International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(5): 3183-3186

Received: 13-07-2019
Accepted: 15-08-2019

Dr. GP Banjara
Department of Agronomy, Indira Gandhi Krishi, Vishwavidhyalaya, Raipur, Chhattisgarh, India

Sanjay Kumar Majgahe
Department of Agronomy, Indira Gandhi Krishi, Vishwavidhyalaya, Raipur, Chhattisgarh, India

Corresponding Author:
Dr. GP Banjara
Department of Agronomy, Indira Gandhi Krishi, Vishwavidhyalaya, Raipur, Chhattisgarh, India

Impact of biofortification of zinc and iron on their content and uptake of chickpea (*Cicer arietinum* L.) in Chhattisgarh plains

Dr. GP Banjara and Sanjay Kumar Majgahe

Abstract
The present investigation "Impact of biofortification of zinc and iron on their content and uptake of chickpea (*Cicer arietinum* L.) in Chhattisgarh plains" was carried out during rabi season in 2016-17 and 2017-18 at Instructional Cum Research Farm of IGKV, Raipur (Chhattisgarh). The soil of experimental field was clayey (*Vertisols*) in texture, locally known as "*Kanhar*" which was low, medium and high in available N, P_2O_5 and K_2O, respectively. The experiment was laid out in Split Plot Design with four replications. The experiment consists of two genotypes and six different nutrient levels treatment combinations. It was found significantly difference between both genotypes and all nutrient levels treatment. The chickpea genotype Indira chana-1was found significantly higher in Zn and Fe content and Zn and Fe uptake, seed yield, stover yield and harvest index over the genotype Vaibhav during both the years and on mean basis. Treatment RDF (20:50:20) + 0.5% $ZnSO_4$ and 0.1% FeSO4 through foliar application in pre flowering and pod development stage recorded significantly highest in Zn and Fe content and Zn and Fe uptake seed yield, stover yielda and harvest index over all nutrient levels treatment and lowest in RDF (20:50:20) (Standard control) during both the years and on mean basis.

Keywords: Chickpea, biofortification, zinc and iron, uptake, content

Introduction

Pulses are a vital source of stable protein food for the poor and vegetarians which represent the wide population of country. The Recommended Dietary Allowances (RDA) for adult male is 60 g and 55 g for female per day. The per capita availability of pulses is 42 g day^{-1}. The legumes crops can utilize limited soil moisture and nutrients more efficiently than cereals and well adapted under highly adverse condition. In India, pulses occupies 29.46 mha area and contributes 22.95 mt production with an average productivity of 779 kg ha^{-1}. Total pulse area in Chhattisgarh is 884.5 thousand hectares which contribute 527.1 thousand tonnes production with an average productivity of 476.1 kg ha^{-1} (Anonymous, 2016-17a) [4]. Pulse produced on 12-13 percent of global arable land. India is the first in the world production and area contributed around 70 percent to the world production. Chickpea grown over 40 countries.

Effective biofortification techniques need to be recognized and applied in an effort to enrich the micronutrient content in the staple crops. Biofortification is process of improving the bioavailabily of vital minerals in economic parts of crop through agronomic intervention or genetics selection, may be the solution to mitigate malnutrition or hidden hunger. Conventional interventions have a confined impact, so biofortification has been proposed as an alternative long-term technique for enhancing mineral nutrients (Zhu *et at.*, 2007) [42]. In the sequence of micronutrient malnutrition; iron is also playing a vital role. Its deficiency is a highly prevalent nutritional disorder afflicting 2.5 to 5 billion people around the globe (Yip, 2002) [41] where poor households and pre-school children are severely affected due to high demand for iron (Benoist *et al*. 2008) [8]. Iron acts as a co-factor for several enzymes performing basic functions in human body. Inadequate supply of iron contributes to disability, anemia and stunted mental growth (Sheftela *et al*. 2011) [34]. Its malnutrition may be reduced by enhancing the bio-available iron content through iron supplementation and food fortification (Rana *et al*. 2012) [30]. These attempts are usually expensive and difficult to sustain on daily basis particularly in undernourished countries (Best *et al*. 2011) [9]. Therefore, it seems most desirable that crop fortification with iron content would be cost effective approach to overcome the hidden hungers of iron.

