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Effect of Different Methods of Application of Zinc and Boron on Yield and Nutrient uptake of Chickpea (*Cicer arietinum* L.)

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ABSTRACT

A field experiment was conducted during *Rabi* 2017 at KVK Kandali, Hassan to study the effect of different methods of application of zinc and boron on yield and nutrient uptake of chickpea with twelve treatments and replicated thrice using RCBD. The experimental results revealed that significantly higher total biomass 1944 (kg ha^{-1}) and seed yield (1262 Kg ha^{-1}) was recorded with POP + foliar application of Zn as $ZnSO_4$ @ 0.5 per cent + B as Solubor @ 0.2 per cent (T_{11}) which was on par with POP + soil application of $ZnSO_4$ @ 15 kg ha^{-1} + Solubor @ 5 kg ha^{-1} (T_{12}) and POP (T_2). Higher total uptake of nitrogen (65.59 kg ha^{-1}), phosphorous (6.63kg ha^{-1}) and potassium (20.55 kg ha^{-1}) was also recorded in T_{11} (POP+ foliar application of Zn as $ZnSO_4$ @ 0.5 % + B as Solubor @ 0.2 %) and the lowest was found in the absolute control treatment (T_1).

Keywords : Foliar spray, Zinc, Boron, Yield and Nutrient uptake in Chickpea

THE biggest challenge for India is its ever increasing population and to match it with food production. By 2025, India's food grain requirement to feed the estimated population of 1,400 million will be 300 million tonnes (Kumar, 2012). In India, the arable land is limited and we have exceeded the carrying capacity of the land. Because of limited land area, there is a need to increase the productivity.

Chickpea (*Cicer arietinum* L.) is the most important ancient pulse crop being traditionally grown during rabi in India and cultivated mainly in semi-arid and warm temperate regions of world where the temperature is 20-30^0 C (Farshid, A 2011). Chickpea belongs to the Leguminaceae family. It contains 22.25 per cent protein which is almost three times more than that of cereals. Chickpea is the highest protein yielding grain legume. The crop has the capacity to fix 140 kg N ha^{-1} in a growing season (Harsha Hirdyani, 2014). 100 g of chickpea seeds provides 360 calories of energy, 5.2 g fat, 2.2 g minerals and 55 g carbohydrates. The malic and oxalic acid present in green leaves are very useful for recovering from intestinal disorder.

Zinc deficiency leads to reduction of stem elongation, auxin activities, protein synthesis, flowering and fruit development and also growth period is prolonged resulting in delayed maturity (Chatterjee, 2015). Boron plays an important role in new cell development in meristemetic tissues, proper pollination and fruit or seed formation and nodule formation in legumes (Valenciano *et al.*, 2010). It is also involved in translocation of sugars, synthesis of amino acid, protein, carbohydrate metabolism and movement of N, P, starch and sugar (Miwa *et al.*, 2010).

MATERIAL AND METHODS

A field experiment was conducted during *Rabi* season of 2017 to study the 'Effect of different methods of application of zinc and boron on yieldand nutrient uptake of chickpea (*Cicer arietinum* L.)'.

Initial soil samples were collected from the field and analyzed for physical and chemical properties. Soil samples were collected using core sampler. Soil samples collected from the experimental sites were dried under shade, mixed thoroughly and gently ground with wooden pestle and mortar without breaking the primary particles and passed through 2 mm sieve. Available Nitrogen was determined by micro Kjeldhal method, Subbaiah and Asija (1956), available phosphorus was determined by Brays - I method, Brays and Kurtz (1945) and potassium was determined using flame photometer as outlined by Piper (1966). Micro nutrients of plant samples were analyzed (Piper,1966) by making suitable dilution of di-acid extract, the samples were fed to the atomic absorption spectrophotometer using appropriate hallow cathode lamp. The 2 mm sieved samples were thoroughly mixed and analyzed for pH, electrical conductivity andavailable nutrients status (N, P, and K). The soil was sandy loam in texture with neutral in soil reaction (7.4), normal electrical conductivity (0.37 dSm^{-1}), and medium in organic carbon (0.48 per cent) content. The soil was medium in available nitrogen (312.55 kg ha^{-1}) medium in available P_2O_5 (39.76 kg ha^{-1}) and medium in available K_2O (176.45 kg ha^{-1}). DTPA extractable zinc (Linday *et al.,*1978) was deficient (0.40 mg kg^{-1}) and hot water soluble boron was also deficient (0.36 mg kg^{-1}), (Table 1).

Seed yield and total biomass of the chickpea crop was recorded at harvest. Grain and straw samples were collected separately from each plot soon after the harvest of the crop. The samples were initially air-dried cut in to pieces and then oven dried at 70^0 C for overnight, later grounded in willey mill to powder and stored. The powdered grain and straw samples drawn at harvest from each treatment in each replication were analysed for various parameters.

