Original Research Article

EFFECT OF ZINC FORTIFICATION ON QUALITY, YIELD AND ECONOMICS OF SWEETCORN

Abstract:

A field experiment was performed at Agricultural College, Bapatla, ANGRAU, Guntur during *kharif* season of 2020 to evaluate the efficacy of zinc nutrition on quality, yield and economics of sweetcorn. Experiment was carried out in Randomized Block Design and comprising of nine treatments with three replications. The results disclosed that application of recommended dose of fertilizers along with soil application of 10 kg ha^{-1} Zn EDTA + two foliar sprays of nano zinc @ 250 ppm at 20 & 40 DAS registered remarkably higher protein content (12.98%) and zinc content (34.59 ppm) in kernel which was considered to be superior over the remaining zinc management practices tried. Also, highest green cob (12,638 kg ha^{-1}), green fodder (19,674 kg ha^{-1}), stover yield (7,590 kg ha^{-1}) and gross returns (□ 1,93,360 ha^{-1}) was recorded from the treatment with soil application of Zn EDTA @ 10 kg ha^{-1} + two foliar sprays of nano zinc @ 250 ppm at 20 & 40 DAS along with RDF over control. However, highest net returns (□ 1,38,664 ha^{-1}) and benefit cost ratio (2.74) was recorded with RDF + $ZnSO_4$ @ 25 kg ha^{-1} (Soil) + Nano ZnO @ 250 ppm at 20 and 40 DAS (Foliar spray). The effectiveness of Zn EDTA compared to $ZnSO_4$ is responsible for the higher quality parameters and yield of sweetcorn but due to its higher cost, Net returns and B;C ratio are maximum for the plots treated with $ZnSO_4$ making it more economically viable.

Key words: Zn EDTA, Nano ZnO, Indole-3-Acetic acid, Zinc nutrition, Kernel and Abiotic Stress

INTRODUCTION:

Sweetcorn, which is grown worldwide as an annual field crop [24] is basically an American crop and later introduced in India in 16th century. It is a short duration crop (75-80 days) belonging to a family Poaceae. The prominent states of maize being grown are Uttar Pradesh, Rajasthan, Bihar, Madhya Pradesh, Karnataka, Punjab, Andhra Pradesh, Himachal Pradesh [4]. Apart from staple food crop for humans, maize also accounts for a major poultry emerged as a multipurpose popular cereal crop with increasing demand among the public owing to its sweet kernels. It accounts for about 25-30% sugar content especially at milk stage which is more in comparison to 2-5% of sugar content in normal corn. In addition to its demand for fresh sweetcorn in hotels, it is also used as raw materials for various industrial products like dextrin, starch syrup and dextrose which ultimately enhanced sweetcorn significance both in local and global markets [2].

Intensive agriculture using current technologies, including the introduction of high-yielding varieties and the constant application of high-analysis fertilizers, has resulted in a deficit of micronutrients, notably zinc [2]. Zn deficiency is the most damaging to crop development and productivity of all micronutrients [21]. Ultimately, it has progressed to an alarming level in intensively cultivated regions. Micronutrients are important for plant growth and development and involved in various metabolic processes such as cell wall development, chlorophyll formation, photosynthesis, respiration, water absorption, in the formation of primary and secondary metabolites and nitrogen fixation and reduction [1; 31].

Zinc deficiency is a well-known issue in food crops, resulting in lower crop yields and nutritional quality. It is significant because of the impact it has on human health [28]. Zinc deficiency will be grew from 47 percent (in 1970) to 63 percent (in 2025) of the farmed regions in Indian soils owing to the ongoing loss in soil fertility [7]. According to the World Health Organization's study on the risk factors responsible for the development of illnesses and diseases, zinc deficiency ranks 11th among the 20 most significant variables in the world and 5th among the 10 most important ones in developing nations [5]. Maize's susceptibility to zinc deficiency in soil causes a condition known as "White bud" [12], which manifests as white parallel bands between the midrib and leaf border. Zinc fertilization appears to be a promising method for overcoming this problem and meeting crop zinc demands, as it improves the zinc content of the kernel.

