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Response of Foliar Application of Zinc on the Growth and Yield Contributing Parameters in Wheat (*Triticum aestivum* L.)

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ABSTRACT

A field experiment was laid out in randomized block design (RBD) with three replications and seven treatments. The treatments were given : T_0 = Control; T_1 = RDF; T_2 = 100% $ZnSO_4$; T_3 = 100% Zn EDTA; T_4 = 50% $ZnSO_4$; T_5 = 50% Zn EDTA and T_6 = 50% $ZnSO_4$ + 50% Zn EDTA. Analysis of soil and physiological parameters was also done. Morphological, physiological, soil and biochemical parameters were analyzed. T_3 (100% Zn EDTA) led to the highest plant height followed by T_6 (50% $ZnSO_4$ + 50% Zn EDTA) taken at different time intervals viz., 30, 60 and 90 DAS. Tiller number was more in treatment T_3 (100% Zn EDTA). Grain yield was more in the treatment where only RDF was applied. In comparison, the straw yield was higher in T_4 (50% $ZnSO_4$). Results showed that RDF had more impact on the grain yield.

Key words : Zinc, foliar application, wheat, crop growth

INTRODUCTION

Wheat, India's most significant cereal crop, comes second in terms of output and is seeded in the Indo-Gangetic plains' RWC system following the harvest of the preceding rice crop. Wheat is one of the most ancient and significant grain crops. Variations in climate and soil affect the nutritional composition of the wheat grain. It typically contains 12% water, 70% carbohydrates, 13% protein, 2% fat, 1.8% minerals and 2.2% crude fibers.

Zinc plays a crucial role in metabolic functions in cereals and other crops. Rehman *et al.* (2018) reported wheat-based farming methods viz. rice–wheat, cotton–wheat and maize–wheat are prone to Zn shortage due to the high Zn requirement of these crops. Zinc is involved in glucose metabolism, protein synthesis, development of regulator metabolic process, plant pollen production, maintenance of biological membranes, protection against photo-oxidative damage, heat stress and drought stress resistance in plants (Venkatachalam *et al.*, 2017; Umair *et al.*, 2020). Zinc deficiency has become one of the most prevalent trace element deficits in soil and plants across the world, resulting in significant losses in yield and a decline in good nutritional quality (Sultana *et al.*, 2016; Adnan *et al.*, 2020; Toor *et al.,* 2020). The treatment combination of 50% RDP through PEC+50% RDP through fertilizer and soil application of 12.5 kg $ZnSO_4.7H_2O$/ha+one spray of 0.5% Zn was beneficial in reducing antagonistic effect of P on Zn and increasing Zn and Fe concentration in wheat grain (Paramesh *et al.*, 2020). Zinc fertilizer can be applied to the soil or to the plant leaves as a foliar treatment. Zinc application to the soil is simply a cost-effective farming practice (Vadlamudi *et al.*, 2020).

Zinc plays a crucial role in the metabolic functions of cereals and other crops. Rehman *et al.* (2018) reported that essential wheat-based farming methods viz. rice-wheat, cotton-wheat and maize-wheat were prone to Zn shortage due to the high Zn requirement of these crops. Zinc was involved in glucose metabolism, protein synthesis, development regulator metabolic process, plant pollen production, maintenance of biological membranes, protection against photo-oxidative damage, heat stress, and drought stress resistance in plants (Venkatachalam *et al.*, 2017; Umair *et al.*, 2020). After foliar Zn treatment, wheat grain was successfully biofortified with Zn, with no yield loss (Zulfiqar *et al.*, 2020). Overall, the treatment combination of 50% RDP through PEC+50% RDP through fertilizer and soil-applied 12.5 kg $ZnSO_4.7H_2O$/ha+one spray of 0.5% Zn was beneficial in reducing the antagonistic effect of P on Zn and increasing Zn and Fe concentration in wheat grain (Paramesh *et al.*, 2020). Zinc application to the soil or as a foliar application is simply a cost-effective farming practice reported by Vadlamudi *et al.* (2020) and Yuvraj and Subramanian (2020).

MATERIALS AND METHODS

The field experiment was conducted at Lovely Professional University's Agriculture Research Farm, during **rabi** season of the 2020-21. Out of six agro-climatic zones of Punjab, the area lied in the Central plain region. With seven treatments and three replications, the experiment was set up in a randomized block design (RBD). Wheat variety (DBW 222) was selected for the foliar application of zinc fertilizers [T_0 (Control), T_1 (RDF), T_2 (100% $ZnSO_4$), T_3 (100% ZN EDTA), T_4 (50% $ZnSO_4$), T_5 (50% ZN EDTA), T_6 (50% $ZnSO_4$+50% ZN EDTA] in this study with three replications. Packages and practices of PAU were followed in the field. The wheat crop was harvested when spikes were completely dry, and grains were coming out when crushed by hand. All the plots were tied in bundles and dried in the sun, followed by the grain separation to measure the grain yield. Growth and yield parameters i.e. plant height, number of tillers per flag leaf, fresh weight, dry weight, spikes/m^2, test weight, straw yield, grain yield and harvest index were observed or calculated. The data were analyzed by SPSS. The Duncan multiple range tests were used to determine significance (DMRT).