TABLE 1

Initial properties of soil at experimental site KVK Kandali, Hassan

Parameter	Value
pH (1:2.5) (Soil water extract)	7.40
EC (dS/m)	0.37
Organic carbon (%)	0.48
Available N (kg ha^{-1})	312.55
Available P_2O_5 (kg ha^{-1})	39.76
Available K_2O (kg ha^{-1})	176.45
Exchangeable Ca [c mol (p^+) kg^{-1}]	2.20
Exchangeable Mg [c mol (p^+) kg^{-1}]	1.73
Available S (mg kg^{-1})	13.26
DTPA Fe (mg kg^{-1})	17.10
DTPA Mn (mg kg^{-1})	13.97
DTPA Zn (mg kg^{-1})	0.40
DTPA Cu (mg kg^{-1})	0.32
Hot water soluble Boron (mg kg^{-1})	0.36
Soil type	Sandy loam

Treatment Details

The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Recommended dose of fertilizer for chickpea (25:50:25 kg ha^{-1} NPK): FYM: Farm Yard Manure @ 7.5 t ha^{-1}, Seed treatment with rhizobium and PSB common for all the treatments. Foliar spray of Zinc and Boron was taken at 45 days after sowing and Urea spray @ 2 per cent was common for all the treatments. The experiment comprised of twelve treatments. The treatment details are T_1: Absolute control (foliar water spray), T_2: POP (RDF + FYM + Biofertilizers), T_3: Farmers practice (2 bags of DAP), T_4: POP+ soil application of $ZnSO_4$ @ 15 kg ha^{-1}, T_5: POP + soil application of Solubor @ 5 kg ha^{-1}, T_6: POP + foliar application of Zn as $ZnSO_4$ @ 0.25 per cent, T_7: POP + foliar application of Zn as $ZnSO_4$ @ 0.5 per cent, T_8: POP+ foliar application of B as Solubor @ 0.1 per cent, T_9: POP + foliar application of B as Solubor @ 0.2 per cent, T_{10}: POP+ foliar application of Zn as $ZnSO_4$ @ 0.25 per cent + B as Solubor @ 0.1 per cent, T_{11}: POP + foliar application of Zn as $ZnSO_4$ @ 0.5 per cent + B as Solubor @ 0.2 per cent and T_{12}: POP+ soil application of $ZnSO_4$ @ 15 kg ha^{-1} + Solubor @ 5 kg ha^{-1}. Source of zinc was zinc sulphate and boron was solubor.

RESULTS AND DISCUSSION

Seed yield varied significantly due to different methods of application of zinc and boron, application of (T_{11}) POP + foliar application of Zn as $ZnSO_4$ @ 0.5 per cent + B as Solubor @ 0.2 per cent recorded highest seed yield (1262 kg ha^{-1}) and was on par with T_{10} treatment (POP + foliar application of Zn as $ZnSO_4$ @ 0.25 per cent + B as Solubor @ 0.1 per cent 1216 Kg ha^{-1} and T_7 treatment (POP+ foliar application of Zn as ZnSO4 @ 0.5 %) 1207 kg ha^{-1}. However, lower seed yield (765 Kg ha^{-1}) was recorded in (T_1) absolute control. The results are narrated in the Table 2.

TABLE 2

Effect of different methods of application of zinc and boron on seed yield (kg ha^{-1}) and total biomass (kg ha^{-1}) of chickpea

Treatments	Seed yield (kg ha^{-1})	Total Biomass (kg ha^{-1})
T_1: Absolute control (foliar water spray)	765	1115
T_2: POP (RDF + FYM + Biofertilizers)	1064	1587
T_3 : Farmers practice (2 bags of DAP)	861	1291
T_4 : POP+ soil application of $ZnSO_4$ @ 15 kg ha^{-1}	1100	1668
T_5 : POP+ soil application of Solubor @ 5 kg ha^{-1}	1080	1618
T_6 : POP+ foliar application of Zn as $ZnSO_4$ @ 0.25 %	1172	1798
T_7 : POP+ foliar application of Zn as $ZnSO_4$ @ 0.5 %	1207	1864
T_8 : POP+ foliar application of B as Solubor @ 0.1 %	1117	1717
T_9 : POP+ foliar application of B as Solubor @ 0.2 %	1150	1754
T_{10}: POP+ foliar application of Zn as $ZnSO_4$ @ 0.25 % + B as Solubor @ 0.1 %	1216	1910
T_{11}: POP+ foliar application of Zn as $ZnSO_4$ @ 0.5 % + B as Solubor @ 0.2 %	1262	1944
T_{12} : POP+ soil application of $ZnSO_4$ @ 15 kg ha^{-1} + Solubor @ 5 kg ha^{-1}	1129	1695
S.Em.±	45	80.08
CD @ 5%	132	234.87

The data on the Total biomass of chickpea at harvest as influenced by different method of application of zinc and boron are presented in Table 2. At harvest application of T_{11} (POP + foliar application of Zn as $ZnSO_4$ @ 0.5 % + B as Solubor @ 0.2 %) recorded higher total biomass of 1944 kg ha^{-1} fallowed by T_{10} treatment (POP + foliar application of Zn as $ZnSO_4$ @ 0.25 % + B as Solubor @ 0.1 %) 1910 kg ha^{-1} and T_7 treatment (POP + foliar application of Zn as ZnSO4 @ 0.5 %) 1864 kg ha^{-1}, while significantly lower total biomass (1115 kg ha^{-1}) was found in absolute control.

