International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(4): 2570-2573

Received: 07-05-2019
Accepted: 09-06-2019

CB Patil
Assistant Professor (Agronomy), Agricultural Research Station, Badanapur, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

PA Pagar
Scientist (Agronomy), Agricultural Research Station, Badanapur, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

SV Gosavi
Scientist (Agronomy), Agricultural Research Station, Badanapur Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

MD Shrirame
Senior Scientist (Agronomy), Agricultural Research Station, Badanapur Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Correspondence
CB Patil
Assistant Professor (Agronomy), Agricultural Research Station, Badanapur, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Agronomic biofortification of Zn and Fe in chickpea through nutrient application

CB Patil, PA Pagar, SV Gosavi and MD Shrirame

Abstract
A field investigation was conducted at farm of Agricultural Research Station, Badnapur during *rabi* seasons of 2016-17, 2017-18 and 2018-19 in split plot design with four replications to study agronomic biofortification of Zn and Fe in chickpea through nutrient application. Chickpea varieties BDNG-797 (Akash) and Dig Vijay were used in main plot. Whereas, six nutrient application treatments were tested in sub plot *viz.*, N_1 - Recommended dose of NP (Control); N_2 - Recommended NP + 0.5% Zn foliar application (two times: flowering initiation and pod initiation stages); N_3- Recommended NP + 0.1% Fe foliar application (two times: flowering initiation and pod initiation stages); N_4- Recommended NP + 0.5% Zn &0.1% Fe through foliar application (two times: flowering initiation and pod initiation stages); N_5- Recommended NP + seed treatment 2 g Zn/kg of seed and N_6- Recommended NP + soil application of ZnSO4 @ 25 kg ha^{-1}. Results revealed that chickpea variety Dig Vijay recorded significantly higher seed yield than BDNG-797. The treatment receiving recommended NP + Zn and Fe through foliar application (two times: flowering initiation and pod initiation stages) recorded significantly highest seed yield of chickpea than rest of the treatments as well as maximum Zn and Fe content (ppm) in chickpea seed. Gross and B:C ratio followed similar trend. Interaction effects were not evident.

Keywords: Agronomic biofortification, micronutrients, chickpea, Zn and Fe fertlization

Introduction
Chickpea is most important *rabi* pulse crop cultivated in India on 99.54 and 107.63 lakh ha during 2016-17 and 2017-18, respectively with significant contribution in pulse economy. Madhya Pradesh leads in the country in acreage under chickpea during both the years (32.52 and 35.90 lakh ha). Area under chickpea in Maharashtra state was 18.74 and 19.88 lakh ha during 2016-17 and 2017-18 respectively (Anonymous, 2018) [1]. The production of chickpea in India was 9.38 and 11.16 million tonnes during 2016-17 and 2017-18 according to final and third advance estimates, respectively (Anonymous, 2018a) [2]. Shivay *et al.* (2016) [4] reported that Zinc (Zn) and iron (Fe) deficiencies are well-documented public health issue and an important soil constraint to crop production. Generally, there is a close geographical overlap between soil deficiency and human deficiency of Zn and Fe, indicating a high requirement for increasing concentrations of micronutrients in food crops. Breeding new plant genotypes for high grain concentrations of Fe and Zn (genetic biofortification) is an effective strategy to address the problem, but this strategy is a long-term process. A rapid and complementary approach is therefore required for biofortification of food crops with Zn and Fe in the short term. In this regard, agronomic biofortification using micronutrient fertilizers represents a fast and effective strategy.