Zn application influence on synthesis of auxine, nodulation and nitrogen fixation which enhance the plant growth and development of crop and ultimately influence the seeed yield (Kasthurikrishna and Ahlawat, 2000). Application of Zn enhance quality and yields of chickpea reported by *Khan et al.*, 2003 [23].

Material and methods

A field experiment was carried out at Instructional Cum Research Farm of IGKV, Raipur (Chattisgarh), during Rabi season in 2016-17 and 2017-18. The experiment was conducted with two main plots of varieties viz., Vaibhav, Indira chana-1 and six nutrient levels treatment viz., T1: Recommended dose of NPK (standard control), T2: RDF(20:50:20)+ 0.5% $ZnSO_4$ foliar application at flowering and pod formation stage, T3: RDF(20:50:20)+ 0.1% FeSO4 foliar application at pre flowering and pod formation stage, T4: RDF(20:50:20)+ 0.5% $ZnSO_4$ and 0.1% $FeSO_4$ through foliar application at pre flowering and pod formation stage, T5: RDF(20:50:20)+ Seed treatment 2g $ZnSO_4$/ kg of seed, T6: RDF(20:50:20)+ Soil application of $ZnSO_4$ @ 25 kg/ha at basal in sub plots. The data on Zn and Fe content and Zn and Fe uptake seed yield, stover yield and harvest index, were recorded based on two years and on mean basis were tabulated and statistically analyzed.

Table1: Nutrient contents (ppm) in seed of chickpea as influenced by varieties and biofortification of Zn and Fe through agronomic intervention (Pooled data mean of 02 years)

Treatment	Nutrient content in seed (ppm)					
	2016-17		2017-18		Mean	
	Zn (ppm)	Fe (ppm)	Zn (ppm)	Fe (ppm)	Zn (ppm)	Fe (ppm)
Genotype						
Vaibhav	28.54	58.15	29.63	59.83	29.09	58.99
Indira chana 1	30.18	60.72	31.23	63.29	30.70	62.00
CD (0.05%)	0.78	1.59	0.98	1.15	0.68	1.37
Nutrient levels						
Recommended dose of NPK (control)	27.47	55.36	28.18	57.47	27.82	56.41
RDF + 0.5% $ZnSO_4$ foliar application	29.84	58.80	30.80	60.74	30.32	59.77
RDF + 0.1% $FeSO_4$ foliar application	28.34	61.68	29.40	63.54	28.87	62.61
RDF+ 0.05%$ZnSO_4$ and0.01% $FeSO_4$ through foliar application	31.33	62.93	32.51	64.93	31.92	63.93
RDF+ Seed treatment 2g $ZnSO_4$ /kg of seed	28.61	57.80	30.04	60.13	29.32	58.96
RDF+ Soil application of $ZnSO_4$ @ 25 kg/ha (Recommended practice)	30.59	60.02	31.65	62.56	31.12	61.29
CD (0.05%)	1.78	3.26	1.17	3.06	0.99	3.13

Table 2: Nutrient uptake by seed of chickpea as influenced by varieties and biofortification of Zn and Fe through agronomic intervention (Pooled data mean of 02 years)