RESULTS AND DISCUSSION

The plant height varied from 18.44 to 20.88 cm at 30 days and 28.66 (T_6 : 50% $ZnSO_4$ + 50% Zn EDTA) to 31.88 (T_2 : 100% $ZnSO_4$) at 60 days (Table 1). However, the difference was non-significant. The plant height at 90 days was observed 51.94 (T_6 : 50% $ZnSO_4$ + 50% Zn EDTA) to 66.74 cm (T_3 : 100% Zn EDTA). The analysis of variance revealed that plant height was significantly affected by foliar application of Zn solutions. The maximum height was observed when zinc fertilizers were applied for two times. This was due to foliar application of N, K and Zn solution to increase the stem length at the boot stage, resulting in maximum plant height. These results are in close agreement with Sultana *et al.* (2016).

The tillers per plant ranged from 2.0 to 2.5, respectively, at 30 days (Table 1). The lowest and highest tillers were observed from 3.77 (control) to 5.77 (T_3 : 100% Zn EDTA) at 60 days. Similarly, the lowest and highest tillers per plant were observed from 6.00 (Control) to 8.55 (T_3 : 100% Zn EDTA) at 90 days (Table 2). Tillers at 30 days showed a significant difference from T_4 to T_0, followed by the T_6. However, T_0, T_1, T_3, T_5, and T_2 were at par with each other. At 60 and 90 days, there was no significant difference in tillers per plant (Fig. 1). Application of micronutrients zinc as a fertilizer showed more tillers. It was noticed by the application of zinc fertilizer as control plot had the smaller number of tillers. Rehman *et al.* (2018) also reported that zinc fertilizers helped in vegetative growth by increasing tillers in cereal crops.

Table 1. Effect of different zinc fertilizers as a foliar application on plant height at 30, 60 and 90 days

Treatments	30 days	60 days	90 days
T_0	19.82^a±1.03	31.11^a±0.29	60.76^a±1.27
T_1	19.88^a±0.77	30.44^a±1.82	63.34^a±3.05
T_2	19.33^a±1.01	31.88^a±1.54	63.86^a±1.47
T_3	19^a±0.69	30a±1.33	66.74^a±1.92
T_4	18.44^a±0.29	29.55^a±1.93	61.06^a±1.46
T_5	20.88^a±0.4	30.11^a±1.45	61.72^a±0.76
T_6	20.66^a±1.2	28.66^a±0.83	51.94^b±2.77

Table 2. Effect of zinc foliar spray on tiller number per plant

Treatments	30 days	60 days	90 days
T_0	2^c±0	3.77±0.48	6±0.69
T_1	2^c±0	5±0.69	7.88±0.86
T_2	2.16^c±0.09	5.11±0.44	7.88±0.55
T_3	2^c±0	5.77±0.77	8.55±0.98
T_4	2.5^a±0.09	4.88±0.48	7.44±0.58
T_5	2^c±0	5.22±0.86	7.88±1.17
T_6	2.33^b±0	5.66±0.5	7.77±1.05

The spikes/m^2 ranged from 282 (T_0 : Control) to 333.6 (T_1 : RDF) at harvesting. The highest spikes were obtained in T_1 followed by the T_4 (50% $ZnSO_4$) with a length of (329.6), and T_3 (100% Zn EDTA) with a length of (323). T_5 (50% Zn EDTA) obtained the subsequent higher number of spikes with (308), followed by T_2 (100% $ZnSO_4$) with 304.33 spikes at 143 days (Fig. 1). These treatments were significant with each other. The lowest were recorded in treatment T_6 (50% $ZnSO_4$ + 50% Zn EDTA) with a length of 288 followed by the last treatment T_0 (Control) with a 282 spikes/m^2. There was

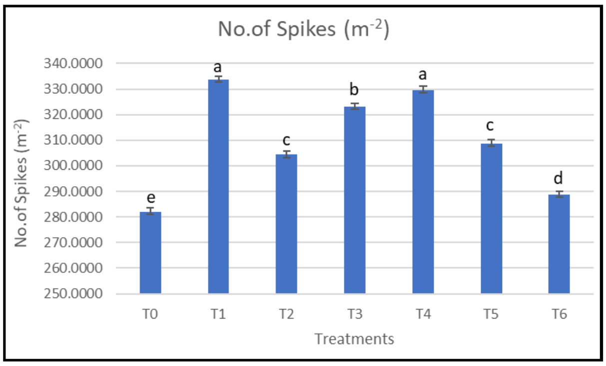

Fig. 1. Effect of zinc foliar spray on spikes/m^2.

a significant difference between these treatments. Paramesh *et al.* (2020) reported improvement in spikes/m^2 after application of zinc fertilizer.

