield and nutrient uptake by chickpea. Journal of Food Legumes. 2008; 21(2):112-114.
10. Tagore GS, Namdeo SL, Sharma SK, Kumar N. Effect of *Rhizobium* and phosphate solubilizing bacterial inoculants on symbiotic traits, nodule leghemoglobin and yield of chickpea genotypes. International J of Agron. 2013; Article ID 581627, 8 pages.
11. Thenua OVS, Sharma RK. Effect of phosphorus, sulphur and phosphate solubilizing bacteria on productivity and nutrient uptake of chickpea (*Cicer arietinum* L.). Ann. Agric. Res. New Series. 2011; 32(3 & 4):116-119.