Treatment	Nutrient uptake by seed (kg ha^{-1})					
	2016-17		2017-18		Mean	
	Zn	Fe	Zn	Fe	Zn	Fe
Genotype						
Vaibhav	0.045	0.091	0.048	0.097	0.046	0.094
Indira chana 1	0.051	0.103	0.055	0.111	0.053	0.107
CD (0.05%)	0.003	0.007	0.002	0.007	0.003	0.007
Nutrient levels						
Recommended dose of NPK (control)	0.039	0.079	0.041	0.083	0.040	0.081
RDF + 0.5% $ZnSO_4$ foliar application	0.050	0.099	0.054	0.106	0.052	0.102
RDF + 0.1% $FeSO_4$ foliar application	0.046	0.100	0.049	0.106	0.048	0.103
RDF+ 0.05%$ZnSO_4$ and0.1% $FeSO_4$ through foliar application	0.055	0.110	0.059	0.118	0.057	0.114
RDF+ Seed treatment 2g $ZnSO_4$ /kg of seed	0.046	0.092	0.049	0.098	0.047	0.095
RDF+ Soil application of $ZnSO_4$ @ 25 kg/ha (Recommended practice)	0.052	0.103	0.056	0.111	0.054	0.107
CD (0.05%)	0.004	0.008	0.003	0.008	0.003	0.008

Table 3: Yields of chickpea as influenced by bio-fortification through foliar supplementation of Zn and Fe agronomic intervention (Pooled data mean of 02 years)

Treatment	Seed yield (kg/ha)			Stover yield (kg/ha)			Harvest index (%)		
Genotype									
	2016-17	2017-18	Mean	2016-17	2017-18	Mean	2016-17	2017-18	Mean
Vaibhav	1563.85	1616.10	1589.98	2642.65	2733.62	2688.14	37.17	37.10	37.14
Indira chana 1	1692.47	1742.74	1717.60	2744.03	2800.96	2772.50	38.16	38.30	38.23
CD (0.05%)	82.25	81.82	82.02	NS	56.74	57.58	0.66	NS	1.00
Nutrient levels									
Recommended dose of NPK (control)	1420.00	1450.27	1435.14	2651.83	2719.22	2685.53	34.87	34.78	34.83
RDF(20:50:20) + 0.5% $ZnSO_4$ foliar application	1680.65	1740.74	1710.69	2795.26	2779.50	2787.38	37.53	38.47	38.00
RDF(20:50:20) + 0.1% $FeSO_4$ foliar application	1621.38	1668.51	1644.94	2736.41	2764.49	2750.45	37.20	37.62	37.42
RDF(20:50:20)+ 0.5%$ZnSO_4$ and 0.1%$FeSO_4$ through foliar application	1743.84	1818.09	1780.96	2614.87	2814.46	2714.66	40.06	39.26	39.65
RDF(20:50:20)+ Seed treatment 2g $ZnSO_4$ /kg of seed	1599.11	1633.31	1616.21	2785.13	2731.98	2758.55	36.52	37.38	36.95
RDF(20:50:20)+ Soil application of $ZnSO_4$ @ 25 kg/ha basal (Recommended practice)	1703.98	1765.61	1734.79	2576.57	2794.12	2685.35	39.81	38.71	39.27
CD (0.05%)	84.08	86.05	84.95	NS	NS	NS	1.24	1.28	1.14

Results and Discussion

Nutrient contents and uptake

The data on nutrient contents of chickpea genotypes and different nutrient levels treatments during both the years and on mean basis was recorded and presented in Table.1

Data indicated that chickpea genotype Indira chana-1was found significantly superior in Ze and Fe content over the variety Vaibhav during both the years and on mean basis.

It was recorded that treatment RDF (20:50:20)+ 0.5% $ZnSO_4$ and 0.1% $FeSO_4$ through foliar application at pre flowering and pod formation stage has maximum Ze and Fe content compared to other treatments which is par to treatment RDF(20:50:20)+ Soil application of $ZnSO_4$ @ 25 kg ha^{-1} at basal during both the years and on mean basis and the minimum Ze and Fe content found under treatment RDF (20:50:20) (standard control).