Zinc is generally more available in acid soils than in alkali ones. Mostly pH induced deficiencies of zinc occur in pH range of 6 to 8. The critical pH for availability of Zn is 5.5 to 6.5. In the alkaline range particularly above pH 7.85, zinc forms negatively charged ions called zincate ions, thus reducing the availability due to the formation of calcium zincate. The presence of organic matter may promote the availability of zinc by complexing with zinc. Zinc deficiencies are more common in calcareous soils because it was adsorbed on CaCO3 rendering it unavailable to plants.in addition to this, zinc deficiency is observed in soils containing very high amount of phosphates. In clay minerals, montmorillonite adsorbs more Zn.

Normally, $ZnSO_4$ is the sole dependable source of zinc fertilizer due to its low cost and is availability in the market, however several different sources of zinc fertilizer are now accessible. Soils with strong fixation and adsorption processes favour chelating compounds such as Ethylene diamine tetra acetic acid (EDTA) to augment the availability of zinc and other trace metals in the soil solution. Metal ions in chelated forms are inert and readily available to plants. Similarly, zinc oxide nanoparticles pave way as innovative fertilizer nutrients for crops since they increase productivity, nutrient usage efficiency, and confer resistance to biotic and abiotic stress, therefore enriching edible plant portions with zinc.

Satdev *et al.* [25] showed that foliar application of ZnO nano particles @ 500 ppm gave significantly maximum growth and yield attributes *viz.* plant height at 60 DAS (173.67 cm) , number of cobs per plant (1.73), straw yield (7.12 t ha^{-1}) and cob yield (18.98 t ha^{-1}) of sweetcorn over other treatments. It also showed that seed treatment of ZnO nano particles @ 1000 ppm also improved the growth, yield attributes, sweetcorn yield in South Gujarat conditions. Partha [23] also showed that two foliar sprays of zinc at tasselling and milking stage along with soil application of ZnSO4 25 kg ha-1 registered significantly, maximum number of cobs (45.47), increased cob length (18.50 cm), cob girth (11.56 cm), Green cob yield (4101 kg ha-1), fodder yield (5677 kg ha-1) and harvest index (41.74%) in sweetcorn compared to QPM and pop corn, while the lower harvest index is recorded with no zinc treatment(41.30%).

Appropriate Zn application methods are important for optimal absorption and use. Furthermore, it can be used as a foliar spray or as a soil treatment. Though zinc applied to the soil promotes grain yield, its presence in the kernel was only enhanced by foliar spraying of zinc fertilizer [29]. As a result, it is advised to use a combination of soil and foliar zinc applications to boost both kernel zinc content and yield [10].

Materials and Methods

The current experiment entitled "Studies on zinc management in sweetcorn" was carried out at Agricultural College Farm, Bapatla, Guntur, Andhra Pradesh, during *kharif* season of 2020-21. Experiment was laid out in randomized block design (RBD) comprising of nine treatments and replicated thrice. The treatments of zinc application are T_1: Control (RDF), T_2: RDF + $ZnSO_4$ @ 25 kg ha^{-1} (Soil application), T_3: RDF + $ZnSO_4$ @ 0.5 % foliar spray at 20 & 40 DAS, T_4: RDF + Zn EDTA @ 10 kg ha^{-1} (Soil application), T_5: RDF + Zn EDTA @ 0.5 % (Foliar spray) at 20 and 40 DAS, T_6: RDF + Nano ZnO @ 250 ppm at 20 & 40 DAS (Foliar spray), T_7: RDF + Nano ZnO @ 500 ppm at 20 & 40 DAS (Foliar spray), T_8: RDF + $ZnSO_4$ @ 25 kg ha^{-1} (Soil) + Nano ZnO @ 250 ppm at 20 & 40 DAS (Foliar spray) and T_9: RDF + Zn EDTA @ 10 kg ha^{-1} (Soil) + Nano ZnO @ 250 ppm at 20 & 40 DAS (Foliar spray). Sugar-75, a robust and vigorously performing hybrid sweetcorn short duration variety (75-80 days) developed by Syngenta, was employed in the current experiment.

