The Pharma Innovation Journal 2021; 10(12): 3048-3052

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(12): 3048-3052

www.thepharmajournal.com
Received: 13-09-2021
Accepted: 23-11-2021

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Effect of varieties and micronutrient applications on growth and qualitative characters of chickpea (*Cicer arietinum* L.)

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Abstract
A field experiment was conducted to study the effect of varieties and micronutrient applications on growth and quality of chickpea during two consecutive *rabi* seasons of years 2018-19 and 2019-20, respectively. The experiment was laid out in split plot design with three varieties in main plot *viz.* (V_1) KGD-1168, (V_2) Radhey and (V_3) KWR-108 and seven micronutrient treatments in sub plots *viz.* (M_1) Control, (M_2) Zinc @ 0.5%, (M_3) Boron @ 0.2%, (M_4) Iron @ 0.1%, (M_5) Zinc @ 0.5% + Boron @ 0.2%, (M_6) Zinc @ 0.5% + Iron @ 0.1% and (M_7) Zinc @ 0.5% + Boron @ 0.2% + Iron @ 0.1%. The results reported that the higher growth parameters *viz.* plant height, number of branches plant^{-1}, fresh weight plant^{-1} and dry weight plant^{-1} were recorded with variety Radhey. However it was statistically at par with variety KWR-108 during both the experimental years. Among the micronutrients, application of M_7 (Zinc @ 0.5% + Boron @ 0.2% + Iron @ 0.1%) recorded higher growth parameters with quality produce which were at par with Zinc @ 0.5% + Boron @ 0.2% and Zinc @ 0.5% + Iron @ 0.1%.

Keywords: Boron, ferrous, micronutrients, plant height and zinc

Introduction
Chickpea (*Cicer arietinum* L.) the premier pulse crop of Indian subcontinent, is predominantly consumed as a pulse; dry chickpea is also used in preparation of a variety of snacks, sweets and condiments and green fresh chickpea are commonly consumed as a vegetable. It is one of the most important pulse crop grown in semi-arid and tropical climate. India is the largest chickpea producer as well as consumer in the world. According to the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) chickpea seeds contain on average 21.1% protein, 64% total carbohydrates (47% starch, 6% soluble sugar), 5% fat, 6% crude fibre and 3% ash. High mineral content has been reported for phosphorus (340 mg per 100 g), calcium (190 mg per 100 g) and magnesium (140 mg per 100 g), iron (7 mg per 100 g) and zinc (3 mg per 100 g). The germinated seeds are recommended to cure scurvy. Malic and oxalic acids secreted from leaves locally known as 'Amb', helps to lower the blood cholesterol level. Recent studies have also shown that they can assist in lowering of cholesterol in the bloodstream (Pittway *et al.*, 2008) [24].

The shortage of pulses has aggravated the problem of malnutrition in humans and thus, there is an urgent need for meeting their increasing demand by manipulating the production technologies appropriately. This could be achieved by increasing the area under these crops or by increasing their per unit productivity. The area under pulses does not seem likely to expand, as the land has become limiting factor due to rapid industrialization and urbanization. The low production of this crop is due to improper use of fertilizers, weed competition, improper time of sowing and seed rate, pest and disease management and selection of genotypes (Gaur *et al.*, 2010) [10]. Chickpea varieties play an important role in the production of pulses. Selection of proper variety for a set of agro-climatic conditions is very important to achieve maximum potential, because of differential growth and development behaviour due to different genetic characters of varieties. There are several evidences indicating that the high yielding chickpea varieties are showing response to application of micronutrients. Critical evaluation and selection of the superior varieties with high yield potential and good quality for particular region is, therefore always has a good promise.

In modern agriculture micronutrients are becoming deficient day by day due to intensive cultivation with high yielding varieties of crops using high analysis fertilizers, which not only reduce the crop productivity but also deteriorates the quality of produce.