The data depicted in table 2, showed genotypes had significant influence on Ze and Fe uptake. Genotype Indira chana-1was found significantly higher in Ze and Fe uptake over the variety Vaibhav during both the years and on mean basis. It was found that treatment RDF (20:50:20) + 0.5% $ZnSO_4$ and 0.1% $FeSO_4$ through foliar application at pre flowering and pod formation stage has maximum Ze and Fe uptake which is par to treatment RDF (20:50:20)+ Soil application of $ZnSO_4$ @ 25 kg ha^{-1} at basal during both the years and on mean basis while treatment RDF(20:50:20) (standard control) recorded minimum Ze and Fe uptake.

This might be due to application of Zn increase the Zn concentration in soil solution, which resulted in increasing intake of the nutrient from soil solution as results grain and straw yields increased, the uptake in seed and stover also increased significantly. Similar results reported by singh *et al*. (2001). As well as due to Zn and Fe involved in many enzymatic reaction, photosynthesis and synthesis of growth regulators which helps in elongation of root and increase nutrient absorption by crop. Similar results observed by Ramezani *et al*. (2016) [31].

Seed and stover yield (kg/ha)

Based on both the years and on mean basis data of seed yield, stover yield and harvest index of chickpea genotypes and different nutrient levels treatments was recorded and presented in Table.3

Data shows that chickpea genotype Indira chana-1was found significantly higher in seed yield, stover yield and harvest index over the variety Vaibhav during both the years and on mean basis.

Treatment RDF (20:50:20)+ 0.5% $ZnSO_4$ and 0.1% $FeSO_4$ through foliar application at pre flowering and pod formation stage has maximum seed yield, stover yield and harvest index which is par to treatment RDF(20:50:20)+ Soil application of $ZnSO_4$ @ 25 kg ha^{-1} at basal and RDF(20:50:20) + 0.5% $ZnSO_4$ foliar application at pre flowering and pod formation stage during both the years and on mean basis while minimum in treatment RDF(20:50:20) (standard control). The stover yield was showing non significant among all nutrient levels treatments during both the years and on mean basis. Similarly seed yield of chickpea was also significantly influenced under all zinc and iron fortification treatments. Among various fortification treatments, the foliar application of zinc and iron at pre flowering and pod formation stage recorded significantly higher seed yield over all the treatments. All the zinc and iron fertilization treatments significantly increased the seed yield over control. The highest seed yield of 1598 Kg/ha was recorded with T4 treatment (RDF + Zn (0.5%) and Fe (0.05%) foliar spray) over rest of the Zn and Fe fortified treatments including control (Kapilashiv Bazgalia and Brij Nandan 2017).

Conclusion

It is quite obvious from the both the years and on mean basis study that the Zn and Fe fortification has positive effects on Zn and Fe content, uptake and yield of chickpea varieties. Keeping the objectives of the investigation under consideration the following conclusion can be drawn.

The chickpea genotype Indira chana-1 shows higher Zn and Fe content and uptake, seed yield, stover yield and harvest index than genotype Vaibhav. Among the different six nutrient levels treatments application of RDF (20:50:20) +0.5% $ZnSO_4$ and 0.1% $FeSO_4$ through foliar application at pre flowering and pod formation was found significantly higher values of Zn and Fe content, Zn and Fe uptake, seed yield, stover yield and harvest index.