Increase in seed yield and total biomass might be due to the zinc which is responsible for protein synthesis, promotion of shoot growth and production of more number of branches resulting in increased pod yield. Boron aids in carbohydrate metabolism and translocation of sugar in the plant. Similar results were obtained by Jahiruddin *et al.* (2015); Patel *et al.* (2011).

The data pertaining to total nitrogen, phosphorus and potassium uptake by chickpea crop differed significantly due to different method of application of zinc and boron at harvest and the results are narrated in the Table 3.

Nitrogen, phosphorus and potassium uptake by chickpea crop was recorded significantly higher in T_{11} treatment which consists of POP + foliar application of Zn as $ZnSO_4$ @ 0.5 per cent + B as Solubor @ 0.2 per cent (65.59, 6.63 and 20.55 kg ha^{-1} respectively). It was on par with T_{10} treatment which consist of POP + foliar application of Zn as $ZnSO_4$ @ 0.25 per cent + B as Solubor @ 0.1 per cent (62.85, 6.16 and 19.45 kg ha^{-1} respectively) and T_7 treatment which consist of POP + foliar application of Zn as $ZnSO_4$ @ 0.5 per cent(60.12, 5.79 and 18.40 kg ha^{-1} respectively). However, significantly lower nitrogen, phosphorus and potassium uptake by chickpea crop (31.11, 2.29 and 9.20 kg ha^{-1} respectively) was recorded in T_1 (absolute control) treatment.

Significantly higher N uptake by chickpea was recorded in T_{11} (POP + foliar application of Zn as $ZnSO_4$ @ 0.5 % + B as Solubor @ 0.2 %) and lower uptake was recorded in T_1 (Absolute control) in grain and straw. Parimala *et al.,* (2013) reported similar observation However, application of boron along with zinc resulted in much higher N uptake values as compared to the application of boron alone.

Significantly higher P uptake by grain and straw were recorded in T_{11} (POP + foliar application of Zn as $ZnSO_4$ @ 0.5 % + B as Solubor @ 0.2 %) and it was significantly superior over all other treatments. Lower

TABLE 3

Effect of different methods of application of zinc and boron on total uptake N, P and K (kg ha^{-1}) of chickpea

Treatments	Total N uptake (kg ha^{-1})	Total P uptake (kg ha^{-1})	Total K uptake (kg ha^{-1})
T_1 : Absolute control (foliar water spray)	31.11	2.29	9.20
T_2 : POP (RDF + FYM + Biofertilizers)	45.90	3.71	13.76
T_3 : Farmers practice (2 bags of DAP)	36.45	2.75	10.89
T_4 : POP + soil application of $ZnSO_4$ @ 15 kg ha^{-1}	49.54	4.38	15.22
T_5 : POP + soil application of Solubor @ 5 kg ha^{-1}	47.43	3.94	14.46
T_6 : POP + foliar application of Zn as $ZnSO_4$ @ 0.25 %	56.53	5.30	17.17
T_7 : POP + foliar application of Zn as $ZnSO_4$ @ 0.5 %	60.12	5.79	18.40
T_8 : POP + foliar application of B as Solubor @ 0.1 %	51.94	4.60	15.81
T_9 : POP+ foliar application of B as Solubor @ 0.2 %	54.34	5.00	16.46
T_{10}: POP + foliar application of Zn as $ZnSO_4$ @ 0.25 % + B as Solubor @ 0.1 %	62.85	6.16	19.45
T_{11}: POP + foliar application of Zn as $ZnSO_4$ @ 0.5 % + B as Solubor @ 0.2 %	65.59	6.63	20.55
T_{12} : POP + soil application of $ZnSO_4$ @ 15 kg ha^{-1} + Solubor @ 5 kg ha^{-1}	52.25	4.69	15.93
S.Em.±	2.94	0.29	0.90
CD @ 5%	8.62	0.86	2.66

P uptake was reported in T_1 (Absolute control) in grain and straw. Frashid Aref (2011) reported that the application of Zn and B at all levels and in combination had increased the uptake of P in both grain and straw compared to control.

Significantly higher K uptake by grain and straw were recorded in T_{11} (POP + foliar application of Zn as $ZnSO_4$ @ 0.5 % + B as Solubor @ 0.2 %) treatment but lower K uptake was recorded in T_1 (Absolute control). Use of zinc caused significantly higher K uptake when applied alone or in combination with solubor. An identical effect was seen when B was applied to the soil along with zinc. Application of solubor along with zinc sulphate recorded significantly higher uptake of potassium as compared to their application alone. Gangwar *et al.,* (2012) have reported that, an increase in potassium uptake due to the application of Boron in groundnut. A synergistic effect of B and Zn on K uptake had been reported by Pathak *et al.* (2012).

This may be concluded from the results of the present study that foliar application of zinc @ 0.5 per cent and boron @ 0.2 per cent along with the package of practice increased yield and uptake of nutrients in chickpea crop. Combined foliar application of zinc and boron was more advantageous than soil application of zinc and boron for chickpea crop.

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