Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.2832

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **5 (3):** 726-734 (2017)

International Journal of Pure & Applied Bioscience

Research Article

OPEN ACCESS

Impact Assessment of Land Configuration and Bio-Organic on Nutrient Uptake and Quality of Chickpea (*Cicer arietinum* L.) Under Coastal Salt Affected Soil

Vikas Vishnu[1*], V. P. Usadadia[2], Anil Kumar Mawalia[1], M.M. Patel[2] and Viral Kumar A. Patel[2]

[1]Department of Agronomy, N.M. College of Agriculture, Navsari Agricultural University, Navsari- 396 450 (Gujarat), India

[2] Soil and Water Management Research Unit, Navsari Agricultural University, Navsari - 396 450 (Gujarat), India

*Corresponding Author E-mail: hortsuren@gmail.com

Received: 11.04.2017 | Revised: 23.04.2017 | Accepted: 24.04.2017

ABSTRACT

An experiment was conducted at Coastal Soil Salinity Research Station, NAU, Danti, during rabi seasons of 2014-15 and 2015-16 with the objective of find out the effect of land configuration and bio-organic on nutrient uptake and quality of chickpea (Cicer arietinum L.) under coastal salt affected soil. The results of the study revealed that sowing of chickpea on ridge and furrow significantly increased nutrients i.e., N, P and K uptake by chickpea crop over flat bed sowing (L_1), but it was statistically at par with raised bed sowing (L_2) while, protein content in grain did not influence significantly due to land configuration treatments. Moreover, significantly the highest protein content in grain, nitrogen, phosphorus and potassium uptake by chickpea crop were recorded under application of vermicompost @ 2 t/ha + bio-fertilizer (Rhizobium + PSB) (B_4). The interaction effect of L x B failed to influence protein content in grain and uptake of nitrogen and potassium by chickpea, however, P uptake by crop was significantly higher under treatment combination L_3B_4 as compared to all other treatment combinations except, L_3B_3 during 2014-15 and in pooled results.

Key words: *Bio-organic, Chickpea, Land configuration, Nutrient uptake, Quality*

INTRODUCTION

Pulses are an integral part of Indian dietary system due to richness in protein and other important nutrients such as calcium, iron and vitamin *viz*., carotene, thiamine, riboflavin and niacin. Indian population is predominantly vegetarian and protein requirement for the growth and development of the human being is mostly met from pulses, it contains 22 to 25 per cent protein, which is almost twice than wheat and thrice that of rice.

Cite this article: Vishnu, V., Usadadia, V.P., Mawalia, A.K., Patel, M.M. and Patel, V.K.A., Impact Assessment of Land Configuration and Bio-Organic on Nutrient Uptake and Quality of Chickpea (*Cicer arietinum* L.) Under Coastal Salt Affected Soil, *Int. J. Pure App. Biosci.* **5(3):** 726-734 (2017). doi: http://dx.doi.org/10.18782/2320-7051.2832

Among the grain legumes, chickpea (*Cicer arietinum* L.) commonly known as Bengal gram and locally *Chana* is an important and unique food legume, because of its use in the variety of food products like snacks, sweets, *etc*. Condiments and vegetables are prepared from its world-wide. It is also consumed in the form of processed whole seed (boiled, roasted, parched, fried, steamed sprouted, *etc*.) or as dal flour (*Besan*). Chickpea is a good source of protein (18 to 22%), carbohydrate (52 to 70%), fat (4 to 10%), minerals and vitamins. It is also an excellent animal feed, its stover has good forage value. India is the largest producer of chickpea in the world sharing 65.25 and 65.49 per cent area and production, respectively. In India, chickpea occupies about 9.93 million hectares area with total production of 9.53 million tonnes with an average productivity of 960 kg/ha. While in Gujarat, chickpea is grown in an area of 2.50 lakh hectares, producing 3.10 lakh metric tonnes with productivity of 1251 kg/ha[2], which is high compared to national average productivity.