Reference

1. Akay A. Effect of zinc fertilizer applications on yield and element contents of some registered chickpeas varieties. African Journal of Biotechnology. 2011; 10(60):12890-12896.
2. Alam MA, Kumar M. Effect of zinc on growth and yield of rice var. Pusa Basmati-1 in Saran district of Bihar. Asian Journal of Plant Science and Research. 2015; 5(2):82-85.
3. Auld DS. Zinc coordination sphere in biochemical zinc sites. Biometals. 2001; 14:271-313.
4. Anonymous. Krishi Darshika, I.G.K.V., Raipur, (C.G.), 2016-17b.
5. Baraker B, Jha SK, Wani SP, Garg KK. Effect of balanced fertilizer management practices on factor of productivity on groundnut (*Arachis hypogaea* L.) cultivation. International Journal of Chemical Studies. 2017; 5(4):1288-1291.
6. 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.
7. Bhamare RS, Sawale DD, Jagtap PB, Tamboli BD, Kudam M. Effect of iron and zinc on growth and yield of french bean in iron and zinc deficient inceptisol soil. International Journal of Chemical Studies. 2018; 6(3):3393-3399.
8. Benoist BD, Mclean E, Andersson M, Rogers L. Iodine deficiency in 2007: Global progress since 2003. Food Nutrition Bulletin. 2008; 9(3):195-202.
9. Best C, Neufingerl N, Rosso JMD, Transler C, Briel TD, Osendarp S. Can multi micronutrient food fortification improve the micronutrient status, growth, health, and cognition of schoolchildren? A systematic review. Nutrition Reviews. 2011; 69(4):186-204.
10. Cakmak I, Kalayci M, Ekiz H, Braun HJ, Yilmaz A. Zinc deficiency an actual problem in plant and human nutrition in Turkey. A NATO-Science for Stability Project. Field Crops Research. 1999; 60: 175-188.
11. Dadkhah N *et al.* The effects of zice fertilizer on some physiological characteristics of chickpea (*Cicer arietinum* L.) under water stress. Iranian Journal of Pulses Research 6.2, 2015, 59-72.
12. Dayanand, Mehta SM, Verma RK. Seed yield and economics of chickpea (*Cicer arietinum*) as influenced

