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Shaikh Wasim Chand
Department of Agronomy, College of Agriculture, Rajendranagar, PJTSAU, Hyderabad, Telangana, India

R Susheela
Senior Scientist (Agronomy), AICRP on Forage Crops & Utilization, ARI, Rajendranagar, Hyderabad, Telangana, India

D Sreelatha
Senior Scientist (Agronomy), AICMIP, Maize Research Centre, ARI, Rajendranagar, Hyderabad, Telangana, India

K Madhavi
Principal Scientist (SSAC), Soil Test Crop Response, ARI, Rajendranagar, Hyderabad, Telangana, India

M Chandani Patnaik
Principal Scientist (SSAC), AICRP on Micro Nutrients, ARI, Rajendranagar, Hyderabad, Telangana, India

Correspondence
Shaikh Wasim Chand
Department of Agronomy, College of Agriculture, Rajendranagar, PJTSAU, Hyderabad, Telangana, India

Agronomic bio-fortification of zinc fertilization on nutrient uptake of baby corn (*Zea mays* L.)

Shaikh Wasim Chand, R Susheela, D Sreelatha, K Madhavi and M Chandani Patnaik

Abstract
Field experiment was carried out to study the response of zinc fertilization in baby corn during *kharif* season 2016. The experiment was laid out in a randomized block design consisting of twelve treatments and three replications. Results indicated that nutrient content in plant, husk and corn were significantly higher over control (no zinc). Soil application of $ZnSO_4$ @ 25 kg ha^{-1} + foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS and at 40 DAS recorded significantly higher uptake of nitrogen, phosphorus and potassium in plant, husk and corn. Higher zinc concentration and uptake in plant, husk and corn was also recorded with soil application of $ZnSO_4$ @ 25 kg ha^{-1} + foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS and at 40 DAS over control (no zinc). Among different zinc fertilization treatments significantly higher cob yield and green fodder yield was produced by soil application of $ZnSO_4$ @ 25 kg ha^{-1} + foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS and at 40 DAS over control (no zinc). The results of the study clearly indicated that there was significant response in baby corn with soil application of $ZnSO_4$ @ 25 kg ha^{-1} + foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS and at 40 DAS over control (no zinc) application in Southern Zone of Telangana State.

Keywords: Zinc, baby corn, nutrient uptake, husk, fodder

Introduction
Baby corn is the dehusked young cobs harvested within 2-3 days of silk emergence and are consumed as vegetable due to its sweet flavour. The earliness facilitates crop diversification, increase overall cropping intensity in a year and increases profitability. Attention is now being paid to explore its potential in India for earning foreign exchange besides higher economic returns to the farmers. Overall crop nutrition plays a vital role in plant development and it is generally comprised of macronutrients and micronutrients with major role of macro ones, but the micronutrients even being required in smaller amounts are of equally vital for plant growth and development (Alloway, 2004) [1]. One third of the world population is reported at the risk of malnutrition due to inadequate dietary intake of zinc (Cakmak, 2009) [6]. About 50% of Indian soils are deficient in zinc causing low level of zinc and yield losses in fodder crops and affecting the health of the livestock (Singh, 2011) [17].

According to the recent survey, zinc deficiency in human nutrition is the most wide spread nutritional disorder, next to iron, vitamin 'A' and iodine. Nearly, 49% of the global population does not meet their daily-recommended intake of 15 mg day-1 of zinc for an adult and is one of the leading risk factors associated with diseases such as diarrhoea and retarded growth contributing to the death of 8,00,000 people each year. Widespread deficiencies of zinc have been reported right through East Asia, to the tune of 50-70% in India and Pakistan. The regions with Zn deficient soils are also the regions where Zn deficiency in human beings is widespread, for example in India, Pakistan, China, Iran and Turkey (Cakmak *et al.*, 1999; Alloway, 2004; Hotz and Brown, 2004) [6, 1, 7].

Zinc fertilization is essential for keeping sufficient amount of available zinc in soil solution (by soil application of zinc) and in leaf tissue (by foliar application of zinc) which contributes to the maintenance of adequate root zinc uptake. Zinc has a key role as a structural constituent or regulatory co-factor of a wide range of enzymes and proteins in many important biochemical pathways and these are mainly concerned with carbohydrate metabolism, both in photosynthesis and in the conversion of sugars to starch, protein metabolism, auxin metabolism, pollen formation, maintenance of integrity of biological membranes and resistance to infection by certain pathogens (Alloway, 2008) [2].