Farmers are not well aware about nutrients management of chickpea. They apply only inadequate major nutrients to chickpea. Four micronutrients *i.e*. Manganese (Mn), Iron (Fe), Copper (Cu) and Boron (B) are required for higher plants (Welch *et al.,* 2005) [33]. This has been well documented to involve in photosynthesis, nitrogen fixation, respiration and other biochemical pathway (Foth and Ellis, 2006) [9]. Micronutrients are essential for the normal growth of plants (Kennedy *et al*., 2003) [16]. Micronutrient malnutrition affects more than half of the world population particularly in the developing countries (Alloway, 2008) [2] and in particular Fe and Zn deficiency in human nutrition are wide-spread in developing Asian countries including India (Shively *et al.,* 2014) [27]. Iron plays an important role in chlorophyll synthesis, being a structural component of hems, hematic and leg-haemoglobin and it is also an important part of the enzyme nitrogen's, which is essential for the N_2 fixation in legumes. The agronomic importance of chickpea is linked to its high protein content and other essential minerals, especially micronutrients. Zinc plays an important role in formation of chlorophyll and growth hormones (Hotz and Brown, 2004; Welch and Graham, 2004) [13, 34]. Zn is recognized as essential component of several enzyme systems having vital roles in the plant metabolism, e.g. carbonic anhydrase for reversible hydration of CO_2 to form HCO_3^- for transport and utilization of CO_2 in photosynthesis. It is also responsible for resisting pH changes in cytoplasm. Zn is involved in auxin metabolism like, tryptophan synthesis, tryptamine metabolism (Shively *et al.,* 2014) [27]. Secondly, Iron is a nutrient that all plants need to function properly. Many of the vital functions of the plant, like enzyme, chlorophyll production, nitrogen fixation, and development and metabolism are all dependent on iron. Without iron, the plant simply cannot function properly (Shively *et al.,* 2014) [27].

Boron regulates transport of sugars through membranes, cell division, cell development and auxin metabolism. Without adequate levels of boron, plants may continue to grow and add new leaves but fail to produce fruits or seeds. The application of B is important when the concentration of B in the soil is less than 0.3 mg kg^{-1} (Ahlawat *et al*., 2007) [1]. A continuous supply of boron is important for adequate plant growth and optimum yields. Boron (B) may cause yield losses of up to 100% (Ahlawat *et al.*, 2007) [1]. In general, each tonne of chickpea grain removes 38 g of Zn and it has been estimated that 35 g of B and 1.5 g of Mo are also removed from the soil (Ahlawat *et al*., 2007) [1]. Furthermore, nutrients particularly, micronutrients when applied to the foliage are generally absorbed more rapidly through trichomes present in leaves as well as providing a means of quickly correcting the plant nutrient deficiencies (Welch and Graham, 2004) [34].

However, information regarding varieties and application of micronutrients in chickpea production in Uttar Pradesh is lacking. Keeping in view the above discussed facts of sufficient information and sparce related research, the present investigation was undertaken to find out the effect of varieties and micronutrients application on growth and quality of chickpea in Kanpur conditions.

Material and Methods

The experiment was conducted during two consecutive *rabi* seasons of years 2018-19 and 2019-20, respectively at Students' Instructional Farm, Chandra Shekhar Azad University of Agriculture & Technology, Kanpur, situated at latitude of 25º 26' to 26º 58 North latitude and East latitude of 79º 31' to 80º 34', with altitude of 125.9 meters above the mean sea level. The total rainfall of 37.5 and 164.0 mm were received during crop growing season of year, 2018-19 and 2019-20, respectively. Soil of the experiment field had sandy loam in texture, slightly alkaline in reaction, low in electrical conductivity, low in organic carbon, available nitrogen and medium in available phosphorus and potassium. However, soil was deficient in micronutrients.

The experiment was laid out in split plot design with three varieties in main plot *viz*. (V_1) KGD-1168, (V_2) Radhey and (V_3) KWR-108 and seven micronutrient treatments in sub plots *viz*. (M_1) Control, (M_2) Zinc @ 0.5%, (M_3) Boron @ 0.2%, (M_4) Iron @ 0.1%, (M_5) Zinc @ 0.5% + Boron @ 0.2%, (M_6) Zinc @ 0.5% + Iron @ 0.1% and (M_7) Zinc @ 0.5% + Boron @ 0.2% + Iron @ 0.1%. Each main plot was surrounded by a buffer of 1.5 m width whereas subplot was surrounded by 0.5 m width to protect the plots from accidental irrigation and gain of water through seepage. The treatments were replicated three times. The recommended dose of fertilizers (20:50:50 kg N:P:K ha^{-1}) were applied through prilled urea for nitrogen, single super phosphate for phosphorus, muriate of potash for potash. However, application of Zinc, boron and iron was applied as per treatment by using zinc sulphate monohydrate for zinc, boric acid for boron and ferrous sulphate for iron. Full single super phosphate, muriate of potash and 1/2 part of urea were applied at the time of sowing and remaining 1/2 part of prilled urea was broadcasted at 30 days after sowing. Application of micronutrients was done by using knapsack sprayer at 25 and 50 days after sowing. Observations related to growth characters were observed at maturity stage during both the years. Protein content in seed was estimated by method suggested by AOAC (1990) [3]. However, protein yield in seed (kg ha^{-1}) was calculated by multiplying the protein content (%) in seed with their respective yields. The data relating to each character were analyzed as per the procedure of analysis of variance and significance was tested by "F" test (Gomez and Gomez 1984) [11].

