Influence of biofortification of zinc and iron on yield and economics of chickpea (*Cicer arietinum* L.)

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**Abstract**

The present investigation “Influence of biofortification of zinc and iron on yield and economics of chickpea (*Cicer arietinum* L.)” 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, P2O5 and K2O, 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 different between both genotypes and all nutrient levels treatment. The chickpea genotype Indira chana-1 was found significantly higher in seed yield, stover yield, harvest index, gross return, net return and B:C Ratio over the genotype Vaibhav during both the years and on mean basis except stover yield (2016-17) and harvest index (2017-18). In all nutrient levels treatment is significantly different except stover yield during both the years and on mean basis. Treatment RDF (20:50:20) + 0.5% ZnSO4 and 0.1% FeSO4 through foliar application in pre flowering and pod development stage recorded significantly highest in seed yield, stover yield, harvest index, gross return, net return and B:C Ratio over all nutrient levels treatment followed by treatment RDF (20:50:20) + Soil application of ZnSO4 @ 25 kg/ha at basal and lowest in RDF (20:50:20) (Standard control) during both the years and on mean basis.

**Keywords:** Chickpea, biofortification, zinc and iron, seed yield, economics

**Introduction**

Pulses are an important source of proteins and it also constitutes starch, vitamin, and minerals. Chickpea (*Cicer arietinum*) is a very important pulse crop in the leguminous family. This light brown coloured pulse is considered to be a good source of protein and is also called by the name of “Garbanzo beans” which are in the family of *Fabaceae* (in Latin, *Pisum*). Chickpea is the second most important pulse crop after pigeon pea in the world for human diet and other use. Since 1990, a rise in the productivity of chickpea in India has been observed from 614 kg per hectare to 735 kg per hectare. The yield of chickpea was highest in Andhra Pradesh (1615 kg./ha), followed by Bihar (1000 kg./ha), West Bengal (1000 kg./ha.) M.P. (926 kg./ha), U.P. (892 kg./ha) and Gujarat (892 kg./ha.). The yield of other states is below the country average (808 kg./ha.). In Chhattisgarh, chickpea is grown over an area of 366,10 thousand ha and average productivity of 1100 kg/ha (Anonymous, 2016-17).

Chickpea seed has carbohydrate (38-59%), fiber (3%), oil (4.8 to 5.5%), ash (3%), Calcium (0.2%) and phosphorus (0.3%). Digestibility of protein varies from 76-78 % and its carbohydrate from 57-60 % (Hulse, 1991, Huisman and van der poel, 1994). 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 seed yield (Kasthurikrishna and Ahlawat, 2000). Application of Zn enhance quality and yields of chickpea reported by Khan et al., 2003 [1].
Material and Methods
A field experiment was carried out at Instructional Cum Research Farm of IGKV, Raipur (Chhattisgarh), 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% FeSO_4 foliar application at pre flowering and pod formation stage, T4: RDF(20:50:20)+ Seed treatment 2g ZnSO_4/kg of seed, T5: RDF(20:50:20)+ Soil application of ZnSO_4 @ 25 kg/ha at basal in sub plots. The data on seed yield, stover yield, harvest index, gross return, net return and B: C Ratio were recorded based on two years and on mean basis were tabulated and statistically analyzed.

Table 1: Yields of chickpea as influenced by bio-fortification through foliar supplementation of Zn and Fe (Pooled data mean of 02 years)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Seed yield (kg/ha)</th>
<th>Stover yield (kg/ha)</th>
<th>Harvest index (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genotype</td>
<td>2016-17</td>
<td>2017-18</td>
<td>Mean</td>
</tr>
<tr>
<td>Vaibhav</td>
<td>1563.85</td>
<td>1616.10</td>
<td>1589.98</td>
</tr>
<tr>
<td>Indira chana 1</td>
<td>1692.47</td>
<td>1742.74</td>
<td>1717.60</td>
</tr>
<tr>
<td>CD (0.05%)</td>
<td>82.25</td>
<td>81.82</td>
<td>82.02</td>
</tr>
</tbody>
</table>

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 2778.37 37.53 38.47 38.00
- RDF(20:50:20)+ 0.1% FeSO_4 foliar application 1621.38 1644.94 1644.94 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 2614.66 40.06 39.26 39.65
- RDF(20:50:20)+ Seed treatment 2g ZnSO_4/kg of seed 1599.11 1663.31 1661.21 2785.13 2731.98 2754.58 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