Methodology
The present investigation was conducted at farm of Agricultural Research Station, Badnapur during *rabi* seasons of 2016-17, 2017-18 and 2018-19 in split plot design with four replications. Chickpea varieties BDNG- 797 (Akash) and Dig Vijay were used in main plot. Whereas, six nutrient application treatments were tested in sub plot *viz.*, N_1 - Recommended dose of NP (Control); N_2 - Recommended NP + 0.5% Zn foliar application (two times: flowering initiation and pod initiation stages);N_3- Recommended NP + 0.1% Fe foliar application(two times: flowering initiation and pod initiation stages); N_4- Recommended NP + 0.5% Zn & 0.1% Fe through foliar application (two times: flowering initiation and pod initiation stages); N_5- Recommended NP + seed treatment 2 g Zn/kg of seed and N_6- Recommended NP + soil application of ZnSO4 @ 25 kg ha^{-1}. Fertilizers were applied as per

treatments. One protective irrigation was given after sowing for germination along with one irrigation at flowering stage. Gross mmonetary returns, net mmonetary returns and benefit: cost ratio were calculated. Data generated was subjected to statistical analysis and results are interpreted. The initial and final nutrient status of soil was estimated. Seed samples were analyzed for Zn and Fe content.

Results and discussion

The results presented in table 1 to 4 indicated that there is significant influence of Zn and Fe on production potential and nutritive value of chickpea seeds. During all three years of study chickpea variety Dig Vijay recorded significantly higher seed yield than BDNG-797. Pooled results also indicated similar trend. Srinivasarao *et al.* (2006) [6] also reported that when selecting P-efficient genotypes of chickpea, it is essential to apply deficient micronutrients.

During first and second years of study treatment receiving recommended NP + Zn and Fe through foliar application (two times: flowering initiation and pod initiation stages) recorded significantly higher seed yield of chickpea which was on par with treatment receiving recommended NP + 0.5% Zn foliar application (two times); recommended NP + 0.1% Fe foliar application (two times) and RDF+ soil application of $ZnSO_4$@25 kg ha^{-1} (recommended practice). Lowest seed yield was recorded by application of only recommended NP. Whereas, during third year of study and pooled results indicated that treatment receiving recommended NP + Zn and Fe through foliar application (two times: flowering initiation and pod initiation stages) recorded significantly highest seed yield of chickpea than rest of the treatments. Interaction effects were not evident.

Combination of all micronutrients *viz.*, Fe + B + Zn + Mo could increase the grain yield significantly to the tune of 25.3% over RDF alone (Gupta and Sahu, 2012) [3]. Singh *et al.* (2004) [8] observed that content and uptake of Fe, Mo, Zn, N and P increased significantly with the addition of micronutrients individually or in combination over the control.

Pooled data presented in Table 2 revealed that treatment receiving recommended NP + 0.5% Zn & 0.1% Fe through foliar application (two times: flowering initiation and pod initiation stages) recorded significantly highest gross and net returns as well as benefit: cost ratio.

Maximum Zn and Fe content (ppm) in chickpea seed was observed due to application of recommended NP + 0.5% Zn & 0.1% Fe through foliar application (two times: flowering initiation and pod initiation stages) during three years of study. Pooled results also registered the similar trend. Singh *et al.* (2016) [5] mentioned that biofortification, the process of increasing the bioavailable concentrations of essential elements in edible portions of crop plants through agronomic intervention or genetic selection, may be the solution to malnutrition mitigation. The application of iron and zinc in combinations resulted in significant increase in growth, yield and nutrient uptake by chickpea over recommended package of practice alone (Pooja and Sarawad, 2019) [7].

Table 1: Seed yield (Kg ha^{-1}) of chickpea as affected by different treatments (2016-17, 2017-18 and 2018-19 and pooled)

