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Response of Different Source and Method of Zinc Application on Productivity of Wheat (*Triticum aestivum* L.) in South- West Rajasthan

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ABSTRACT

A field experiment was conducted during *Rabi* 2022-23 and 2023-24 at Instructional Farm (Agronomy), Rajasthan College of Agriculture, Udaipur (Rajasthan) to study the effect of different source and method of zinc application on productivity of wheat (*Triticum aestivum* L.) in South- West Rajasthan. The experiment was laid out in Randomized Block Design with three replications. Nine treatments were applied using the soil and foliar method, using two distinct zinc sources ($ZnSO_4.7H_2O$ and Zn-EDTA) either alone or in combinations ($ZnSO_4.7H_2O$ + Zn-EDTA). Results showed that significantly highest number of effective tiller per meter row length, test weight, grain yield and straw yield of wheat was recorded under application of $ZnSO_4.7H_2O$@1.25 kg Zn ha^{-1} as SA + Zn-EDTA@1.25 kg Zn ha^{-1} as SA + $ZnSO_4.7H_2O$@0.5% FS at 45 DAS + Zn-EDTA@0.5% FS at 75 DAS + ZSB (T_9) over control. Therefore, when zinc was applied through combined soil application of $ZnSO_4.7H_2O$@1.25 kg Zn ha^{-1} and Zn-EDTA@1.25 kg Zn ha^{-1} plus 0.5% foliar spray of $ZnSO_4.7H_2O$ at 45 DAS and Zn-EDTA at 75 DAS along with ZSB proved to have higher productivity can be recommended in South-West Rajasthan.

Key words: *Productivity, Zinc, ZSB, Zn-EDTA,* $ZnSO_4.7H_2O$

Introduction

Zinc is widely recognized as the most crucial micronutrient for ensuring optimal and healthy plant growth (Tahir *et al*., 2018). In the Indian context, zinc is recognized as the third most critical nutrient limiting yield, following nitrogen and phosphorus (Takkar and Randhawa, 1978) and this leads to production of low Zn containing rice. Soil application of $ZnSO_4.7H_2O$ is the most common way to apply Zn to field crops, although there have been some field experiments with Zn–EDTA (Karak *et al*., 2005). Low availability of Zn in alkaline calcareous soils is a serious problem in India, Pakistan, Turkey, China and several other countries. Karak *et al.* (2005) observed that Zn-EDTA supplies a significant amount of zinc to plants without interacting with soil components, as the central Zn^{2+} metal is surrounded by chelate ligands. Zn-EDTA is generally three to five times more efficient than $ZnSO_4$ at improving yield and grain zinc concentration in wheat, rice, maize and navy bean, at the same soil application rate. Therefore, there is a crucial need to identify zinc fertilizers with higher use efficiency and minimal environmental impacts.