The soil sample anlaysis indicated that the experimental soil was classified as sandy clay (sand- 72.5% and clay-21.3%) in texture, neutral in reaction (6.86) and low in organic carbon (0.35%) and available nitrogen (210 kg ha^{-1}), medium in available phosphorus (23.0 kg ha^{-1}) medium in available potassium (258 kg ha^{-1}) and low in available zinc (0.42 mg kg^{-1}). All the treatments received the recommended amount of 180:60:50 NPK kg ha^{-1}. At the time of sowing, 1/3rd of Urea was given as a basal, 1/3rd at the knee high stage, and 1/3rd at tasseling by manual application through broad casting. As a basal dosage, the entire dose of single super phosphate and muriate of potash was applied by broad casting method. $ZnSO_4$ micronutrient was supplied as a basal (broad cast) and foliar application (sprayer) depending on the treatment. The weekly mean maximum and minimum temperature ranged from 25.2°C to 32.2°C during the crop growth period (Fig.1, 2 & 3).

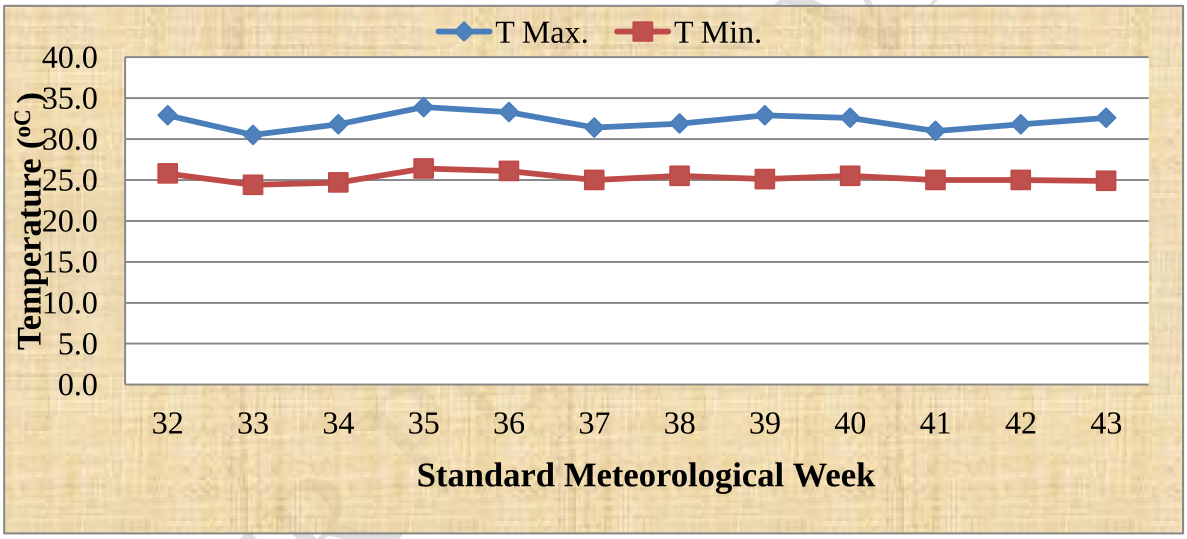

Fig. 1. Weekly mean maximum and minimum temperatures during the crop growth period.