Treatments	Seed yield (Kg ha^{-1})			
	2016-17	2017-18	2018-19	Pooled
A) Varieties (V):2				
V_1 - BDNG-797 (Akash)	1615	1736	1400	1583
V_2 - Dig Vijay	1825	1949	1510	1761
SE ±	27.90	45.51	13.96	24.07
CD at 5%	72.21	125.95	38.64	70.49
B) Nutrients levels (foliar / Soil application) (N): 6				
N_1 - Recommended dose of NP (Control)	1477	1666	1264	1469
N_2 - Recommended NP + 0.5% Zn foliar application (two times: flowering initiation and pod initiation stages)	1806	1862	1479	1716
N_3- Recommended NP + 0.1% Fe foliar application(two times: flowering initiation and pod initiation stages)	1766	1892	1543	1734
N_4- Recommended NP + 0.5% Zn &0.1% Fe through foliar application(two times: flowering initiation and pod initiation stages)	1883	1989	1733	1868
N_5- Recommended NP + seed treatment 2 g Zn/kg of seed	1657	1795	1311	1588
N_6- Recommended NP + soil application of Zn SO_4 @25 kg/ha	1728	1852	1398	1659
SE±	53.63	58.62	58.21	27.37
CD at 5%	148.45	162.24	168.09	80.16
C) Interaction(V x N) SE±	75.85	82.90	82.31	38.71
CD at 5%	NS	NS	NS	NS
CV (%)	8.82	9.00	11.32	9.60
GM	1720	1842	1455	1672

Table 2: Gross monetary returns (Rs ha^{-1}), net monetary returns (Rs ha^{-1}) and B:C ratio of chickpea as affected by different treatments (Pooled: 2016-17, 2017-18 and 2018-19)

Treatments	Gross monetary returns (Rs ha^{-1})	Net monetary returns (Rs ha^{-1})	B:C ratio
A) Varieties (V):2			
V_1 - BDNG-797 (Akash)	68380	38886	2.31
V_2 - Dig Vijay	75902	46408	2.57
SE ±	692	692	0.024
CD at 5%	2026	2026	0.070
B) Nutrients levels (Foliar / Soil application) (N): 6			
N_1 - Recommended dose of NP (Control)	63258	34932	2.33

N_2 - Recommended NP + 0.5% Zn foliar application (two times: flowering initiation and pod initiation stages)	74005	43978	2.46
N_3- Recommended NP + 0.1% Fe foliar application(two times: flowering initiation and pod initiation stages)	74929	44852	2.49
N_4- Recommended NP + 0.5% Zn &0.1% Fe through foliar application(two times: flowering initiation and pod initiation stages)	81014	50836	2.68
N_5- Recommended NP + seed treatment 2 g Zn/kg of seed	68240	39612	2.38
N_6- Recommended NP + soil application of Zn SO_4 @25 kg/ha	71399	41672	2.40
SE+	1497	1497	0.05
CD at (5%)	4385	4385	0.14
C) Interaction (V x N) SE+	2117	2117	0.071
CD at 5%	NS	NS	NS
CV (%)	9.60	15.69	9.67
GM	72141	42647	2.44

Table 3: Zn and Fe content (ppm) in chickpea seed as affected by different treatments

Treatments	Zn content (ppm) in chickpea seed	Fe content (ppm) in chickpea seed
A) Varieties (V):2		
V_1 - BDNG-797 (Akash)	41.38	83.79
V_2 - Dig Vijay	37.10	70.92
B) Nutrients levels (Foliar / Soil application) (N): 6		
N_1 - Recommended dose of NP (Control)	31.85	73.06
N_2 - Recommended NP + 0.5% Zn foliar application (two times: flowering initiation and pod initiation stages)	47.37	73.78
N_3- Recommended NP + 0.1% Fe foliar application(two times: flowering initiation and pod initiation stages)	32.45	83.40
N_4- Recommended NP + 0.5% Zn &0.1% Fe through foliar application(two times: flowering initiation and pod initiation stages)	50.32	84.25
N_5- Recommended NP + seed treatment 2 g Zn/kg of seed	35.95	74.73
N_6- Recommended NP + soil application of Zn SO_4 @25 kg/ha	37.56	74.94
GM	39.25	77.36

Table 4: Available nutrient status of soil after harvest (2016-17, 2017-18 and 2018-19)