Materials and Methods

The experiment was laid out at Instructional Farm

(Agronomy), Rajasthan College of Agriculture, Udaipur during *Rabi* 2022-23, 2023-24. This region falls under agro-climatic zone-IVa (Sub- humid Southern Plain and Aravalli Hills) of Rajasthan. Soil was clay loam in texture, alkaline in pH (8.27±0.18) and electrical conductivity was normal (0.557±0.05 dS m^{-1}), medium in organic carbon (0.56±0.05%); low in available nitrogen (263.25±5.77 kg ha^{-1}), available phosphorus (21.24 ±0.91 kg ha^{-1}), high in available potassium (367.23 ±6.42 kg ha^{-1}) and low in available zinc (0.584±0.074 mg kg^{-1}). Wheat variety Raj-4238 was sown at the seed rate of 100 kg ha^{-1} at row to row spacing of 22.5 cm. The experiment was laid out using Randomized Block Design with three replications. There were 9 treatments having combination of two different zinc source ($ZnSO_4.7H_2O$ and Zn-EDTA) and method of application (soil and foliar) *viz.* Control (T_1), $ZnSO_4.7H_2O$@5 kg Zn ha^{-1} as SA (T_2), $ZnSO_4.7H_2O$@2.5 kg Zn ha^{-1} as SA+ $ZnSO_4.7H_2O$@0.5% FS at 45 DAS (T_3), $ZnSO_4.7H_2O$@1.25 kg Zn ha^{-1} as SA+ $ZnSO_4.7H_2O$@0.5% FS at 45 and 75 DAS + ZSB (T_4), Zn-EDTA@5 kg Zn ha^{-1} as SA (T_5), Zn-EDTA@2.5 kg Zn ha^{-1} as SA + Zn-EDTA@0.5% FS at 45 DAS (T_6), Zn-EDTA@1.25 kg Zn ha^{-1} as SA + Zn-EDTA@0.5% FS at 45 and 75 DAS + ZSB (T_7), $ZnSO_4.7H_2O$@ 1.25 kg Zn ha^{-1} as SA + Zn-EDTA@1.25 kg Zn ha^{-1} as SA (T_8) and $ZnSO_4.7H_2O$@ 1.25 kg Zn ha^{-1} as SA + Zn-EDTA@1.25 kg Zn ha^{-1} as SA + $ZnSO_4.7H_2O$@0.5% FS at 45 DAS + Zn-EDTA@0.5% FS at 75 DAS + ZSB (T_9).

Results and Discussion

Yield Attributes and Yield

The number of effective tillers per meter row length, test weight, grain yield and straw yield of wheat was significantly influenced due to different source and method of zinc application over the control during 2022 -23, 2023-24 and on pooled basis (Table 1). Between two sources of zinc application, the combined application of Zn-EDTA and $ZnSO_4.7H_2O$ recorded significantly highest yield attributes and yield of wheat over sole application of Zn-EDTA or $ZnSO_4.7H_2O$. Between two methods of zinc application, the combined use of soil and foliar method showed significantly maximum results in yield attributes and yield of wheat over soil application alone. On basis of pooled data, the significantly highest number of effective tillers $meter^{-1}$ row length (72.96) and test weight (42.65 g) of wheat was recorded with application of $ZnSO_4.7H_2O$@1.25 kg Zn ha^{-1} as SA + Zn-EDTA@1.25 kg Zn ha^{-1} as SA + $ZnSO_4.7H_2O$@0.5% FS at 45 DAS + Zn-EDTA@0.5% FS at 75 DAS + ZSB (T_9), however, it was not substantially different from treatment T_7 (Zn-EDTA@1.25 kg Zn ha^{-1} as SA + Zn-EDTA@0.5% FS at 45 and 75 DAS + ZSB), T_6 (Zn-EDTA@2.5 kg Zn ha^{-1} as SA + Zn-EDTA@0.5% FS at 45 DAS) and T_4 ($ZnSO_4.7H_2O$@1.25 kg Zn ha^{-1} as SA + $ZnSO_4.7H_2O$@0.5% FS at 45 and 75 DAS + ZSB) over control. Similarly maximum grain yield (3995 kg ha^{-1}) and straw yield (4867 kg ha^{-1}) of wheat was found with combined application of $ZnSO_4.7H_2O$ and Zn-EDTA through soil + foliar method along with ZSB as in T_9 and T_9 was statistically at par with T_7 (Zn-EDTA@1.25 kg Zn ha^{-1} as SA + Zn-EDTA@0.5% FS at 45 and 75 DAS + ZSB) and T_6 (Zn-EDTA@2.5 kg Zn ha^{-1} as SA + Zn-EDTA@0.5% FS at 45 DAS) in pooled data over control.

The increased in yield attributes and yield of wheat was recorded with zinc application might be due to vital role of Zn in plant physiology and helps in improving the photosynthetic efficiency, carbohydrate transformation, and seed development resulted in better biomass accumulation and better yield (Alloway, 2008). Furthermore, Zn foliar application supports proper pollen function, fertilization, and germination therefore induced reproductive development by raising the grain and straw yield. Moreover, zinc enhances the absorption of essential elements by increasing the cation exchange capacity of roots, further contributing to the overall health and productivity of the plant (Abdoli *et al*., 2014). The supply of zinc contributed to accelerate the auxin metabolism in plants, as auxins are involved in cell division which in turn promotes root and shoot growth and thus facilitates more number of effective tillers in crop. Our findings are in accordance with Ramzan *et al*. (2020).