Material and Methods

Field experiment was conducted at College Farm, College of Agriculture, Rajendranagar, Hyderabad, Telangana State, during *kharif* season, 2016. The experimental site is geographically situated at $17^0 19'$ N latitude, 78^0 28' E longitude and at an altitude of 542.3 m above sea level which falls under Southern Telangana Agro-climatic region. The minimum and maximum temperatures ranged from 22.3 ˚C and 29.6 ˚C during crop growing period. The experiment was laid out in a randomized block design consisting of twelve treatments and replicated thrice. The treatments of zinc fertilization consisted, T_1: Control (No zinc), T_2: Foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS, T_3: Foliar spray of $ZnSO_4$ @ 0.2% at 40 DAS, T_4: Foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS and at 40 DAS, T_5: Soil application of $ZnSO_4$ @ 12.5 kg ha^{-1}, T_6: T_5 + Foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS, T7: T_5 + Foliar spray of $ZnSO_4$ @ 0.2% at 40 DAS, T8: T_5 + Foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS and at 40 DAS, T9: Soil application of $ZnSO_4$ @ 25 kg ha^{-1}, T10: T9 + Foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS, T11: T9 + Foliar spray of $ZnSO_4$ @ 0.2% at 40 DAS, T12: T9 + Foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS and at 40 DAS.

A short duration baby corn variety, VL-1 was used by adopting a spacing of 40 cm x 20 cm. The recommended dose of 150:60:50 NPK kg ha^{-1} was applied to all treatments. Nitrogen was applied in two splits per treatment i.e. half as basal and half at 30 days after sowing in form of urea. Phosphorus, potassium and zinc were applied in the form of single super phosphate, muriate of potash and zinc sulphate respectively. The fertility status of the experimental soil was low in organic carbon (0.20%) as well as available nitrogen (248.27 kg ha^{-1}), medium in available phosphorus (35.70 kg ha^{-1}) and high in potassium (487.9 kg ha^{-1}). The soil was deficient in available zinc content (0.44 ppm).

Representative baby corn samples were collected from each treatments. The collected samples i.e. plant, husk and corn were oven dried 70 ˚C for 48 hours, powdered and analyzed for N, P, K, and Zn contents. Nitrogen content in plants, husk and corn samples was estimated by modified Micro Kjeldahl method (Piper, 1996) [14], phosphorous content was estimated by Vanado-molybdo phosphoric acid method (Jackson, 1973) [8], potassium content was estimated by Flame Photometer (Jackson, 1973) [8] and zinc concentration was determined by using Atomic Absorption Spectrophotometer (Lindsay and Norvell, 1978) [9]. At harvest, the cob yield (kg ha^{-1}) and green fodder yield (t ha^{-1}) were recorded. Data were statistically analyzed as suggested by Panse and Sukhatme (1978) [12].

Results and Discussion

The results obtained were significantly differed with zinc fertilization treatments (Table. 1). It was observed that higher nutrient uptakes (N, P, K and Zn) in plant, husk and corn with zinc applications over control (no zinc). Significantly higher nitrogen uptake (150.89 kg ha^{-1}) in plant and in corn (38.97 kg ha^{-1}) was observed with soil application of $ZnSO_4$ @ 25 kg ha^{-1} + foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS and at 40 DAS and in husk (60.39 kg ha^{-1}) was recorded with soil application of $ZnSO_4$ @ 25 kg ha^{-1} + foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS whereas lower uptake was recorded with control no zinc application as, in plant (86.71 kg ha^{-1}), in husk (45.20 kg ha^{-1}) and in corn (22.01 kg ha^{-1}). The increase in nitrogen uptake might be due to steady and continuous availability of instant nitrogen in the rhizosphere. Increase in N content with Zn application could be attributed to synergistic effect between N and Zn (Mahdi *et al.* 2012) [10].

Significantly higher phosphorus uptake recorded in plant (18.57 kg ha^{-1}) with soil application of $ZnSO_4$ @ 25 kg ha^{-1} + Foliar spray of $ZnSO_4$ @ 0.2% at 40 DAS, in husk (10.34 kg ha^{-1}) and in corn (4.90 kg ha^{-1}) with soil application of $ZnSO_4$ @ 25 kg ha^{-1} + Foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS and at 40 DAS whereas lower phosphorus uptake observed in plant (11.78 kg ha^{-1}) with Foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS, in husk (7.27 kg ha^{-1}) with no zinc application and in corn (3.73 kg ha^{-1}) with Foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS and at 40 DAS (Table. 1). The increase in nutrient uptake with increasing level of zinc application was reported by Arya and Singh (2000) [3], Mahdi *et al.* (2012) [10] and Paramesh *et al.* (2014) [13].