Table 2: Economics of chickpea as influenced by bio-fortification through foliar supplementation of Zn and Fe (Pooled data mean of 02 years)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Cost of cultivation (Rs/ha)</th>
<th>Gross return (Rs/ha)</th>
<th>Net return (Rs/ha)</th>
<th>B:C ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genotype</td>
<td>2016-17</td>
<td>2017-18</td>
<td>Mean</td>
<td>2016-17</td>
</tr>
<tr>
<td>Vaibhav</td>
<td>5651.27</td>
<td>7301.97</td>
<td>6476.17</td>
<td>37891.53</td>
</tr>
<tr>
<td>Indira chana 1</td>
<td>7809.03</td>
<td>80523.11</td>
<td>79714.07</td>
<td>57933.09</td>
</tr>
<tr>
<td>CD (0.05%)</td>
<td>3785.80</td>
<td>3707.72</td>
<td>3746.18</td>
<td>3785.80</td>
</tr>
</tbody>
</table>

Nutrient levels
- Recommended dose of NPK (control) 20557 66851.83 73725.29 66938.57 45994.93 46768.29 46381.57 2.24 2.28 2.26
- RDF + 0.5% ZnSO_4 foliar application 20822 78424.51 80421.34 74924.02 57602.51 59601.54 58602.02 2.77 2.86 2.81
- RDF + 0.1% FeSO_4 foliar application 20887 75698.28 71383.95 64184.68 58411.26 62561.95 55351.62 2.62 2.69 2.66
- RDF+ ZnSO_4 and FeSO_4 through foliar application 21152 81087.55 83889.08 24888.31 59935.55 62737.06 61336.31 2.83 2.97 2.90
- RDF+ Seed treatment 2g ZnSO_4/kg of seed 20607 74745.19 5544.17 5144.67 54318.19 4937.15 5437.67 2.63 2.67 2.65
- RDF+ Soil application of ZnSO_4 @ 25 kg/ha (Recommended practice) 21807 79255.48 15498.08 80402.63 37448.45 74724.81 85895.63 2.63 2.74 2.69
- CD (0.05%) 3898.37 3867.79 3876.47 3898.37 3867.79 3876.47 0.19 0.18 0.18

Results and Discussion
Seed and stover yields (kg/ha)
The data on seed yield, stover yield and harvest index 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-1 was 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.

Seed yields of chickpea genotype were significantly influence under different nutrient levels treatments. 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 seed yield, stover yield and harvest index compared to other treatments which is par to treatment RDF(20:50:20)+ 0.5% ZnSO_4 and 0.1% FeSO_4 through 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 seed yield, stover yield, harvest index, gross return, net return and B: C Ratio were recorded based on two years and on mean basis were tabulated and statistically analyzed.
synthesis of chlorophyll and plant growth regulator and also improves photosynthesis and assimilates transportation to sink and finally increases seed yields. Similar results were reported by Mali et al. (2003) [1]. 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].

Economics
The Chickpea genotypes and all nutrient levels treatments wise economic returns were worked out by calculating operating cost of individual treatment. The data on gross returns, cost of cultivation, net return and B:C ratio of chickpea genotypes and different nutrient levels treatments during both the years and on mean basis was recorded and presented in Table.2.

Among chickpea genotypes Indira chana-1 was found significantly higher in gross return and net return and B: C ratio over the variety Vaibhav during both the years and on mean basis.

As regards to different nutrient levels treatments combination of Zn and Fe, the significant variation was found in all treatments. The maximum gross return, net return and B:C ratio was recorded under treatment RDF(20:50:20)+ 0.5% ZnSO4 and 0.1% FeSO4 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 ZnSO4 @ 25 kg ha⁻¹ at basal and treatment RDF(20:50:20)+ 0.5% ZnSO4 foliar application at pre flowering and pod formation stage during both the years and on mean basis and minimum under treatment RDF(20:50:20) (Standard control).

Among the various zinc and iron fortification treatments, the treatment T4 treatment (RDF + Zn (0.5%) and Fe (0.05%) foliar spray) registered highest net returns (40960 ₹/ha) and gross return (57833 ₹/ha) which was followed by treatment T7 (RDF+ seed treatment + Soil application of ZnSO4 @ 25Kg/ha and T6 (RDF + soil application of ZnSO4 @ 25 kg/ha). However, application of T4 treatment (RDF + Zn (0.5%) and Fe (0.05%) foliar spray) registered its, superiority in obtaining highest B: C ratio (2.42) which was followed by treatment T7 i.e. RDF+ seed treatment + Soil application of ZnSO4 @ 25 kg/ha) (1.93). Whereas, the lowest benefit: cost ratio 1.15 was recorded with the treatment T1 (Recommended dose of NPK (control) (Kapilashiv Bazgalia and Brij Nandan et al 2017).

Conclusion
On the basis of two years data and on mean basis it concluded that the chickpea genotype Indira chana-1 give higher seed yield, stover yield, harvest index, gross return and net return than genotype Vaibhav. Nutrient levels treatments application of RDF (20:50:20) +0.5% ZnSO4 and 0.1% FeSO4 through foliar application at pre flowering and pod formation stage has beneficial influence on seed yield, gross return and net return.

References
18. Dadkhah N et al. The effects of zice fertilizer on some physiological characteristics of chickpea (Cicerarrietinum)