Results and Discussions

Effect of varieties

Varieties of chickpea influenced significantly almost all the growth parameters *viz,* plant height, number of branches $plant^{-1}$, fresh weight $plant^{-1}$ and dry weight $plant^{-1}$ at maturity stage (Table 1). Variety, Radhey recorded highest values during both the experimental years for plant height (66.35 and 67.63 cm), number of branches $plant^{-1}$ (17.87 and 18.02), fresh weight $plant^{-1}$ (213.81 and 217.91 g) and dry weight $plant^{-1}$ (21.06 and 21.56 g). However, variety KWR-108 recorded higher values which were significantly at par with Radhey variety for all the growth parameters.

The plant height is the varietal character and may be influenced by the environment. Varietal variation in plant height was reported by Durga *et al*. (2005) [8]; Chitanya and Chandrika (2006) [6]; Badini *et al*. (2015) [4]. Increase in number of branches may also be due to variation in production of branches $plant^{-1}$ in individual variety was due to variation in their growth behavior reflected due to differences in genetic makeup. A similar result was also reported by Chauhan and Singh (2000) [7]; Neenu *et al*. (2014) [22]. The accumulation of higher fresh and dry weight production in

Radhey variety was due to enhanced growth characters like CGR (crop growth rate), RGR (relative growth rate), photosynthetic rate and chlorophyll content coupled with better utilization of moisture and nutrients from the soil with high yield potential and improved characters as compared to other varieties. Similar results were reported by Kumar and Deshmukh (2006) [18]; Kumar *et al*. (2006) [19]; Meena and Baldev (2013) [20].

Data revealed (Table 2) that nitrogen and protein content in seed failed to show marked variation due to varieties during both the experimental years. Significantly higher (421.06 and 448.50 kg ha^{-1}) protein yield of chickpea seed was recorded in variety V_2 (Radhey) which was statistically at par with V_3 (KWR-108) but both significantly superior over V_1 (KGD-1168) during both the experimental years. This might be due to higher protein content in variety V_2 (Radhay). However, higher protein yield is due to higher seed yield in respective treatment. Similar results were observed with the findings of Rashid *et al*. (2013) [26]; Uttamrao *et al*. (2018) [30].

Effect of micronutrients

Among the micronutrient, application of Zinc @ 0.5% + Boron @ 0.2% + Iron @ 0.1% recorded significantly higher plant height (67.84 and 68.78 cm), no. of branches $plant^{-1}$ (18.24 and 18.54), fresh weight $plant^{-1}$ (215.85 and 219.75 g) and dry weight $plant^{-1}$ (21.26 and 21.74 g) during *rabi*, 2018-19 and 2019-20, respectively. However, application of Zinc @ 0.5% + Boron @ 0.2% and Zinc @ 0.5% + Iron @ 0.1% were statistically at par with Zinc @ 0.5% + Boron @ 0.2% + Iron @ 0.1%.

Taller plant height might be due to the combined foliar application of different micronutrients might have accelerated the rate of metabolic activities in the plant system that might have resulted in increasing height of the plant. The similar trend of results was also reported with the application of micronutrient mixture through foliar application by Verma *et al*. (2004) [32]; Patel *et al*. (2009) [23]; Tahir *et al*. (2013) [29] in chickpea. Increase in branches $plant^{-1}$ due be the result of availability of required quantity of essential plant nutrients at various growth stages leading to hastening the metabolic processes of plant that might have resulted in production of more number of branches. The results of this study are also in line with Pradhan *et al*. (2018) [25].

The fresh and dry weigh of chickpea is product of luxurious plant growth and assimilation of photosynthates. Chickpea fertilized with M_7 (Zinc @ 0.5% + Boron @ 0.2% + Iron @ 0.1%) enjoyed healthy crop growth due to sufficient availability of micro nutrients. Enrichment of soil with micro nutrients made it efficient utilization micro nutrients. Iron enhanced chlorophyll metabolism, zinc is helpful in carbohydrate and protein synthesis and protected the chickpea crop against photo oxidative damage. Boron also regulated transport of sugar through membrane and played quite essential role for cell division and cell development. The results are in close association with Velenciano *et al.* (2010) [31] and Balai *et al.* (2017) [5].