In Table. 1, Potassium uptake in plant (141.29 kg ha^{-1}), in husk (80.21 kg ha^{-1}) and in corn (26.44 kg ha^{-1}) recorded significantly higher with soil application of $ZnSO_4$ @ 25 kg ha^{-1} + Foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS and at 40 DAS over control no zinc application (in plant 89.55 kg ha^{-1}, in husk 44.92 kg ha^{-1} and in corn 17.22 kg ha^{-1}). The nutrient uptake by the crop is determined by its nutrient content and yield. The uptake of any nutrient is the function of its content and dry matter production by the crop. Higher nutrient content in the produce and higher biomass production of baby corn might be the pertinent reason for higher uptake of nutrients. Application of Zn along with recommended dose of nutrients enhanced the total uptake of nitrogen, phosphorus and zinc by maize crop (Tetarwal *et al.* 2011) [19].

Similarly, zinc concentration in plant (26.80 ppm), husk (31.40 ppm) and corn (53.14 ppm) was significantly higher with soil application of $ZnSO_4$ @ 25 kg ha^{-1} + Foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS and at 40 DAS over control no zinc application (Table. 2) which results, 12.10 ppm in plant, 16.03 ppm in husk and 29.79 ppm in corn. Total zinc uptake (in plant, husk and corn) of 532.00 g ha^{-1} was recorded with soil application of $ZnSO_4$ @ 25 kg ha^{-1} + Foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS and at 40 DAS which was significantly superior over control no zinc application (188.49 g ha^{-1}). Increase in zinc concentration and uptake with high level of zinc was also reported by Shivay and Prasad (2014) [16]. Application of zinc causes higher chlorophyll content and this had apparently a positive effect on photosynthesis activity, synthesis of metabolites and growth regulating substances, activation of enzymes, oxidation and metabolic activities and ultimately better growth and development of crop which led to increase in nutrient concentration and uptake that produces more biomass production (Alloway, 2008) [2].

Similarly, significantly higher cob yield (6550 kg ha^{-1}) and green fodder yield (27.76 t ha^{-1}) was found with soil application of $ZnSO_4$ @ 25 kg ha^{-1} + Foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS and at 40 DAS over control (no zinc). Zinc treatment either by soil or foliar application led to an increase in the cob yield by 10.0% to 35.5% and in the green fodder yield by 3.1% to 24.0% over control no zinc application (Table. 3). Yield is an ultimate end product of many yield contributing components, physiological and morphological processes taking place in plants during growth and development (Mona, 2015) [11]. Zinc fertilization has beneficial effect on physiological process, plant metabolism and plant growth, which leads to higher yield. Increase in cob yield with application of zinc was also reported by Rakesh kumar and Bohra (2014) [15]. Increase in green fodder yield might be due to the enhanced translocation of photosynthates with applied zinc, which resulted in higher production of green fodder in the respective levels of nutrient. Similar results of significantly higher fodder yield with Zn application was also reported by Mahdi *et al.* (2012) [10], Balwinder kumar *et al.* (2013) [4] and Mona (2015) [11].