The grain yield ranged from 49.66 (T_0 : Control) to 57.5 (T_1 : RDF) at the time of harvesting. The highest yield was observed in T_1 followed by T_4 (50% $ZnSO_4$) with a yield of (55.5), and T_3 (100% Zn EDTA) with a yield of (55.13). The treatment T_5 (50% Zn EDTA) obtained subsequent higher yield with (54.33), followed by the T_2 (100% $ZnSO_4$) with a yield of (53.73). These treatments were at par with each other, and there was no significant difference between these. The lowest yield was recorded in treatment T_6 (50% $ZnSO_4$+50% Zn EDTA) with a yield of (51.23), which was followed by the treatment T_0 (Control) with a yield of 49.66 g (Fig. 2.). There was no significant difference between these treatments. Thus, the RDF was the most suitable under-maintained condition other than treatments. Treatment with 100% RDF of NPK (120 : 60 : 60 kg/ha) was the most suitable treatment for wheat productivity (Meena *et al.*, 2017). The zinc treatment showed increased yield in T_4 (50% $ZnSO_4$). Foliar application of zinc played a significant role in the yield and yield components of wheat. Yield components were influenced

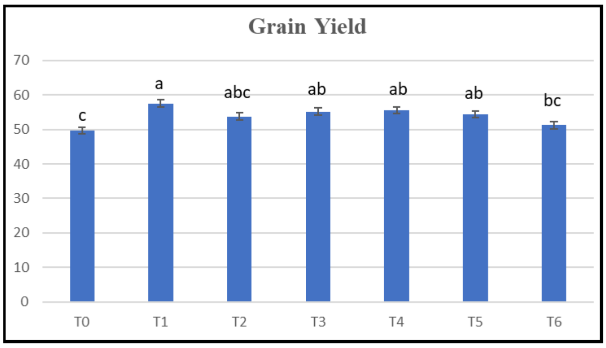

Fig. 2. Effect of zinc fertilizer on grain yield.

significantly due to the foliar application of Zn. These results are in close agreement with those of Sultana *et al.* (2016), Firdous *et al.* (2018) and Rehman *et al.* (2018).

The Harvest Index ranged from 39.79 (T_0 : Control) to 42.29 (T_1 : RDF). The highest harvest index was obtained in T_1 followed by T_4 (50% $ZnSO_4$; 41.29), T_3 (100% Zn EDTA; 41.21), T_5 (50% Zn EDTA; 41); T_2 (100% $ZnSO_4$; 40.81) and T_6 (50% $ZnSO_4$ + 50% Zn EDTA; 39.97). There was significant difference in these treatments (Fig. 3). Firdous *et al.* (2018) found a significant difference in harvest index due to different zinc application treatments in wheat. Zinc was one of the essential minerals for plant development and growth.

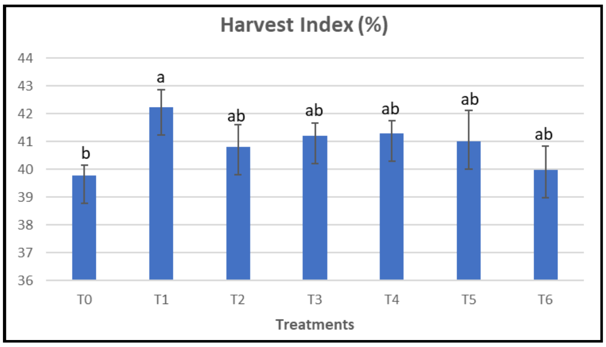

Fig. 3. Effect of different treatments on HI.

Incorporation of T_3 (100% Zn EDTA) led to the highest plant height followed by T_6 (50% $ZnSO_4$ + 50% Zn EDTA) at different stages of sampling; 30, 60, 90 DAS. The plant height varied at 30, 60 and 90 days. Highest plant height reached at 90 DAS. Thus, the application of Zinc EDTA increased plant height, but there was not much significant difference compared to other treatments. Application of Zinc EDTA increased the plant tillers with significant difference from T_0 (Control) to other treatments at 30 days. Later on there was no significant difference at 60 and 90 days.

Highest flag leaf at 30, 60 and 90 DAS was observed by incorporation of T_1 (RDF). However, T_1 (RDF) and T_5 (50% Zn EDTA) were at par. This indicated that zinc had the same impact on flag leaf as RDF. Incorporation of the T_1 (RDF) increased the yield at the time of harvesting. Similar results were also noticed by Rehman *et al.* (2018). There was almost a 10 q/ha difference compared to T_0 (Control). This was significant yield loss where no fertilizers were applied. T_1 (RDF) followed by T_4 (50% $ZnSO_4$), T_3 (100% Zn EDTA), T_5 (50% Zn

EDTA), T_2 (100% $ZnSO_4$), T_6 (50% $ZnSO_4$ + 50% Zn EDTA). The lowest yield was noticed in the T_0 (Control). According to Zulfiqar *et al.* (2020), foliar Zn treatment followed by soil application resulted in the highest grain Zn content and bioavailability.

CONCLUSION

Zinc was one of the most important minerals for plant development and growth. Plant growth, output and yield were affected by application of zinc in deficient soils. The wheat crop can be successfully biofortified with Zn after foliar Zn treatment without any yield loss.

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