Among the different micronutrient treatments (Table 2), significantly higher nitrogen content in seed (3.47 and 3.52%) and protein content (21.69 and 22.00%) was recorded with M_7 (Zinc @ 0.5% + Boron @ 0.2% + Iron @ 0.1%) which was at par with M_5 (Zinc @ 0.5% + Boron @ 0.2%) and M_6 (Zinc @ 0.5% + Iron @ 0.1%). However, M_1 (Control) recorded least nitrogen and protein content in seed during both the years. This might be due to the availability of N, P and K alongwith Zinc, boron, iron and thereby increasing more availability to plants. This confirms the findings of Jain *et al*. (2007) [14]; Kaya *et al.* (2010) [15]; Gupta *et al.* (2012) [12] and Khan *et al.* (2014) [17].

Significantly higher protein yield (Table 2) of 468.94 and 500.72 kg ha^{-1} was observed with application of M_7 (Zinc @ 0.5% + Boron @ 0.2% + Iron @ 0.1%) over rest of the treatments during both the experimental years. However, significantly lesser protein yield was observed with M_1 (Control). This is because of higher seed yield. The results are in close association with Singh *et al*. (2004) [28] and Morad *et al*. (2015) [21].

Table 1: Effect of varieties and micronutrients on growth characters of chickpea at maturity

Treatments	Plant height (cm)		No. of branches $plant^{-1}$		Fresh weight $plant^{-1}$ (g)		Dry weight $plant^{-1}$ (g)	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
Varieties								
V_1: KGD-1168	62.19	62.96	15.22	15.69	174.22	177.07	17.08	17.36
V_2: Radhey	66.35	67.63	17.87	18.02	213.81	217.91	21.06	21.56
V_3: KWR-108	57.17	57.84	16.64	17.12	196.64	200.70	19.18	19.48
S.Em±	2.14	2.17	0.54	0.56	6.17	6.23	0.70	0.73
LSD (p=0.05)	6.44	6.53	1.63	1.68	18.52	18.73	2.12	2.19
Micronutrients								
M_1: Control	56.98	58.02	14.64	14.92	169.12	173.60	16.58	17.02
M_2: Zinc @ 0.5%	61.27	62.12	16.69	16.97	193.39	196.25	18.96	19.24
M_3: Boron @ 0.2%	60.29	61.24	16.24	16.56	189.82	193.19	18.61	18.94
M_4: Iron @ 0.1%	59.78	60.57	15.87	15.99	182.99	185.84	17.94	18.22
M_5: Zinc @ 0.5% + Boron @ 0.2%	64.29	65.47	17.38	17.97	210.85	214.10	20.77	20.99
M_6: Zinc @ 0.5% + Iron @ 0.1%	62.87	63.49	16.97	17.65	202.23	207.22	19.63	20.12
M_7: Zinc @ 0.5% + Boron @ 0.2% + Iron @ 0.1%	67.84	68.78	18.24	18.54	215.85	219.75	21.26	21.74
S.Em±	1.91	1.93	0.43	0.45	4.76	4.86	0.62	0.63
LSD (p=0.05)	5.78	5.81	1.31	1.36	14.29	14.58	1.86	1.90

Table 2: Effect of varieties and micronutrients on nitrogen content (%), protein content (%) and protein yield (kg ha^{-1}) of chickpea

Treatments	Nitrogen content in seed (%)		Protein content (%)		Protein yield (kg ha^{-1})	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
Varieties						
V_1: KGD-1168	3.13	3.15	19.56	19.69	375.75	397.74
V_2: Radhey	3.18	3.22	19.88	20.13	421.06	448.50
V_3: KWR-108	3.15	3.18	19.69	19.88	406.20	428.61
S.Em±	0.12	0.13	0.47	0.51	6.11	7.06
LSD (p=0.05)	NS	NS	NS	NS	18.36	21.19
Micronutrients						
M_1: Control	2.78	2.80	17.38	17.50	324.83	339.33
M_2: Zinc @ 0.5%	3.18	3.21	19.88	20.06	405.15	428.08
M_3: Boron @ 0.2%	3.06	3.08	19.13	19.25	384.51	406.75
M_4: Iron @ 0.1%	2.94	2.99	18.38	18.69	361.53	392.86
M_5: Zinc @ 0.5% + Boron @ 0.2%	3.36	3.38	21.00	21.13	440.16	470.57
M_6: Zinc @ 0.5% + Iron @ 0.1%	3.29	3.32	20.56	20.75	434.43	446.54
M_7: Zinc @ 0.5% + Boron @ 0.2% + Iron @ 0.1%	3.47	3.52	21.69	22.00	468.94	500.72
S.Em±	0.09	0.10	0.38	0.42	4.22	4.31
LSD (p=0.05)	0.28	0.30	1.14	1.27	12.67	12.95

