

Wheat Yield and its Enrichment Influenced by Different Zinc Levels and Sources

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INTRODUCTION

Zinc deficiency in soils is a global micronutrient deficiency occurring in many countries, including millions of ha of cultivated areas in Iran (Malakouti and Mashayekhi 1995). About 40% of the arable soils in Iran are Zn-deficient. Zinc deficiency in Iran is particularly pronounced in arid and semi-arid regions, which are the major wheat growing areas in the country (Balali et al. 1999). Adverse soil chemical conditions, including high pH and CaCO₃ content, and low organic matter content, an imbalanced fertilization, and high HCO₃⁻ levels in the irrigation water, are considered the main factors for the widespread Zn deficiency in calcareous soils of arid and semi-arid regions (Malakouti and Lotfollahi 1999). In this study, the effects of Zn levels and sources on wheat yield, yield parameters and Zn concentrations in wheat grain were investigated.

METHODS

The field experiments were conducted under irrigated conditions for a 3-year period at the Sanandaj Agricultural Research Center, Kurdistan in 1995-1997. The experiment was designed as a factorial randomized complete-block with four replications. Zinc levels (factor A) were 0, 20 40 kg Zn ha⁻¹. Zinc sources (factor B) were ZnO and ZnSO₄.5H₂O. Zinc was incorporated into the soil. The *Triticum aestivum* cultivar MV-17, the potential cultivar in Kurdistan, was chosen. Yield, Thousand Kernel Weight (TKW), and Zn concentrations of whole shoots, flag leaves and mature grain were determined. The statistical analyses were performed using MSTATC software and LSD tests.

RESULTS AND DISCUSSION

Compared to the control, Zn levels increased grain yield of wheat significantly, but Zn source did not have a significant effect on grain yield (Table 1).

Table 1. Mean effects of Zn levels and sources on wheat yield (1995-97).

Source	Zn level (kg ha ⁻¹)			average
	0	20	40	
ZnO	4897A	5604A	5894A*	5465A
ZnSO ₄ . 5H ₂ O	5103A	6033A	6055A**	5730A
Average	5000b	5818a	5975a	

*, ** Significant at 0.05 and 0.01 probability levels, respectively.

With respect to overall averages, Zn treatments also significant effects on Zn concentrations in grain and blade leaves, Zn uptake and apparent recovery (Table 2).

Table 2. Zinc concentrations in blade leaves and grain, Zn uptake and apparent recovery influenced by Zn treatments (1995-97).

Treatment	Zn content(mg kg ⁻¹)		Zn uptake (mg kg ⁻¹)	Apparent Recovery (%)
	leaf	grain		
Zn ₀ (ZnO)	11.4d**	13.0c	84.0	-
Zn ₂₀ (ZnO)	21.0c	20.1bc	139.4	2.77
Zn ₄₀ (ZnO)	37.0a	28.2ab	191.8	2.69
Zn ₀ (ZnSO ₄ . 5H ₂ O)	11.3d	14.2c	94.0	-
Zn ₂₀ (ZnSO ₄ . 5H ₂ O)	23.4c	27.3ab	207.5	5.68
Zn ₄₀ (ZnSO ₄ . 5H ₂ O)	30.2b	35.0a	243.5	3.74
LSD(a=0.05)	6.4	9.4	-	-
C.V. (%)	7.9	8.8	-	-

** significant at 0.01 probability level

On the basis of NPK fertilization, applying Zn fertilizer, significantly reduced the concentrations of Fe, Mg and Mn in the grain. While concentrations of N and Zn in grain increased with Zn application, there was no influence on Ca, Cu, P and K concentrations. Statistical analysis revealed that grain yields of winter wheat in the experiment were negatively related to concentrations of Ca, Fe, Mn, N and P in grains, and positively related to K and Mg concentrations, but the linear correlation with Zn was not significant at the 5% probability level. This indicated that Zn was not the only yield-limiting nutrient. Furthermore, the effect of increasing Zn applications on grain yield might be due to the influence on concentrations and balance of other nutrients in the grain, including Ca, Cu, K, Mg, Mn and N. By combining information obtained from each ratio, the order in which the plant required these nutrients was: Zn > N > P > Cu > Mn > K > Fe > Mg.

CONCLUSIONS

In this research, the effects of Zn levels and sources, the relationships between grain yield and nutrient concentrations, and nutrient ratios were studied. The results revealed three major findings. 1. Applying Zn to soil increased grain yield of winter wheat significantly. The considerable increases in grain yield with Zn applications indicate the necessity of Zn for plants. 2. The application of ZnSO₄.5H₂O to the soil offset Zn deficiency successfully and increased grain yield by 20%. Zinc applications affected the nutrient balance by increasing N and Zn and decreasing Fe and Mn concentrations in the wheat grain. 3. The concentration of nutrients and their ratios showed significant correlations with grain yield and hence could be employed as nutrient indices for the diagnosis of Zn deficiency.

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