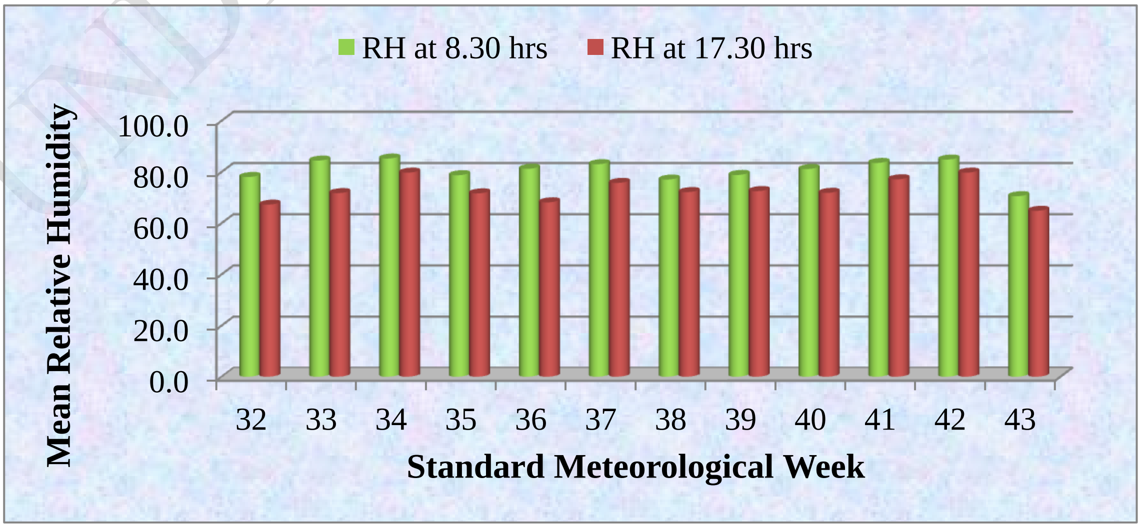

Fig. 2. Weekly mean relative humidity during the crop growth period.

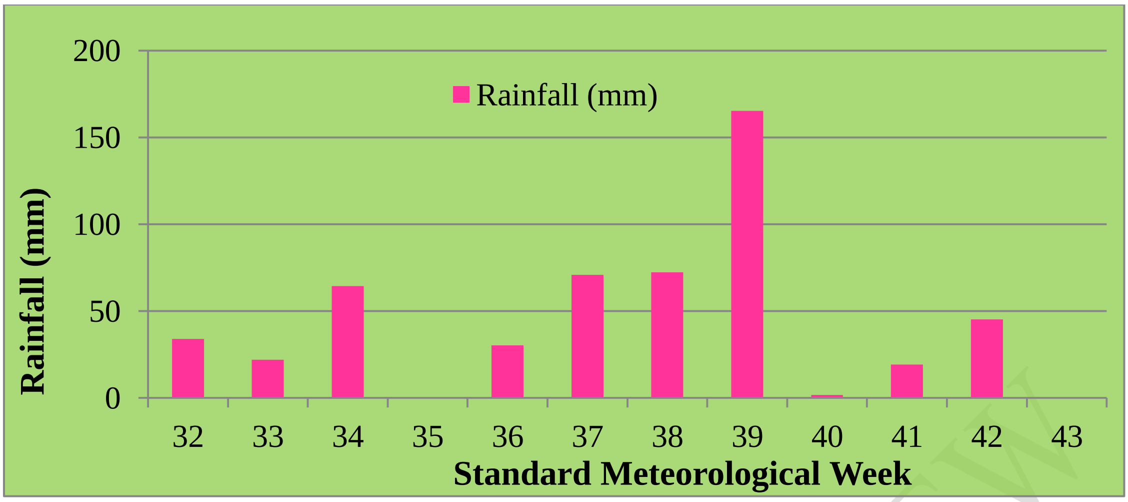

Fig.3. Weekly rainfall during the crop growth period

Kernel Protein Content (%)

The seed samples collected at harvest were ground into fine powder and analyzed for assessing the different quality parameters. Kernel nitrogen content, estimated by micro-Kjeldhal method [13] was multiplied by the factor 6.25 and expressed as protein content [6] of the kernel.

Protein content (%) = Total N content (%) × 6.25

Kernel Zinc Content (ppm)

Zinc content in kernel was estimated as per the method prescribed by Lindsay and Norvell [18] by using DTPA (Diethylene triamine penta acetate) solution with Atomic Absorption Spectrometer.