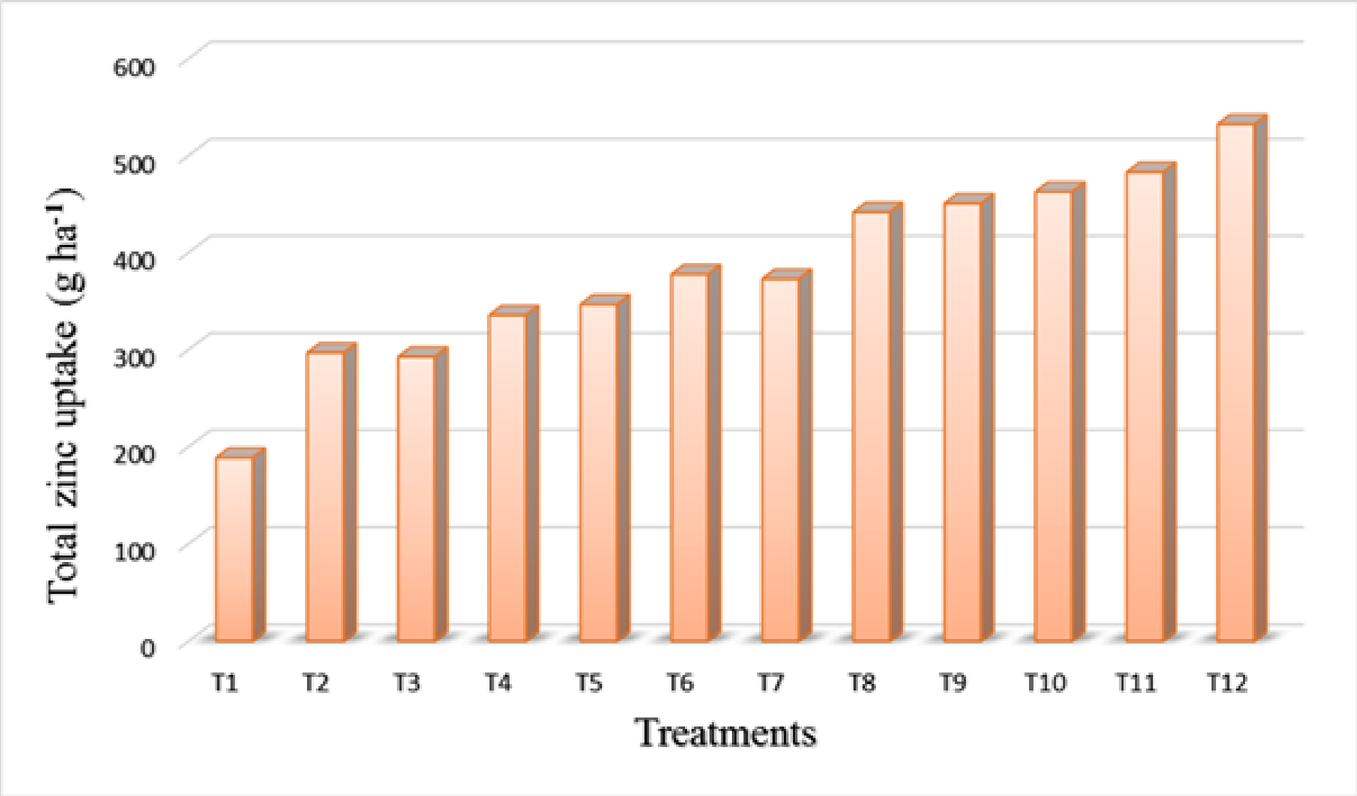

Fig 1: Total zinc uptake (g ha^{-1}) i.e. in plant, husk and corn as influenced by zinc fertilization.

Conclusion

Zinc application in zinc deficient soil has shown improvement in nutrient contents of plant, husk and corn. It is concluded that among different zinc fertilization treatments studied in baby corn, soil application of $ZnSO_4$ @ 25 kg ha^{-1} + foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS and at 40 DAS recorded significantly higher uptake of nitrogen, phosphorus and potassium and also zinc concentration and uptake in plant, husk and corn over control (no zinc) application. Similarly, significantly higher cob yield and green fodder yield was also reported with soil application of $ZnSO_4$ @ 25 kg ha^{-1} + foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS and at 40 DAS. The result of the present study advised that soil application of $ZnSO_4$ @ 25 kg ha^{-1} + foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS and at 40 DAS is better for producing zinc rich baby corn and green fodder which helps to improve zinc deficiency in human beings and animals.

Table 1: Nitrogen, phosphorus and potassium uptake by plant, husk and corn (kg ha^{-1}) as influenced by zinc fertilization.