In India, salt affected soils occupy about 9.38 million ha of cultivated land of which around 41 per cent is sodic *i.e.,* 3.88 million ha and 5.5 million ha are saline soils (including coastal)[7]. In Gujarat, an area of 1.69 million ha is affected by either salinity or sodicity or both[12]. On account of higher proportion of exchangeable Na on exchange complex, the high clay containing soils of south Gujarat exhibit poor physical conditions *viz.*, low permeability, crusting and hardening of surface soil upon drying and cracking. As a result of this, restricted air and water movement in soil and poor root growth is observed. High substrate salinity is a major limiting factor for crop production in coastal habitats. As with many other pulses, chickpea is a salt-sensitive crop and yield is seriously reduced particularly by chloride salinity. High salinity decreases substrate water potential and thus restricts water and nutrient uptake by the roots, high salinity may also cause ionic imbalance and toxicity in plants.

Poor soil management is one of the major constraints for low productivity of crops particularly in clayey soil. The germination, penetration, development and proliferation of root in the soil are dependent on the physical conditions of soil *viz*., looseness, friability, infiltration rate, soil crusting, *etc*. Therefore, land configuration can play an important role for easy and uniform germination as well as for better growth and development of plant. In these circumstances, ridges and furrow or raised bed sowing under such situation is advantageous as compared to flat bed sowing as it provides better aeration, root development and also protect the crop from water logging condition. In our country, chickpea is usually sown on flat bed by seed drill. Several research workers have indicated that manipulation of sowing method provides better environment for germination, growth and development, which eventually increase the crop yield. It is particular useful in areas having poor quality of irrigation water, because it helps to avoid direct contact of young plants with poor quality of irrigation water. Raised bed method of sowing has been found helpful to minimize the effect of temporary water logging and salt injury to plants[1]. Chickpea grain yield can be increased by providing suitable sowing method. So there is need to adopt a suitable management practices like a proper sowing method land configuration, such as ridge and furrow method have shown good promise for enhancing the performance of chickpea crop.

Organic manure improves the soil physico-chemical and biological properties of soil. It is supply of primary, secondary and micronutrients for proper growth and development of the plants and increase activity of soil microbes through providing energy. It act as thermo regulation in soil and also improves buffering and exchange capacities of soil. Organic manures although, not useful as sole sources of nutrients, but it also good complementary source with inorganic fertilizers which improve the nutrient uptake by crop and quality of grains. The efficient strains of nitrogen fixing, phosphate solubilizing or cellulolytic micro-organisms used for application to seed, soil or composting area with the objectives of increase the population of such beneficial micro-organisms like *Rhizobium, Azotobactor, Azospirillum*, Cynobactaria, *Bacillus*, *Pseudomonas*, *etc.* While, among the bio-fertilizers *Rhizobium* inoculation is cheapest, easiest and safest method of supplying nitrogen to legume through symbiotic nitrogen fixation process. Moreover, 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. Thus, adopting proper nutrient management practices in conjunction with PSB will help improve the yield and quality of chickpea, besides maintaining the soil fertility. The conjunctive uses of bio-fertilizers *viz., Rhizobium* and phosphate solubilizing bacteria *i.e., Pseudomonas striata* have cumulative effect on the pulses. Considering the above facts in view, the investigation was carried out with the objective to evaluate effect of land configuration and bio-organic on nutrient uptake and quality of chickpea (*Cicer arietinum* L.) under coastal salt affected soil of south Gujarat.