This study shows that the application of chelated Zn-EDTA was the main reason for higher grain and straw yield of wheat as chelated zinc has more capacity to transport Zn to plants from soil. Zn-EDTA have capacity to keep zinc available to plants for longer time than that with other Zn sources ($ZnSO_4$) due to lesser transformation of applied Zn through EDTA chelates into unavailable forms (Alvarez *et al*., 2010). Additionally, Zn-EDTA diffused farther than $ZnSO_4$ which led to higher bio-accessibility of zinc to crop thus improved crop yield (Zhao *et al*.,

Table 1. Effect of different source and method of zinc application on yield attributes and yield of wheat (on pooled data basis)

Treatments		Number of effective tillers meter^{-1} row length	Test weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
T_1	Control	60.92	35.96	3252	3966
T_2	$ZnSO_4.7H_2O$@5 kg Zn ha^{-1} as SA	66.12	38.84	3491	4235
T3	$ZnSO_4.7H_2O$@2.5 kg Zn ha^{-1} as SA + $ZnSO_4.7H_2O$@0.5% FS at 45 DAS	66.83	38.92	3503	4274
T4	$ZnSO_4.7H_2O$@1.25 kg Zn ha^{-1} as SA + $ZnSO_4.7H_2O$@0.5% FS at 45 and 75 DAS + ZSB	71.49	41.60	3772	4615
T5	Zn-EDTA@5 kg Zn ha^{-1} as SA	67.23	39.15	3540	4584
T6	Zn-EDTA@2.5 kg Zn ha^{-1} as SA + Zn-EDTA@0.5% FS at 45 DAS	71.85	42.36	3904	4745
T7	Zn-EDTA@1.25 kg Zn ha^{-1} as SA + Zn-EDTA@0.5% FS at 45 and 75 DAS + ZSB	72.67	42.50	3920	4767
T8	$ZnSO_4.7H_2O$@ 1.25 kg Zn ha^{-1} as SA + Zn-EDTA@1.25 kg Zn ha^{-1} as SA	65.74	38.42	3489	4227
T9	$ZnSO_4.7H_2O$@ 1.25 kg Zn ha^{-1} as SA + Zn-EDTA@1.25 kg Zn ha^{-1} as SA + $ZnSO_4.7H_2O$@0.5% FS at 45 DAS + Zn-EDTA@0.5% FS at 75 DAS + ZSB	72.96	42.65	3995	4867
	SEm±	0.86	0.50	48.68	53.64
	CD (P=0.05)	2.47	1.44	140.21	154.48

2014). The results are in agreement with Takkar and Randhawa (1978), who reported that the efficiency of the chelated-Zn was proved superior towards increase in yield of rice grain than that of equivalent amount of Zn application as $ZnSO_4.7H_2O$. Similar results were reported by Hussain *et al.* (2012), Kulhare *et al.* (2017), Shivay *et al*. (2015) and Ghasal *et al*. (2017)

The utilization of different sources of zinc with ZSB exhibited a positive role in yield attributes and yield of wheat. ZSB enhanced availability of zinc through solubilization of minerals and make available which were in unavailable forms of zinc and also the production of growth hormones by ZSB (Verma *et al.*, 2023). ZSB maintains zinc availability in the soil throughout the crop season. The positive response of ZSB on improving yield of was also reported by Vaid *et al.* (2014) and Yadav *et al.* (2023).

Conclusion

On the basis of experimental finding, it can be concluded that the combined soil application of $ZnSO_4.7H_2O$@1.25 kg Zn ha^{-1} and Zn-EDTA@1.25 kg Zn ha^{-1} plus 0.5% foliar application of $ZnSO_4.7H_2O$ at 45 DAS and Zn-EDTA at 75 DAS along with ZSB can be recommended in wheat variety Raj-4238 for higher productivity in South-West Rajasthan.

Conflict of Interest- None

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