Conclusions

From the above overall study, it is recommended that to obtain higher growth with quality produce of chickpea should be grown by variety Radhey with application of M_7 (Zinc @ 0.5% + Boron @ 0.2% + Iron @ 0.1%) under ago-climatic conditions of Kanpur region of Uttar Pradesh.

Acknowledgement:

Authors are highly thankful to Department of Crop Physiology, Chandra Shekhar Azad University of Agriculture & Technology, Kanpur for providing all the necessary facilities and kind support.

References

1. Ahlawat IPS, Gangaiah B, Ashraf Zadid M. Nutrient management in chickpea. Chickpea breeding and management. Wallingford, Oxon, UK, CAB International, 2007, 213-232.
2. Alloway BJ. Micronutrients deficiencies in global crop production. Springer, New York, 2008, 1-539.
3. AOAC. Official Methods of Analysis. fifteenth edition. Helrich, K (ed.), Association of Official Analytical Chemist, Virginia. 1990;1:74.
4. Badini SA, Khan M, Sana UB, Shahbaz KB, Hafeez NB, Waseem B, *et al*. Effect of phosphorus levels on growth and yield of chickpea (*Cicer arietinum* L.) varieties. Journal of Natural Sciences Research. 2015;5(3):169-176.
5. Balai K, Sharma Y, Jajoria M, Deewan P, Verma R. Effect of Phosphorus, and Zinc on Growth, Yield and Economics of Chickpea (*Cicer aritinum* L.). International Journal of Current Microbiology and Applied Sciences. 2017;6(3):1174-1181.
6. Chaitanya SK, Chandrika V. Performance of chickpea (*Cicer arietinum L.*) varieties under varied dates of sowing in chittoor district of Andhra Pradesh. Legume Research. 2006;29(2):137-139.
7. Chauhan MP, Singh IS. Variability estimates and identifying chickpea *(Cicer arietinum* L.*)* genotypes for yield and yield attributes in salt affected soil. Legume Research. 2000;23(3):199-200.
8. Durga K, Koteswara Rao Y, Reddy MV. Performance of chickpea (*Cicer arietinum* L.) genotypes under irrigated and unirrigated conditions. Legume Research. 2005;28(3):226-228.
9. Foth HD, Ellis BG. Climate variability and soil nutrient status along altitudinal gradient in Kigezi highlands, Southern Uganda, Soil fertility, 2nd Ed. Lewis Publications, New York, 2006, 290.
10. Gaur PM, Tripathi S, Gowda CLL, Ranga GV, Sharma HC, Pande S, *et al*. Chickpea Seed Production Manual. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics, 2010, 28.
11. Gomez KA, Gomez AA. Statistical Procedures for Agricultural research (2 ed.), John Wiley and sons, New York, 1984.
12. Gupta SC, Gangawar Suchi, Dubey M. Effect of micronutrients and bio-fertilizers on growth, yield attributing characters, yield and economics of chickpea (*Cicer arietinum* L.). Journal of Soils and Crops. 2012;22(2):287-291.
13. Hotz C, Brown KH. Assessment of the risk of Zn deficiency in population and options for its control. Food and Nutrition Bulletin. 2004;25:S91-S204.
14. Jain VK, Kumar S, Panwar JDS. Response of mungbean (*Vigna radiata*) to phosphorus and micronutrients on N and P uptake and seed quality. Legume research. 2007;30(3):201-204.
15. Kaya M, Sanli A, Tonguc M. Effect of sowing dates and seed treatments on yield, some yield parameters and protein content of chickpea (*Cicer arietinum* L.). African Journal of Biotechnology. 2010;9(25):3833-3839.
16. Kennedy G, Nantel G, Sheety P. The scourge of "*hidden hunger*": Global dimensions of micronutrient deficiencies. Journal of Food Nutrition and Agriculture. 2003;32:8-16.
17. Khan N, Tariq M, Ullah K, Muhammad D, Khan I, Rahaullah K, *et al*. The effect of molybdenum and iron on nodulation, nitrogen fixation and yield of chickpea genotypes (*Cicer arietinum* L.). IOSR Journal of Agriculture and Veterinary Science. 2014;7(1):63-79.
18. Kumar S, Kumar M, Kadion VS. Biomass partitioning and growth of chickpea (*Cicer arietinum* L.) as influenced by sowing dates and genotypes. Legume Research, 2006;29(2):110-113.
19. Kumar P, Deshmukh PS. Sensitivity to moisture stress and growth regulators on yield and yield components of