MATERIAL AND METHODS

The present experiment was carried at Coastal Soil Salinity Research Station, Navsari Agricultural University, Danti during *rabi* 2014-15 and 2015-16, which is located at latitude of 21^o 03’ 02” North and longitude of 72^o 44’ 29” East in southern part of Gujarat at an altitude of 3 m above the mean sea level. As per the soil properties during the cropping seasons of 2014-15 and 2015-16, the soil of the experimental field was clayey in texture, medium in OC and highly saline-sodic and showed low, medium and high rating of available nitrogen, phosphorus and potassium, respectively so this type of soil moderately suitable for growing of chickpea crop. The weather conditions prevailed during crop period of both the years were congenial for satisfactory growth and development of the chickpea crop. Likewise, no severe incidence of diseases and insect were observed during the crop. There were three levels of land configurations (L_1: Flat bed, L_2: Raised bed and L_3: Ridge and furrow) in main plot and four levels of bio-organic [B_1: No organic fertilizer + bio-fertilizer (*Rhizobium* + PSB), B_2: FYM @ 10 t/ha + bio-fertilizer (*Rhizobium* + PSB), B_3: Biocompost @ 5 t/ha + bio-fertilizer (*Rhizobium* + PSB) and B_4: Vermicompost @ 2 t/ha + bio-fertilizer (*Rhizobium* + PSB)] in sub plot laid out in split plot design to chickpea with four replications. Required quantity of organic manure *i.e.*, FYM, biocompost and vermicompost were worked out for gross plot area as per treatment. FYM, biocompost and vermicompost were applied in respective treatments after preparing beds, mix it by using *kudali* and then ridge and furrow and raised beds were prepared. FYM, biocompost and vermicompost @ 10, 5 and 2 t/ha, respectively were applied in respective treatments just before sowing of crop and bio-fertilizer (*Rhizobium* + PSB) as seed treatment was applied as per treatment. The seeds were drilled 5 to 6 cm deep in dry soil condition with a recommended seed rate of 75 kg ha^{-1}. The sowing was done on 9th December, 2014 during the year 2014-15 and during second year on 4th December, 2015. Seeds were covered properly with soil and light irrigation was applied in each plot immediately after sowing and same method was implemented during both the years.

Representative samples from crop were taken separately from each plot for estimation of N, P and K content in grain and stover separately. The samples were oven dried at 65°C for 24 hrs, powdered by mechanical grinder and analyzed for respective nutrient content using following procedures:

Sr. No.	Particular	Procedure used	Reference
1.	Nitrogen (%)	Micro kjeldahl's method (diacid)	Warnke and Barber[17] (1974)
2.	Phosphorus (%)	Vanadomolybdo phosphoric acid yellow colour method	Jackson[8] (1967)
3.	Potassium (%)	Flame photometric method	Jackson[8] (1967)

The uptake of nutrients like nitrogen, phosphorus and potassium by chickpea grain and stover were determined separately using their content in respective part and their production on hectare basis. The uptake of nutrients (N, P and K) by grain and stover were calculated by following formula:

$$\text{Nutrient uptake (kg/ha)} = \frac{\text{Nutrient content in garin/stover (\%)} \times \text{Grain/stover yield (kg/ha)}}{100}$$

Total uptake of respective nutrient was worked out by summation of uptake by grain and stover. However, here more emphasis was given to total uptake of N, P and K nutrients. The protein content was obtained by multiplying nitrogen content of grain with conversion factor of 6.25[3].