Treatments	Nitrogen uptake			Phosphorus uptake			Potassium uptake		
	Plant	Husk	Corn	Plant	Husk	Corn	Plant	Husk	Corn
T_1: Control (No zinc)	86.71	45.20	22.01	12.14	7.27	3.75	89.55	44.92	17.22
T_2: Foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS	103.67	50.75	25.96	11.78	8.00	3.92	97.25	51.09	18.88
T_3: Foliar spray of $ZnSO_4$ @ 0.2% at 40 DAS	98.07	52.91	22.70	14.86	7.76	3.75	129.36	53.88	17.31
T_4: Foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS and at 40 DAS	116.18	55.22	24.19	15.87	9.03	3.73	131.38	53.21	18.53
T_5: Soil application of $ZnSO_4$ @ 12.5 kg ha^{-1}	112.17	55.30	27.44	13.84	9.06	4.11	118.04	62.50	20.08
T_6: T_5 + Foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS	124.04	51.46	28.34	15.85	9.51	3.84	114.08	61.16	19.71
T_7: T_5 + Foliar spray of $ZnSO_4$ @ 0.2% at 40 DAS	120.33	46.28	30.03	15.31	9.41	4.33	128.76	60.60	22.99
T_8: T_5 + Foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS and at 40 DAS	131.55	57.34	30.94	14.60	9.80	4.01	119.30	67.66	21.52
T_9: Soil application of $ZnSO_4$ @ 25 kg ha^{-1}	139.52	54.21	33.97	15.28	9.36	4.46	136.61	71.28	24.36
T_{10}: T_9 + Foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS	139.30	60.39	31.72	17.50	9.50	4.69	129.65	70.22	24.94
T_{11}: T_9 + Foliar spray of $ZnSO_4$ @ 0.2% at 40 DAS	140.78	53.67	36.64	18.57	10.32	4.40	134.62	72.82	25.47
T_{12}: T_9 + Foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS and at 40 DAS	150.89	60.33	38.97	17.99	10.34	4.90	141.29	80.21	26.44
SEm ±	9.60	2.69	1.62	1.32	0.68	0.32	9.23	3.87	1.58
CD (P=0.05)	28.16	7.87	4.75	3.87	2.01	0.92	27.07	11.36	4.62

Table 2: Zinc concentration (ppm) and uptake (g ha^{-1}) as influenced by zinc fertilization,

Treatments	Zinc concentration			Zinc uptake			Total zinc uptake
	Plant	Husk	Corn	Plant	Husk	Corn	
T_1: Control (No zinc)	12.10	16.03	29.79	93.67	57.26	37.55	188.49
T_2: Foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS	18.87	19.25	37.97	167.46	77.90	51.22	296.58
T_3: Foliar spray of $ZnSO_4$ @ 0.2% at 40 DAS	19.00	19.70	36.01	167.57	80.23	44.66	292.47
T_4: Foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS and at 40 DAS	20.23	22.75	42.18	187.76	95.07	52.51	335.34
T_5: Soil application of $ZnSO_4$ @ 12.5 kg ha^{-1}	20.70	22.20	45.40	189.70	95.31	61.33	346.34
T_6: T_5 + Foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS	22.70	23.09	43.65	217.61	102.00	57.87	377.48
T_7: T_5 + Foliar spray of $ZnSO_4$ @ 0.2% at 40 DAS	21.30	24.16	43.48	204.72	104.54	63.42	372.68
T_8: T_5 + Foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS and at 40 DAS	24.25	28.53	47.61	246.49	128.14	66.83	441.46
T_9: Soil application of $ZnSO_4$ @ 25 kg ha^{-1}	25.22	27.69	46.55	255.32	124.11	70.83	450.26
T_{10}: T_9 + Foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS	25.37	28.88	47.55	253.92	137.21	71.31	462.44
T_{11}: T_9 + Foliar spray of $ZnSO_4$ @ 0.2% at 40 DAS	26.40	28.30	42.88	281.14	134.27	67.17	482.58
T_{12}: T_9 + Foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS and at 40 DAS	26.80	31.40	53.14	290.92	154.48	86.61	532.00
SEm ±	1.26	1.33	2.38	18.89	8.77	4.79	23.59
CD (P=0.05)	3.69	3.91	6.98	55.40	25.72	14.06	69.17

Table 3: Cob yield (kg ha^{-1}) and green fodder yield (t ha^{-1}) as influenced by zinc fertilization