Yield (kg ha^{-1})

Fresh green cobs from net plots were harvested, weighed and expressed as green cob yield. After picking of cobs, the plants were immediately cut to the base and the green fodder from net plot was weighed and expressed as green fodder yield. Those plants were retained in field for sun drying on the threshing floor till 15- 20% moisture level then the dry stover yield was recorded.

Economics

The economics of treatments were determined using current market pricing during the year 2020. The input and output costs were compared treatment-wise and gross returns, net returns and the B:C ratio were determined. Data was subjected to statistical analysis using Fisher's method of analysis of variance as suggested by Panse and Sukhatme [22].

Gross return (□ ha^{-1}) = Yield in kg ha^{-1} × price k

Net return (□ ha^{-1}) = Gross Return – Total Cost of cultivation

$$B:C\ Ratio = \frac{\textbf{Net return}\ (₹ha^{-1})}{\textbf{Cost of cultivation}\ (₹ha^{-1})}$$

Results And Discussion:

Green Cob Yield (kg ha^{-1})

Results pertaining to green cob yield of sweetcorn are given in Table 1. The data clearly reveals that integration of soil and foliar application of zinc showed a remarkable effect on cob yield of sweetcorn over application of zinc either as soil or foliar alone.

Among the various treatments tested, the soil application of Zn EDTA @ 10 kg ha^{-1} + foliar sprays of nano zinc @ 250 ppm at 20 and 40 DAS along with RDF (T_9) produced significantly greater green cob yield (12,638 kg ha^{-1}) and was significantly superior to rest of treatments. The next best treatments after T_9 were the plots that received with RDF + $ZnSO_4$ @ 25 kg ha^{-1} (Soil)+ Nano ZnO @ 250 ppm at 20 and 40 DAS (Foliar spray) (T_8) and RDF + Nano ZnO @ 500 ppm at 20 and 40 DAS (Foliar spray) (T_7). The lowest green cob yield (8,009 kg ha^{-1}) was noticed with control *i.e.* treatment received RDF alone.

Yield is the end result of growth factors, yield attributes, and physiological and morphological processes that occur throughout crop development [20]. Thus the improvement in cob yield of sweetcorn might be due to the increased growth characters, yield attributes *i.e.* number of cobs per plant, cob length, cob girth, cob weight and 100 grain weight coupled with higher drymatter accumulation noticed in these treatments due to more availability and absorption of zinc by soil application along with foliar spray might be the probable reason for higher cob yield. Kumar and Bohra [17], Chand *et al*. [11], and Kumar and Salakinkop [16] all observed an increase in yield when Zn had been used.

The use of nano zinc oxide may have triggered enzymes in sweetcorn plants by integrating with chlorophyll formation and increased aminoacid synthesis, such as tryptophan. This increased production is the main location to store carbohydrates in plant as grains, which finally resulted in an increased number of seeds per plant as a source, and storage carbohydrates, and enhanced sweetcorn yield. Ashrafi *et al*. [8] and Satdev *et al*. [25] both reported a similar increment in yield from the use of nano zinc oxide particles.

Green Fodder Yield (kg ha^{-1})

Zinc fortification also showed a significant effect on green fodder yield of sweetcorn similar to green cob yield (Table 1.). Soil application of Zn EDTA @ 10 kg ha^{-1} + foliar sprays of nano zinc @ 250 ppm at 20 and 40 DAS along with RDF (T_9), registered significantly the highest green fodder yield (19,674 kg ha^{-1}) superior over remaining treatments tried. T_9 stood statistically at par with treatments T_8 and T_7 (19,554 and 19,498 kg ha^{-1}). Significantly the lowest green fodder yield (14,388 kg ha^{-1}) was registered in control (T_1) treatment.

Enhanced green fodder yield in Zn-applied plots might be ascribed to increased carbohydrate synthesis with zinc treatment resulting in higher green fodder production. Similar findings of considerably improved green fodder with zinc fertilization were observed by Kumar *et al*. [15], Mona [2015], Chand *et al*. [11] and Shakoor *et al.* [26].