RESULTS AND DISCUSSION

Effect on Nutrient Uptake

The results presented in Table 1 indicated that different levels of land configuration significantly influenced the nitrogen, phosphorus and potassium uptake by chickpea crop during both the years and in pooled analysis. Sowing of chickpea on ridge and furrow method (L_3) significantly increased the N uptake by crop with 79.6 and 82.0 kg/ha but, it was remain at par with raised bed treatment (L_2) during 2014-15 and 2015-16, respectively. Whereas in pooled analysis, all three levels of land configuration differed significantly among each other and remained in order of their significance L_3 (80.8 kg/ha) > L_2 (75.1 kg/ha) > L_1 (66.4 kg/ha). The data on phosphorus uptake by chickpea crop also indicated that significantly higher values of P uptake were 18.69, 19.05 and 18.87 kg/ha by chickpea crop recorded when crop was sown on ridge and furrow (L_3) as compared to flat bed (L_2) during both the years and in pooled results, respectively which was at par with raised bed sowing (L_2) during 2014-15. However, all three levels of land configuration significantly differed from each other and it remained in following order of their significance L_3 > L_2 > L_1 during 2015-16 and in pooled results with respect to P uptake. The results further revealed that chickpea sown on ridge and furrow (L_3) recorded significantly higher potassium uptake by crop which were 44.54 and 44.24 during 2014-15 and in pooled results, respectively but, which was remain at par with raised bed (L_2). Looking to the pooled data on N, P and K uptake by crop observed that treatment L_3 increased the N, P and K uptake by 21.68, 24.39 and 16.76 per cent over treatment L_1, respectively. This might be due to the fact that deeper penetration of roots and better soil environment due to better aeration, microbial activity and good drainage might have received optimum moisture and nutrients for its growth causing more nutrient recovery through grain and stover under ridge and furrow method of sowing, which resulted into higher uptake of N, P and K nutrients by crop. The results are closely resembled with those of Paliwal *et al*[14]., in soybean under ridge and furrow method of sowing, Kumar and Singh[11] in frenchbean under raised bed method of sowing with respect to N, P and K uptake and Jat *et al*[9]., in greengram under raised bed method of sowing with respect to N and P uptake from the soil.

Application of vermicompost @ 2 t/ha + bio-fertilizer (*Rhizobium* + PSB) (B_4)

significantly increased N, P and K uptake by crop which were 84.7, 87.7 and 86.2 kg/ha, 19.94, 20.19 and 20.07 kg/ha, and 44.69, 45.91 and 45.30 kg/ha as compared to treatments B_1 and B_2 during both the years as well as in pooled results, respectively, but it was found statistically at par with treatment B_3 during individual years of study, while in case of P and K uptake, it was also at par with treatment B_3 in their combined analysis during 2014-15 and 2015-16. The lowest N, P and K uptake by crop were registered under treatment B_1 [no organic fertilizer + bio-fertilizer (*Rhizobium* + PSB)] to the chickpea during both the years and in pooled results. Treatment B_4 increases the nitrogen, phosphorus and potassium uptake by chickpea crop to the tune of 46.35, 49.89 and 28.66 per cent over treatment B_1 on the basis of pooled. Similar results also reported by Choudhary *et al*[4]., and Deshpande *et al*[5]., in chickpea. This might be due to combined application of vermicompost and bio-fertilizers increased soil nutrient status (N, P and K) and thereby their uptake by crop. The increased N uptake might be due to its higher N content, fixation of N by *Rhizobium* from atmosphere into the soil, mineralization of nitrogen from organic matter and mineralization effect upon native N. The increased P uptake might be due to PSB, which may solubilization effect on the native phosphorus. The decomposition of vermicompost results in the formation of CO_2, which helps in the solubilization of the native phosphorus, forms the phospho-humic complexes which can be easily assimilated by the plants or isomorphous replacement of phosphate ions by humate ions and coating of sesquioxide particles by humus to form a protective cover that reduces the P fixing capacity of the soil. Thus, the application of vermicompost improved the overall physico-chemical environment of the soil, which may increased the availability of potassium in soil and K uptake by chickpea crop.

The data further revealed that the interaction effect of land configuration and bio-organic on N and P uptake by chickpea crop were failed to exerted their significant variation during both the years and in pooled analysis (Table 2). While in case of P uptake interaction effect between land configuration and bio-organic turned out to be significant during first year and in pooled analysis (Table 2). Significantly the lowest P uptake was recorded under treatment combination L_1B_1 [flat bed sowing and no organic fertilizers + bio-fertilizer (*Rhizobium* + PSB)] which 10.81 and 10.68 kg/ha during 2014-15 and in pooled results, respectively. Moreover, treatment combination L_3B_4 [ridge and furrow sowing and vermicompost @ 2 t/ha + bio-fertilizer (*Rhizobium* + PSB)] observed significantly higher values of P uptake were 20.84 and 21.39 kg/ha but, treatment combinations L_3B_3, L_2B_4, L_1B_4, L_2B_3 and L_3B_2 at par during 2014-15 and L_3B_3 in pooled results. This might be due to favourable environment for better root growth which may increase in P uptake by crop. The result is in conformity with the findings of Paliwal *et al*[14].