Treatments	Cob yield	Green fodder yield
T_1: Control (No zinc)	4832	22.38
T_2: Foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS	5395	23.10
T_3: Foliar spray of $ZnSO_4$ @ 0.2% at 40 DAS	5313	23.33
T_4: Foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS and at 40 DAS	5423	23.66
T_5: Soil application of $ZnSO_4$ @ 12.5 kg ha^{-1}	5645	24.57
T_6: T_5 + Foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS	5744	24.73
T_7: T_5 + Foliar spray of $ZnSO_4$ @ 0.2% at 40 DAS	5785	25.81
T_8: T_5 + Foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS and at 40 DAS	5894	25.92
T_9: Soil application of $ZnSO_4$ @ 25 kg ha^{-1}	6163	27.06
T_{10}: T_9 + Foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS	6250	26.48
T_{11}: T_9 + Foliar spray of $ZnSO_4$ @ 0.2% at 40 DAS	6311	27.48
T_{12}: T_9 + Foliar spray of $ZnSO_4$ @ 0.2% at 25 DAS and at 40 DAS	6550	27.76
SEm ±	135	0.70
CD (P=0.05)	391	2.04

Reference

1. Alloway BJ. Zinc in soils and crop nutrition. International Zinc Association, Brussels, Belgium, 2004.
2. Alloway BJ. Zinc in soils and crop nutrition. 2nd edition published by International Zinc Association and International Fertilizer Association, Brussels, Belgium and Paris, France, 2008, 135.
3. Arya KC, Singh SN. Effect of different levels of phosphorus and zinc on yield and nutrients uptake of maize (*Zea mays*) with and without irrigation. Indian Journal of Agronomy. 2000; 45(4):717-721.
4. Balwinder Kumar, Ram H, Dhaliwal SS, Singh ST. Productivity and quality of fodder corn (*Zea mays* L.) under soil and foliar zinc application. XVII International Plant Nutrition Colloquium and Boron Satellite Meeting Proceeding Book. 2013, 752-753.
5. Cakmak I, Kalayci M, Ekiz H, Braun HJ, Kilinc Y, Yilmaz A. Zinc deficiency as a practical problem in plant and human nutrition in Turkey. A NATO-science for stability project. Field Crop Research. 1999; 60:175-188.
6. Cakmak I. Enrichment of fertilizers with zinc: An excellent investment for humanity and crop production in India. Journal of trace elements in medicine and biology. 2009; 23:281-289.
7. Hotz C, Brown KH. Assessment of the risk of zinc deficiency in populations and options for its control. Food and Nutrition Bulletin. 2004; 25:94-204.
8. Jackson ML. Soil Chemical Analysis. Prentice Hall of India Privet Limited, New Delhi, 1973, 111-226.
9. Lindsay WL, Norvell WA. Development of a DTPA Soil Test for Zinc, Iron, Manganese, and Copper. Soil Science Society of American Journal. 1978; 42:421-428.
10. Mahdi SS, Husain B, Singh L. Influence of seed rate, nitrogen and zinc on fodder maize (*Zea mays*) in temperate conditions of western Himalayas. Indian Journal of Agronomy. 2012; 57(1):85-88.
11. Mona EA. Increasing Zn ratio in a compound foliar NPK fertilizer in relation to growth, yield and quality of corn plant. Journal of Innovations in Pharmaceuticals and Biological Sciences. 2015; 2(4):451-468.
12. Panse VG, Sukhatme PV. Statistical methods for agricultural workers. ICAR, New Delhi. 2nd Edition, 1978, 381.
13. Paramesh V, Dhar S, Vyas AK. Dass AK. Studies on impact of phosphoenriched compost, chemical fertilizer and method of zinc application on yield, uptake and quality of maize (*Zea mays*). Indian Journal of Agronomy. 2014; 59(4):613-618.
14. Piper CS. Soil and plant Analysis. Academic press, New York, 1966, 368.
15. Rakesh Kumar, Bohra JS. Effect of NPKS and Zn application on growth, yield, economics and quality of baby corn. Achives of Agronomy and Soil science. 2014; 60(9):1193-1206.
16. Shivay YS, Prasad R. Effect of source and methods of zinc application on corn productivity, nitrogen and zinc concentrations and uptake by high quality protein corn (*Zea mays*). Egyptian Journal of Biology. 2014; 16:72-78.

17. Singh MV. Assessing extent of zinc deficiency for soil fertility mapping and nutrition security in humans and animals. Indian Journal of Fertilizer. 2011; 7:36-43.
18. Subbaiah BV, Asija GE. A rapid production for the determination of available nitrogen in soil. Current Science. 1956; 25(8):259-260.
19. Tetarwal JP, Baldev R, Meena RS. Effect of integrated nutrient management on productivity, profitability, nutrient uptake and soil fertility in rainfed maize (*Zea mays*). Indian Journal of Agronomy. 2011; 56(4):373-376.