Stover Yield (kg ha^{-1})

The data regarding to effect of zinc fertilization on stover yield of sweetcorn clearly revealed that stover yield was significantly influenced by Zn treatments. Higher stover yield (7,590 kg ha^{-1}) was registered with soil application of Zn EDTA @ 25 kg ha^{-1} + foliar sprays of nano zinc @ 250 ppm at 20 and 40 DAS along with RDF (T_9) and was superior to rest of the treatments tried except with the T_8 and T_7. The lowest stover yield was noticed in control (5,004 kg ha^{-1}). Treatments $T_{4,}$ $T_{2,}$ $T_{3,}$ T_5 and T_6 were also statistically comparable with one another.

Maize is a vigorously growing crop with a long stem and a large number of leaves. This vigorous development, which is associated with taller plants, a greater number of leaves, enhanced drymatter output, and higher green fodder production, might be the possible reason for the exceptionally higher stover yield [3]. It might also due to the foliar application of nano zinc oxide in the current study which can be ascribed to a significant increase in plant drymatter and enhanced stover yield. The current findings are consistent with the findings of Uma *et al*. [30].

Kernel Protein Content (%)

The protein content in sweetcorn was significantly influenced by treatments of zinc Application of recommended dose of fertilizers along with soil application of 10 kg ha^{-1} Zn EDTA + two foliar sprays of nano zinc @ 250 ppm at 20 & 40 DAS (T_9), recorded higher kernel protein content (12.98%), which was superior over the remaining zinc management practices tried.

The increase in protein content with zinc soil application and foliar spray might be related to direct role of zinc in protein and amino acid synthesis, which aided sweetcorn to make optimal use of assimilated nutrients by the plants as and when necessary [27]. In addition to that, nano zinc oxide might aided in improvement of the roots cation-exchange capacity, which therefore enhanced essential nutrient absorption by the roots, especially nitrogen, which is primarily responsible for higher protein content in sweetcorn grains.

Furthermore, Zn is essential for the production of plant growth-promoting compounds such as Indole-3-Acetic acid, as well as carbohydrate and protein metabolism. [19, 25] confirmed the current findings.

Kernel Zinc Content (ppm)

The effect of various treatments on kernel zinc concentration was investigated, and the findings are reported in Table 1. The results demonstrated that the zinc level in kernel changed considerably as a result of the treatments used during the experiment. T_9 treatment (RDF + 10 kg ha^{-1} Zn EDTA + foliar application of nano zinc @ 250 ppm at 20 and 40 DAS) was found to show the higher zinc contents in kernel (34.59 ppm) and it was closely followed by T_8 (33.67 ppm) and T_7 (33.50 ppm). On the other hand, the lowest kernel zinc content was observed in control treatment (20.33 ppm).

The increased zinc concentration in kernel might be ascribed to the fact that zinc supplied through foliage is highly soluble and easily accessible to the plant, resulting in enhanced mobility of zinc throughout the plant, which further augmented zinc accumulation in kernel [26]. It may also be due to the presence of larger levels of Zn in soil solution as a result of the application of Zn EDTA, which promoted higher zinc absorption as compared to $ZnSO_4$ application. These findings are consistent with those of Karak *et al*. [14].

Post-Harvest Available Zinc in Soil

The available zinc in the soil after the harvest of sweetcorn was significantly affected by zinc fertilization (Table.3). The treatments received with soil application of Zn EDTA @ 10 kg ha^{-1} + Nano ZnO @ 250 ppm at 20 and 40 DAS as foliar spray along with RDF (T_9) registered significantly higher available zinc in the soil (0.77 mg kg^{-1}) after the harvest of the crop which was found statistically on par with the treatments T_8 (soil application of $ZnSO_4$ @ 25 kg ha^{-1} (Soil) + Nano ZnO @ 250 ppm at 20 and 40 DAS as foliar spray along with RDF), T_2 (Soil application of $ZnSO_4$ @ 25 kg ha^{-1} along with RDF) and T_4 (Soil application of Zn EDTA @ 10 kg ha^{-1} along with RDF). The lowest post harvest available zinc (0.37 mg kg^{-1}) was recorded in control treatment *i.e.* T_1. Possible reason for the increase in the available zinc in T_9 treatment might be due to the soil application of Zn EDTA @ 10 kg ha^{-1} along with the two foliar sprays. Soil application of the zinc improved the available zinc in the soil, similar results of improved post harvest available nutrient status in the soil by the zinc application was reported by Shakoor *et al*. (26).