Effect on Quality

The results revealed that various land configuration treatments did not exerted significant influence on protein content in chickpea grain (Table 3). The maximum value of protein content in grain recorded under ridge and furrow method (L_3) which were 21.39, 22.13 and 21.76 per cent during first year, second year and in pooled basis, respectively. While, the minimum protein content in grain obtained under flat bed sowing treatment (L_1) which were 21.22, 20.98 and 21.10 per cent during both the years and in pooled results. It is because of protein percentage is computed from nitrogen concentration by multiplying with a factor of 6.25. Ridge and furrow sowing increased protein content in grain might be due to better availability of nitrogen to plant because of better root development and nodule formation which fix more nitrogen under this treatment. The result corroborates with the findings of Rathore[16] in blackgram and Dhimmar[6] in cowpea who reported that land configuration did not significantly affect protein content in grain but, numerically higher under ridge and furrow method.

Significantly higher protein content of 22.37, 22.98 and 22.68 per cent were noted under treatment B_4 [vermicompost @ 2 t/ha + bio-fertilizer (*Rhizobium* + PSB)] during 2014-15, 2015-16 and in pooled results, respectively but, it was at par with treatment B_3 during 2014-15 (Table 3). On the basis of pooled analysis, the trend of protein content in chickpea grain was B_4 (22.68%) > B_3 (21.91%) > B_2 (21.06%) > B_1 (19.97%). The improvement in protein content in grain due to combined effect of vermicompost and bio-fertilizer (*Rhizobium* + PSB) which may increase in nitrogen content in grain. Nitrogen is an integral part of protein and phosphorus is structural element of certain co-enzymes involved in protein synthesis. Increase in protein yield might be due to higher protein content and grain yield under this treatment. The present findings are in concurrence with the findings of Kanwar and Paliyal[10] and Mohmmadi *et al*[13]., with respect to protein content in grain and Pathak *et al*[15]., and Choudhary *et al*[4]., with respect to protein yield of chickpea.

The interaction effect of L x B was not influenced significantly during both the years and in pooled analysis (Table 3).

Table 1: Effect of land configuration and bio-organic on nutrient uptake by chickpea crop

Treatment	Nutrient Uptake (kg/ha)								
	N			P			K		
	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled
(a) Main plot [Land configuration (L)]									
L_1: Flat bed	66.1	66.8	66.4	15.05	15.29	15.17	37.23	38.54	37.89
L_2: Raised bed	76.0	74.2	75.1	17.38	17.31	17.35	41.74	41.57	41.65
L_3: Ridge and furrow	79.6	82.0	80.8	18.69	19.05	18.87	44.54	43.94	44.24
S.Em.±	2.6	2.2	1.7	0.59	0.44	0.37	1.12	1.44	0.91
CD (P=0.05)	9.0	7.8	5.3	2.04	1.53	1.14	3.88	NS	2.81
C.V.%	14.11	12.05	13.11	13.86	10.28	12.19	10.88	13.94	12.51
(b) Sub plot [Bio-organic (B)]									
B_1: No organic fertilizer + bio-fertilizer (*Rhizobium* + PSB)	60.2	57.7	58.9	13.46	13.33	13.39	36.11	34.31	35.21
B_2: FYM @ 10 t ha^{-1} + bio-fertilizer (*Rhizobium* + PSB)	69.3	71.6	70.5	16.10	16.61	16.35	39.98	40.69	40.34
B_3: Biocompost @ 5 t ha^{-1} + bio-fertilizer (*Rhizobium* + PSB)	81.4	81.2	81.3	18.67	18.75	18.71	43.89	44.49	44.19
B_4: Vermicompost @ 2 t ha^{-1} + bio-fertilizer (*Rhizobium* + PSB)	84.7	87.7	86.2	19.94	20.19	20.07	44.69	45.91	45.30
S.Em.±	2.1	2.3	1.5	0.47	0.49	0.34	0.92	1.47	0.87
CD (P=0.05)	6.0	6.6	4.4	1.37	1.42	0.97	2.67	4.26	2.46
Interaction (L×B)	NS	NS	NS	S	NS	S	NS	NS	NS
C.V.%	9.67	10.64	10.17	9.62	9.87	9.75	7.74	12.30	10.28