Treatments	Zn (ppm)	Fe (ppm)	Zn (ppm)	Fe (ppm)	Zn(ppm)	Fe (ppm)
	2016-17		2017-18		2018-19	
Varieties (V): 2						
V_1- BDNG-797	0.47	1.64	0.43	1.58	0.48	1.46
V_2- Dig Vijay	0.45	1.56	0.41	1.44	0.44	1.32
Nutrients levels (foliar / Soil application) (N) : 6						
N_1 - Recommended dose of NP (Control)	0.44	1.56	0.38	1.48	0.42	1.37
N_2 - Recommended NP + 0.5% Zn foliar application (two times: flowering initiation and pod initiation stages)	0.45	1.61	0.39	1.49	0.43	1.39
N_3- Recommended NP + 0.1% Fe foliar application(two times: flowering initiation and pod initiation stages)	0.43	1.59	0.40	1.53	0.43	1.38
N_4- Recommended NP + 0.5% Zn &0.1% Fe through foliar application(two times: flowering initiation and pod initiation stages)	0.42	1.64	0.41	1.52	0.45	1.36
N_5- Recommended NP + seed treatment 2 g Zn/kg of seed	0.41	1.60	0.41	1.51	0.45	1.40
N_6- Recommended NP + soil application of Zn SO_4 @25 kg/ha	0.59	1.62	0.52	1.50	0.57	1.41
General mean	0.46	1.60	0.42	1.51	0.45	1.39

(Initial available nutrient status of soil: (2016-17): 153:14: 436 NPK (Kg/ha); Zn-0.50 ppm Fe-1.96 ppm; (2017-18): 149:13.5: 427 NPK(Kg/ha); Zn-0.46 ppm Fe-186ppm; (2018-19): 134:11.2: 409 NPK(Kg/ha); Zn-0.52 ppm Fe-1.68 ppm

Conclusion

An application of 0.5% Zn and 0.1% Fe through foliar application at flowering initiation and pod initiation growth stages along with recommended dose of NP (25:50 Kg/ha) is essential for maximizing productivity, net monetary returns and enriched Zn and Fe content of chickpea seed.

References

1. Anonymous. Area coverage under *rabi* crops (Reconciled/final). All India Crop Situation- *Rabi* 2017-18 as on 09.02.2018. (http://www.agricoop.nic.in /sites/default/files/CWWG/pdf-Assessed on 20.6.2018), 2018.
2. Anonymous. Third advance estimates of production of food grains for 2017-18 as on 16.05.2018. (https://eands.dacnet.nic.in/Advance_Estimate/3rd_ Adv_Estimatesc201718_Eng.pdf- Assessed on 21.6. 2018), 2018a.
3. Gupta SC, Sahu S. Response of Chickpea to Micronutrients and Biofertilizers in Vertisol. Legume Research. 2012; 35(3):248-251.
4. Shivay YS, Prasad R, Singh U. Micronutrient Fertilizers for Zinc and Iron Enrichment in Major Food Crops: A Practicable Strategy. In: Singh U, Praharaj C, Singh S *et al.* (Eds) Biofortification of Food Crops. Springer, New Delhi, 2016.

5. Singh U, Praharaj CS, Chaturvedi SK, Bohra A. Biofortification: Introduction, Approaches, Limitations, and Challenges. In: Singh U, Praharaj C, Singh S *et al.* (Eds) Biofortification of Food Crops. Springer, New Delhi, 2016.
6. Srinivasarao C, Ganeshamurthy AN, Ali M, Venkateswarlu B. Phosphorus and Micronutrient Nutrition of Chickpea Genotypes in a Multi-Nutrient-Deficient Typic Ustochrept. Journal of Plant Nutrition. 2006; 29(4):747-763.
7. Pooja C, Sarawad IM. Influence of Iron and Zinc on Yield, Quality of Chickpea and Status of Iron and Zinc in Postharvest Soil. Agricultural Science Digest. 2019; 39(1):31-35.
8. Singh M, Chaudhary SR, Sharma SR, Rathore MS. Effect of some Micronutrients on Content and Uptake by Chickpea (*Cicer arietinum*). Agricultural Science Digest. 2004; 24(4):15-17.