The Effect of Various Cultural Practices on Zinc Concentrations of Winter Wheat Grains in Central Anatolia

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INTRODUCTION

It has been long known that the Central Anatolian Plateau of Turkey has a considerable acreage of Zn-deficient soils, especially in the semi-arid, highly calcareous zones of the region where rain-fed wheat and barley are the predominant crops. Starting in the early 1990s, numerous experiments were conducted to find the most effective methods to correct Zn deficiency and to identify the most Zn-efficient cultivars (Kalayci et al. 1999). According to results of previous experiments, although the most efficient way to prevent yield decrease in Zn-deficient areas was found to be soil application, the highest grain-Zn concentrations were obtained from soil plus foliar applications (Cakmak et al. 1999). Within the scope of a project focussing mainly on grain-Zn concentrations, a series of experiments were planned and started in 2005 to examine the effects of various cultural practices on grain-Zn concentrations of the winter-wheat cultivar Bezostaja-1.

METHODS

Two different experiments were conducted in soils that are known to be highly deficient in Zn at the Konya and Eskisehir experimental station. The DTPA-extractable Zn concentrations ranged between 0.09 to 0.39 mg Zn kg^{-1} in the top soil (0-30 cm). Bezostaja-1, the winter wheat variety most widely grown in the region, was used. In the first experiment, the effects of number and timing of foliar Zn applications on grain-Zn concentrations with (50 kg $ZnSO_4$ ha^{-1}) and without (-Zn) soil-applied Zn were studied. Soil applications were performed before planting by spraying onto the soil surface and plowing under. Foliar applications were also made with $ZnSO_4$, using 600 g Zn ha^{-1}. Foliar applications at tillering (Zadoks stage 2.2), initiation of stem elongation (Zadoks 3.1), and heading were compared to controls with no application, resulting in a total of 8 levels including combinations of application times. In the second experiment, the effect of sowing rate and seed priming with Zn on grain-Zn concentrations with and without soil-applied Zn was tested. Soil applications of Zn were the main plots, seed priming was the subplot, and sowing rate was the sub-subplots. Seeds were primed by soaking seeds in 5 mM Zn solution overnight before planting, and compared to controls that were not primed. Low (200 seeds m^{-1}) and high (700 seeds m^{-1}) sowing rates were compared to presently recommended 450 seeds m^{2-1}.

RESULTS AND DISCUSSION

The results of the first year's experiments revealed that soil plus foliar applications of $ZnSO_4$ gave the highest grain-Zn concentrations in both locations, confirming previous results. Although differences were not large, they were statistically significant. The highest grain-Zn concentrations were 25.4 and 20.7 mg kg^{-1} at Konya and Eskisehir locations, respectively, when 50 kg ha^{-1} $ZnSO_4$ and foliar sprays at tillering and stem elongation

(Zadoks 2.2 and 3.1) were applied. Controls had grain-Zn concentrations of 16.9 and 8.7 mg kg^{-1} at Konya and Eskisehir, respectively. Grain-Zn concentrations are shown in Table 1.

Priming increased grain yields significantly, but it was not effective for grain-Zn concentrations. Although the highest grain-Zn concentrations were obtained at the lowest sowing rates (200 seeds $m^{-1)}$, this was accompanied by a significant yield decrease as compared to 450 seeds $m^{-1.}$ The dilution effect is considered the main cause for this.

Table 1. Effect of foliar Zn applications on grain-Zn concentrations with and without soil Zn application.

	Grain Zn Concentration (mg kg^{-1})			
Time of Foliar Zn Application	- Soil Zn	+ Soil Zn	- Soil Zn	+ Soil Zn
	KONYA		ESKISEHIR	
CONTROL	16.9 ± 1.8	22.7 ± 1.8	8.7 ± 0.7	11.1 ± 1.7
TILLERING	22.2 ± 2.6	25.3 ± 2.4	14.4 ± 3.1	17.9 ± 3.2
STEM ELONGATION	18.9 ± 3.2	24.4 ± 0.6	17.4 ± 1.5	19.1 ± 4.0
HEADING	19.3 ± 3.4	24.0 ± 2.5	11.6 ± 2.0	13.6 ± 1.7
TILLERING + STEM ELONGATION	23.8 ± 3.3	25.4 ± 3.1	17.2 ± 2.3	20.7 ± 1.6
TILLERING + HEADING	21.8 ± 2.8	24.1 ± 1.2	14.0 ± 1.1	18.3 ± 3.6
STEM ELONGATION + HEADING	19.8 ± 3.0	22.7 ± 2.3	16.1 ± 2.5	17.7 ± 3.0
TILLERING + STEM ELONGATION + HEADING	18.8 ± 1.8	23.7 ± 1.6	16.8 ± 1.3	17.1 ± 2.5

CONCLUSIONS

Although it is only the first year of the experiments, in light of previous experiences, the following conclusions can be drawn from the results:

1) Grain-Zn concentrations were much lower than desired in general. Extremely low Zn content of experimental field soils, particularly in the lower depths of the profiles, seems to be the main factor preventing higher concentrations despite soil and foliar applications. Higher grain concentrations (up to 60 mg Zn kg^{-1}) were obtained by post-anthesis foliar applications in the past. This will be reconsidered in further stages of the project.
2) High sowing rates are frequently practiced by regional farmers. Besides other detrimental effects, it also seems to be responsible for lowering the already low grain-Zn concentrations.
3) Seed priming shows some promise in increasing yields in Zn-deficient soils, but according to the first year's results, seed priming did not increase grain-Zn concentrations. Therefore, it should be considered as a complementary measure only rather than a unique application.

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