Economics

The economics of sweetcorn production in terms of gross return, net return, and benefit cost ratio were computed and reported in Table 3 to evaluate the economic viability of various treatments under consideration. Significantly, the highest gross return (1,93,360 ha^{-1}) was registered in T_9 treatment treated with soil application of Zn EDTA @ 10 kg ha^{-1} + two foliar sprays of nano zinc @ 250 ppm at 20 & 40 DAS which was statistically comparable with T_8 (1,89,246 ha^{-1}) and T_7 (1,83,944 ha^{-1}). Whereas, the lowest gross return was from the control (1,22,637 ha^{-1}).

The highest net return (1,38,664 ha^{-1}) and benefit cost ratio (2.74) was recorded in T_8 treatment which was comparable with T_9 (1,34,478 ha^{-1} and 2.28) and significant over rest of the treatments indicating that T_8 is economically viable. Similarly, the lowest net return (Rs. 76,255 ha^{-1} and 1.64) and benefit cost ratio was found in control.

The total cost of cultivation is greater in the treatments supplied with zinc EDTA combined with nano foliar sprays due to their higher prices, and similarly the cost of cultivation was lowest in the control treatment (no zinc). The larger net return and B:C ratio in T_8 compared to T_9 might be attributed to the higher cost of Zn EDTA compared to $ZnSO_4$. This might be the possible reason for the higher benefit cost ratio and net return for T_8 though the gross return were higher for T_9. The current results are in conformity with Chand *et al*. [11] and Uma *et al*. [30].

CONCLUSION

It was ascertained that among the various zinc fertilization treatments studied in sweetcorn, soil application of Zn EDTA (10 kg ha^{-1}) combined with two foliar sprays of nano zinc (250 ppm) at 20 and 40 DAS was more effective in improving sweetcorn yield, quality parameters and gross returns. However, the highest net return and B:C ratio was found in RDF + soil application of ZnSO4 @ 25 kg ha^{-1} along with two foliar sprays of nano zinc @ 250 ppm at 20 & 40 DAS showing that it is economically viable due to the less cost of $ZnSO_4$ compared to Zn-EDTA.

Table 1. Green cob yield, Green fodder yield, Stover yield, Kernel protein and zinc content of sweetcorn as influenced by zinc fertilization.

Treatments	Green cob yield (kg ha^{-1})	Green fodder yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Kernel Protein	Zinc Content
T_1 : Control (RDF)	8,009	14,388	5,004	9.67	20.33
T_2 : RDF + $ZnSO_4$ @ 25 kg ha^{-1} (Soil application)	9,517	17,125	6,296	10.80	26.13
T_3 : RDF + $ZnSO_4$ @ 0.50% at 20 and 40 DAS (Foliar spray)	9,306	16,573	6,008	10.23	24.13
T_4 : RDF + Zn EDTA @ 10 kg ha^{-1} (Soil application)	9,566	17,192	6,350	11.17	26.53
T_5 : RDF + Zn EDTA @ 0.5% (Foliar spray) at 20 and 40 DAS	9,313	16,590	6,166	10.37	24.38
T_6 : RDF + Nano ZnO @ 250 ppm at 20 and 40 DAS (Foliar spray)	9,439	17,088	6,282	10.46	24.93
T_7 : RDF + Nano ZnO @ 500 ppm at 20 and 40 DAS (Foliar spray)	12,017	19,498	7,369	12.41	33.50
T_8 : RDF + $ZnSO_4$ @ 25 kg ha^{-1} (Soil) + Nano ZnO @ 250 ppm at 20 and 40 DAS (Foliar spray)	12,371	19,554	7,373	12.55	33.67
T_9 : RDF + Zn EDTA 10 kg ha^{-1} (Soil) + Nano ZnO @ 250 ppm at 20 and 40 DAS (Foliar spray)	12,638	19,674	7,590	12.98	34.59
SEm±	421.96	715.93	331.04	0.48	1.13
CD (p=0.05)	1277.03	2166.70	1001.86	1.45	3.43
CV (%)	7.14	7.08	8.83	7.43	7.13

