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Effect of Biofortification of zinc and iron on yield attributes and yields of chickpea (*Cicer arietinum* L.) through agronomic intervention

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Abstract
The present investigation "Effect of bio fortification of zinc and iron on yield attributes and yields of chickpea (*Cicer arietinum* L.) Through agronomic intervention" 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. Chickpea genotypes 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. Yield attributing characters *viz*. pods/ plant, seed/ plant, test weight and seed yields was found maximum in treatment RDF(20:50:20) + 0.5% $ZnSO_4$ and 0.1% $FeSO_4$ through foliar application in pre flowering and pod development stage followed by treatment RDF(20:50:20)+ Soil application of $ZnSO_4$ @ 25 kg/ha at basal compared to other treatment and lowest in RDF(20:50:20) (Standard control) Where as 100 seed weight of chickpea showing non significant results during both the years and on mean basis.

Keywords: Biofortification, chickpea, *Cicer arietinum* L.

Introduction
Unlike plants, humans also require essential micronutrients and protein for normal physiological functions of the body and general health. Due to low concentration of micronutrients and protein in the staple food, billions of population is lacking sufficient daily intake of micronutrient and protein in their diet sometimes called 'hidden hunger'. The micronutrients most commonly associated with human health problems on a global scale include iron, zinc and iodine. Humans require at least 22 mineral elements for their wellbeing. These can be supplied by an appropriate diet. However, it is estimated that over 30 percent of population is zinc (Zn) deficient and rest with other micronutrients. 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 world. Pulses are important source of proteins and it also constituent starch, vitamin, and minerals. Chickpea is most important Rabi season pulse crop which has high digestible protein, iron, vitamin B and C. Its leaves contain malic acid which is very useful stomach ailments and blood purification (Shakya, *et al.*, 2008) [8].

Chickpea is the second most important pulse crop after pigeon pea in the word for human diet and other use. In Chhattisgarh, chickpea is grown over an area of 366.10 thousand ha and average productivity of 1100 kg/ha (Anonymous, 2016-17b) [2]. Legume crop which has unidue property to form root nodules with the help of symbiotic nitrogen fixing bacteria Rhizobium and fixes atmospheric nitrogen. Chickpea also plays important role in increasing soil fertility due to its nitrogen fixing ability. Micronutrient deficiency Zn and Fe is major problem of now days because of use of high yielding varieties, intensive cropping system, inadequate supply of micronutrient and loss of organic matter content by erosion and pollution. Iron involved in chlorophyll and thylakoid synthesis and development of chloroplast and important element for plant growth and development. 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) [4]. Application of Zn enhance quality and yields of chickpea reported by Khan *et al*., 2003 [5].

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 sub-plot with 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 yields attributing characters were recorded at harvest stage of crops. The data based on two years were tabulated and statistically analyzed.

Table 1: Yield attributing characters of chickpea as influenced by bio-fortification through foliar supplementation of Zn and Fe (Pooled mean of 02 years (2016-17 and 2017-18)

Treatment	Pods/Plant (No.)			Seeds/Pod (No.)			100 Seed weight (g)		
Genotype	2016-17	2017-18	Mean	2016-17	2017-18	Mean	2016-17	2017-18	Mean
Vaibhav	35.67	36.68	36.18	1.33	1.39	1.36	24.73	24.96	24.85
Indira chana 1	37.38	38.47	37.93	1.54	1.63	1.59	26.00	26.25	26.12
CD (0.05%)	0.63	0.57	0.60	0.14	0.14	0.06	0.67	0.68	0.68
Nutrient levels									
Recommended dose of NPK (control)	32.68	33.50	33.09	1.25	1.33	1.29	24.68	24.84	24.76
RDF(20:50:20) + 0.5% $ZnSO_4$ foliar application	36.65	37.60	37.13	1.43	1.50	1.46	25.44	25.69	25.56
RDF(20:50:20) + 0.1% $FeSO_4$ foliar application	36.13	37.23	36.68	1.50	1.55	1.53	25.00	25.21	25.11
RDF(20:50:20)+ 0.5%$ZnSO_4$ and 0.1%$FeSO_4$ through foliar application	39.90	41.28	40.59	1.63	1.70	1.66	26.20	26.56	26.38
RDF(20:50:20)+ Seed treatment 2g $ZnSO_4$/kg of seed	35.15	35.93	35.54	1.35	1.43	1.39	25.03	25.16	25.09
RDF(20:50:20)+ Soil application of $ZnSO_4$ @ 25 kg/ha basal (Recommended practice)	38.65	39.93	39.29	1.48	1.58	1.53	25.85	26.16	26.01
CD (0.05%)	1.56	1.63	1.59	0.17	0.19	0.13	NS	NS	NS