NS- Non Significant, S- Significant

Table 2: Interaction effect of land configuration and bio-organic on phosphorus uptake by chickpea crop

Treatment	Phosphorus uptake by crop (kg/ha)				
	Bio-organic (B)				
Land configuration (L)	B_1	B_2	B_3	B_4	Mean
2014-15					
L_1	10.81	12.30	17.69	19.42	15.05
L_2	13.80	17.50	18.65	19.56	17.38
L_3	15.76	18.49	19.68	20.84	18.69
Mean	13.46	16.10	18.67	19.94	17.04
S.Em±	0.82				
CD (P=0.05)	2.38				
C.V.%	9.62				
Pooled					
Treatment	B_1	B_2	B_3	B_4	Mean
L_1	10.68	13.04	17.72	19.26	15.17
L_2	14.00	17.23	18.61	19.55	17.35
L_3	15.50	18.80	19.80	21.39	18.87
Mean	13.39	16.35	18.71	20.07	17.13
S.Em±	0.59				
CD (P=0.05)	1.67				
C.V.%	9.75				

Table 3: Protein content in grain of chickpea as influenced by land configuration and bio-organic

Treatment	Protein content in grain (%)		
	2014-15	**2015-16**	**Pooled**
(a) Main plot [Land configuration (L)]			
L_1: Flat bed	21.22	20.98	21.10
L_2: Raised bed	21.37	21.32	21.34
L_3: Ridge and furrow	21.39	22.13	21.76
S.Em.±	0.24	0.30	0.19
CD (P=0.05)	NS	NS	NS
C.V.%	4.44	5.63	5.07
(b) Sub plot [Bio-organic (B)]			
B_1: No organic fertilizer + bio-fertilizer (*Rhizobium* + PSB 10^8 CFU/ml, 1.25 lit ha^{-1})	20.08	19.86	19.97
B_2: FYM @ 10 t ha^{-1} + bio-fertilizer (*Rhizobium* + PSB 10^8 CFU/ml, 1.25 lit ha^{-1})	21.02	21.10	21.06
B_3: Biocompost @ 5 t ha^{-1} + bio-fertilizer (*Rhizobium* + PSB 10^8 CFU/ml, 1.25 lit ha^{-1})	21.86	21.97	21.91
B_4: Vermicompost @ 2 t ha^{-1} + bio-fertilizer (*Rhizobium* + PSB 10^8 CFU/ml, 1.25 lit ha^{-1})	22.37	22.98	22.68
S.Em.±	0.25	0.31	0.20
CD (P=0.05)	0.73	0.89	0.56
Interaction (L×B)	NS	NS	NS
C.V.%	4.10	4.92	4.53

CONCLUSIONS

It was concluded that sowing of chickpea on ridge and furrow or raised bed method and organic like vermicompost and biocompost along with bio-fertilizer (*Rhizobium* + PSB) in costal salt affected soils of south Gujarat improves the nutrient uptake by crop and quality of chickpea grain.

Acknowledgement

The authors are thanks to Soil and Water Management Research Unit, Navsari Agricultural University, Navsari for providing financial assistance through NFSM project during the course of investigation.