by foliar application of agrochemicals. Indian Journal of Agricultural Research. 2013; 47(4):359-362.
13. Enania AR, Vyas AK. Effect of phosphorus and zinc application on growth, biomass and nutrient uptake by chickpea in calcareous soil. Annals of Agricultural Research. 1994; 15(4):397-399.
14. Ferrandon M, Chamel AR. Cuticular retention, foliar absorption and translocation of iron, manganese and zinc supplied in organic and inorganic form. Journal of Plant Nutrition. 1988; 11:247-64.
15. FAO. World Agriculture: Towards 2015/2030, Summary Report, Food and Agriculture Organization, Rome, 2015.
16. Ghasemian V, Ghalavand A, Zadeh AS, Pirzad A. The effect of iron, zinc and manganese on quality and quantity of soybean seed. Journal of Phytology. 2010; 2(11):73-79.
17. Gowda KM, Halepyati AS, Koppalkar BG, Rao S. Response of pigeonpea (*Cajanus cajan* L.) to application of micronutrients through soil and foliar spray of macronutrients on yield, economics and protein content. Karnataka Journal of Agriculture Science. 2014; 27(4):460-463.
18. Hidoto L, Worku W, Mohammed H, Taran B. Effects of zinc application strategy on zinc content and productivity of chickpea grown under zinc deficient soils. Journal of Soil Science and Plant Nutrition. 2017; 17(1):112-126.
19. Hotz C, Brown KH. Assessment of the risk of Zn deficiency in population and options for its control. Food and Nutition Bulletin. 2004; 25:S91–S204.
20. Jamal A, Khan MI, Tariq M, Fawad M. Response of mungbean crop to different levels of applied iron and zinc. Journal of Horticulture and Plant Research. 2018; 6:13-22.
21. Jackson ML. Soil chemical analysis. Asia Publication House, Bombay, 1973, 165-167.
22. Jha DP, Sharma SK, Amarawat T. Effect of organic and inorganic sources of nutrients on yield and economics of blackgram (*Vigna mungo* L.) grown during kharif. Agricultural Science Digest. 2015; 35(3):224-228.
23. Khan HR, Mc Donald GK, Rengel Z. Zn fertilization improves water use efficiency, *grain* yield and seed Zn content in chickpea. Plant and Soil. 2003; 249:389-400.
24. Mali GS, Sharma NN, Acharya HK, Gupta SK, Gupta PK. Response of pigeon pea to S and Zn fertilization on vertisols in south- eastern plain of Rajasthan. Advances in Arid Legumes Research, 2003, 267-271.
25. Nandan B, Sharma BC, Chand G, Bazgalia K, Kumar R, Banotra M. Agronomic fortification of Zn and Fe in chickpea an emerging tool for nutritional security – A Global Perspective. Acta Scientific Nutritional Health. 2018; 2:12-19.
26. Pandey N *et al.* Foliar application of Zn at flowering stage improves plant’s performance, yield and yield attributes of black gram. Indian Journal of Experimental Biology. 2013; 51:548-555.
27. Shivay YS *et al.* Genetic Variability for zinc use efficiency in chickpea as influenced by zinc fertilization. International Journal of Bio-resource and stress management 5.1, 2014a, 031-036.
28. Parimala K. *et al.* Effect of Nutrient Sprays on Yield and Seedling Quality Parameters of Chickpea (*Cicer arietinum* L.). Plant Archives 13.2, 2013, 735-737.
29. Pathak GC *et al.* Improving reproductive efficiency of chickpea by foliar application of zinc. Brazilian Journal of Plant Physiology 24.3, 2012, 173-180.
30. Rana A, Joshi M, Prasanna R, Shivay YS, Nain L. Biofortification of wheat through inoculation of plant growth promoting rhizobacteria and cyanobacteria. Journal of Soil Biology. 2012; 50:118-126.
31. Ramezani A, Sajedi NA, Yarahmadi HM. The effect of foliar application of iron, zinc, and selenium on nutrient uptake and yield of Alfalfa. International Research Journal of Applied and Basic Sciences. 2016; 10(5):557-562.
32. Shakya MS, Patel MM, Singh VB. Knowledge level of chickpea growers about chickpea production technology. Indian Research Journal of Extention Education. 2008; 8:65-68.
33. Shamsi K. Effect of Sowing Date and Row Spacing on Yield and Yield Components of Chickpea under Rain fed Conditions in Iran. Islamic Azad University, Kermanshah Branch, Iran. Journal of Applied Biosciences. 2009; 17:941-947.
34. Sheftela AD *et al.* The long history of iron in the universe and in health and disease. Biochimica et Biophysica Acta (BBA) - General Subjects 1820. 2011; 3:161-187.
35. Singh RS, Yashwant SON, Sharma SN. Effect of nitrogen and micronutrient on growth yield and nutrient uptake by French bean. Indian Journal Pulses Research. 2001; 19(1):67-69.
36. Umamaheswari P, Singh CP. Influence of irrigation levels and micronutrients (Fe and Zn) on yield and yield attributes of rajmash (*Phaseolus vulgaris* L.). Legume Research. 2002; 25(2):121-123.
37. Vasudevan SN, Doddagoudar SR, Macha SI, Shakuntala NM, Patil SB. Augmenting productivity of major crops through seed polymer coating with micronutrients and foliar spray. Journal of Advanced Agricultural Technologies. 2016; 3(3):150-153.
38. Verma CB, Pyare R, Aslam M, Verma VK, Singh V, Sharma H. Enhancing growth, yield and quality of lentil through foliar spray of zinc, urea and thiourea under rainfed condition. Agriways. 2017; 5(2):123-127.
39. Wasmatkar RP, Inyole GP, Raut PD. Effect of different levels of sulphur and zinc on quality of nutrient of soybean. Journal of Maharashtra Agriculture university. 2002; 27(3):244-246.
40. White PJ, Broadley MR. Biofortification of crops with seven mineral elements often lacking in human diets iron, zinc, copper, calcium, magnesium, selenium and iodine. New Phytol. 2009; 182:49-84.
41. Yip R. Prevention and control of iron deficiency: policy and strategy issues. Journal of Nutrition. 2002; 132(4):802-805.
42. Zhu C, Naqvi S, Gomez-Galera S, Pelacho AM, Capell T, Christou P. Transgenic strategies for the nutritional enhancement of plants. Trends Plant Science. 2007; 12(12):548-555.