Table 2: Yields of chickpea as influenced by bio-fortification through foliar supplementation of Zn and Fe (Pooled mean of 02years (2016-17 and 2017-18)

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

Yield attributing characters

The data presented in Table 1 revealed that treatment genotypes Indira chana-1was found significantly superior in number of pods/plant, seeds/pod and 100 seed weight over the variety Vaibhav during both the years and on mean basis.

As regards to nutrient levels treatment application RDF (20:50:20) + 0.5% $ZnSO_4$ and 0.1% $FeSO_4$ through foliar application was found significantly superior in number of pods/ plant, seeds/ and 100 seed weight to other treatments, but it was at par to treatment RDF (20:50:20) + Soil application of $ZnSO_4$ @ 25 kg/ha at basal whereas 100 seed weight was showing non significant difference to other treatment during both the years and on mean basis. Minimum no. of pods/plant and seeds/pod was found in treatment RDF (20:50:20) (Standard control). This might be due to more number of new loading sinks and role of Zn in metabolic activity. The higher photosynthetic rate, translocation and assimilation of metabolites in the sink which ultimately increase number of pods plants^{-1}. Similar results was reported by Singh *et al*. (2015) [8]. To spray of Zn and Fe increase the translocation of assimilates to sink. Similar observation reported by Ram *et al*. (2013).

Seed and stover yields (kg/ha)

The data on seed yield, stover yield and harvest index was recorded and presented in Table 2 during both the years and on mean basis Among chickpea genotypes 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 except stover yield during year 2016-17 and harvest index during year 2017-18.

As regards to different nutrient levels treatments combination of Zn and Fe, the significant variation was found in all treatments. The maximum seed yield, stover yield and harvest index was recorded under treatment RDF(20:50:20) + 0.5% $ZnSO_4$ and 0.1% $FeSO_4$ through foliar application at pre flowering and pod formation stage compared to other

treatments However it was at 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. and the minimum seed yield under 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. This might be due to zinc application enhance protein and carbohydrates synthesis and their transportation to the site of seed formation. The application of iron sulphate play an important role in synthesis of cholorophyll and plant growth regulator and also improves photosynthesis and assimilates transportation to sink and finally increases seed yields. Similar results was reported by Mali *et al*. (2003) [6] and Jin *et al*. (2008) [8]. The treatment RDF (20:50:20)+ Soil application of ZnSO4@ 25 kg ha-1 at basal, RDF(20:50:20)+0.5% ZnSO4 foliar application at pre flowering and pod formation stage and RDF(20:50:20)+0.5% FeSO4 foliar application at pre flowering and pod formation stage was at par with treatment RDF(20:50:20)+ZnSO4 and FeSO4 through foliar application at pre flowering and pod formation stage." Similar results observed by Anitha *et al*. (2005) [1].

Conclusion

On the basis of two years data and on mean basis it concluded that The chickpea genotype Indira chana-1 give higher yield attributing parameters and seed yield, than genotype Vaibhav. 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 stage has beneficial influence on yields attributing characters and seed yield.

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