Table 2. Post harvest soil available nutrient status (kg ha^{-1}) as influenced by zinc fertilization

Treatments	AvailableZn (mg kg^{-1})
T_1 : Control (RDF)	0.37
T_2 : RDF + $ZnSO_4$ @ 25 kg ha^{-1} (Soil application)	0.72
T_3 : RDF + $ZnSO_4$ @ 0.50% at 20 and 40 DAS (Foliar spray)	0.50
T_4 : RDF + Zn EDTA @ 10 kg ha^{-1} (Soil application)	0.73
T_5 : RDF + Zn EDTA @ 0.5% (Foliar spray) at 20 and 40 DAS	0.52
T_6 : RDF + Nano ZnO @ 250 ppm at 20 and 40 DAS (Foliar spray)	0.56
T_7 : RDF + Nano ZnO @ 500 ppm at 20 and 40 DAS (Foliar spray)	0.57
T_8 : RDF + $ZnSO_4$ @ 25 kg ha^{-1} (Soil) + Nano ZnO @ 250 ppm at 20 and 40 DAS (Foliar spray)	0.75
T_9 : RDF + Zn EDTA 10 kg ha^{-1} (Soil) + Nano ZnO @ 250 ppm at 20 and 40 DAS (Foliar spray)	0.77
SEm±	0.02
CD (p=0.05)	0.07
CV	6.28

Table 3. Cost of cultivation, Gross returns (□ ha^{-1}), Net returns (□ ha^{-1}) and B:C ratio of sweetcorn as influenced by zinc fertilization.

Treatments	Cost of cultivation (□ ha^{-1})	Gross returns (□ ha^{-1})	Net returns (□ ha^{-1})	B : C ratio
T_1 : Control (RDF)	46,382	1,22,637	76,255	1.64
T_2 : RDF + $ZnSO_4$ @ 25 kg ha^{-1} (Soil application)	47,082	1,45,908	98,826	2.10
T_3 : RDF + $ZnSO_4$ @ 0.50% at 20 and 40 DAS (Foliar spray)	46,452	1,42,589	96,137	2.07
T_4 : RDF + Zn EDTA @ 10 kg ha^{-1} (Soil application)	55,382	1,46,665	91,283	1.65
T_5 : RDF + Zn EDTA @ 0.5% (Foliar spray) at 20 and 40 DAS	48,632	1,42,773	94,141	1.94
T_6 : RDF + Nano ZnO @ 250 ppm at 20 and 40 DAS (Foliar spray)	49,882	1,44,721	94,839	1.90
T_7 : RDF + Nano ZnO @ 500 ppm at 20 and 40 DAS (Foliar spray)	56,382	1,83,944	1,27,562	2.26
T_8 : RDF + $ZnSO_4$ @ 25 kg ha^{-1} (Soil) + Nano ZnO @ 250 ppm at 20 and 40 DAS (Foliar spray)	50,582	1,89,246	1,38,664	2.74
T_9 : RDF + Zn EDTA 10 kg ha^{-1} (Soil)+ Nano ZnO @ 250 ppm at 20 and 40 DAS (Foliar spray)	58,882	1,93,360	1,34,478	2.28
SEm±		6383.37	6324.02	0.13
CD (p=0.05)		19318.75	19139.12	0.46
CV		7.05	10.35	10.80

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