REFERENCES

1. Akbar, G., Hamilton, G., Hussain, Z. and Yasin, M., Problem and potential raised bed cropping systems in Pakistan. *Pakistan Journal of Water Resource*, **11(1):** 11-15 (2007).
2. Anonymous, Statistical year book, India 2013-14. Ministry of statistics and programme implementation. *http://www.mospi.nic.in*. (2015).
3. Bhuiya, Z.H. and Chowdhary, S.U., Effect of N, P, K and S on the protein and oil content of groundnut grown in Bharahmaputra flood plain soil. *Indian Journal of Agricultural Science* **44**(11): 751-754 (1974).
4. Choudhary, R.L., Choudhary, A.A., Khawale, V.S., Potkile, S.N. and More, S.R., Nutrient management studies in chickpea (*Cicer arietinum* L.). *Journal of Soil and Crops*, **18(1):** 174-177 (2008).
5. Deshpande, A.N., Dalavi, S.S., Pandey, S.H., Bhalerao1, V.P. and Gosavi, A.B., Effect of rock phosphate along with organic manures on soil properties, yield and nutrient uptake by wheat and chickpea. *Journal of the Indian Society of Soil Science*, **63(1):** 93-99 (2015).
6. Dhimmar, S.K., Response of *kharif* cowpea (*Vigna unguiculata* L.) to land configuration and bio-fertilizers under south Gujarat conditions. *M.Sc. (Agri.) Thesis*, Department of Agronomy, Navsari Agricultural University, Navsari, India (2003).
7. IAB., Indian Agriculture in Brief. (27th edition). Agriculture Statistics Division, Ministry of Agriculture, Govt. of India, New Delhi (2000).
8. Jackson, M.L., *Soil Chemical Analysis*. Prentice Hall of India Pvt. Ltd., New Delhi. pp. 183-192 (1967).
9. Jat, R.A., Arvadia, M.K., Tandel, B., Patel, T.U. and Mehta, R.S., Response of saline water irrigated greengram (*Vigna radiate* L.) to land configuration, fertilizer and farm yard manure in Tapi command area of south Gujarat. *Indian Journal of Agronomy* **57(3):** 270-274 (2012).
10. Kanwar, K. and Paliyal, S.S., Influence of phosphorus management and organic manuring on uptake and yield of chickpea (*Cicer arietinum* L.). *Himachal Journal of Agricultural Research*, **30(1):** 38-43 (2004).
11. Kumar, B. and Singh, G.R., Response of frenchbean (*Phaseolus vulgaris* L.) to various sowing methods, irrigation levels and nutrient substitution in relation to its growth, seed yield and nutrient uptake. *Journal of Food Legumes*, **27(2):** 108-111 (2014).
12. Minhas, P.S., Sharma, O.P and Patil, S.G., Twenty-five years of research on management of salt affected soils and use of saline water in agriculture. CSSRI publication, Karnal (1998).
13. Mohammadi, K., Ghalavand, A. and Aghaalikhani, M., Effect of organic matter and bio-fertilizers on chickpea (*Cicer arientum* L.) quality and biological nitrogen fixation. *World Academy of Science, Engineering and Technology*, **4(8):** 937-942 (2010).
14. Paliwal, D.K., Kushwaha, H.S and Thakur, H.S., Performance of soybean (*Glycine max* L.)–wheat (*Triticum aestivum* L.) cropping system under land configuration, mulching and

nutrient management. *Indian Journal of Agronomy*, **56(4):** 334-33 (2011).

15. Pathak, S., Namdeo, K.N., Chakrawarti, V.K. and Tiwari, R.K., Effect of bio-fertilizers, diammonium phosphate and zinc sulphate on growth and yield of chickpea (*Cicer arientum* L.). *Crop Research*, **26(1):** 42-46 (2003).
16. Rathore, V.S., Response of blackgram (Phaseolus mungo L.) to land configuration and weed management practices under south Gujarat conditions. *M.Sc.(Agri.) Thesis*, Department of Agronomy, Navsari Agricultural University, Navsari, India (2002).
17. Warnke, D.D. and Barber, S.P., Root development and nutrient uptake by corn grown in solution culture. *Agronomy Journal*, **66:** 514 (1974).