two chickpea (*Cicer arietinum* L.) genotypes at different growth stages. Legume Research. 2006;29(3):175-180.
20. Meena BS, Baldev R. Effect of integrated nutrient management on productivity, soil fertility and economics of chickpea (*Cicer arietinum* L.) varieties in vertisols. Annals of Agricultural Research. 2013;34(3):225-230.
21. Morad Shaban, Mohsen L, Younes H, Ezatollah N, Foroozan K, Mitra Y, *et al*. Response of chickpea (*Cicer arietinum* L.) cultivars to integrated application of Zinc nutrient with water stress. International Journal of Agriculture and Crop Sciences. 2015;4(15):1074-1082.
22. Neenu S, Ramesh K, Ramana S, Biswas AK, Subba Rao A. Growth and yield of different varieties of Chickpea (*Cicer arietinum* L.) as influenced by the phosphorus nutrition under rainfed conditions on Vertisols. International Journal of Bio-Resource and Stress Management. 2014;5(1):053-057.
23. Patel MM, Patel IC, Patel PH, Patel AG, Acharya S, Tikka SBS. Impact of foliar nutrition of zinc and iron on the productivity of cowpea under rainfed condition. Journal of Arid Legumes. 2009;6(1):49-51.
24. Pittaway JK, Roberston IK, Madeleine JB. Chickpea may influence fatty acid and fiber intake in an ad Libitum Diet, leading to small improvements in serum lipid profile and glycemic control. Journal of the Academy of Nutrition and Dietetics. 2008;108(6):1006-1013.
25. Pradhan A, Thakur A, Sonboir HL. Response of rice varieties to different levels of nitrogen under rainfed aerobic ecosystem. Indian Journal of Agronomy. 2018;59(1):76-79.
26. Rashid M, Abd El Lateef, Tawfik MM, Hozyin M, Bakry BA, Elewa TA, *et al*. Soil and foliar fertilization of mungbean (*Vigna radlata* (L.) wilczek) under Egyptian conditions. Elixir Agriculture. 2013;47:8622-8628.
27. Shively GJ, Singh GD, Singh WS. Effect of foliar application of iron, zinc and manganese on chickpea. Indian Journal of Agronomy. 2014;59(1):80-85.
28. Singh M, Chaudhary SR, Sharma SR, Rathore MS. Effect of some micronutrient and uptake by chickpea. Agriculture Science Digest. 2004;24(4):268-270.
29. Tahir M, Hyder A, Tahir S, Naeem M, Rehman A. Production potential of mungbean (*Vigna radiata* L.) in response to sulphur and boron under agro ecological conditions of Pakistan. International Journal of Mod. Agriculture. 2013;2(4):166-172.
30. Uttamrao TM, Babu R, Topgyal T, Manhas S, Bhoyar V, Solanke G, Kumar S. Physico-biochemical evaluation of certain promising varieties of chickpea (*Cicer arietinum* L.) grown along the banks of Ganga River in Uttar Pradesh. International Journal of Chemical Studies. 2018;6(5):2160-2164.
31. Valenciano JB, Boto JA, Marcelo V. Response of chickpea (*Cicerareitinum* L.) yield to Zinc, Boron and Molybdenum application under pot conditions. Spanish Journal of Agricultural Research. 2010;8(3):797-807.
32. Verma CB, Lallu, Yadav RS. Effect of boron and zinc application on growth and yield of pigeonpea. Indian Journal of Pulses Research. 2004;17(2):149-151.
33. Welch RM, Singh G, Graham RD. Agriculture: the real nexus for enhancing bioavailable micronutrients in food crops. Journal of Trace Elements in Medicine and Biology. 2005;18:299-307.
34. Welch RM, Graham RD. Breeding for micronutrients in staple food crops from human nutrition prospective. Journal of Experimental Botany. 2004;55:353-364.