Investigation of Zinc uptake efficiency in six variety of Iranian bread wheat

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ABSTRACT

In view the significant role of zinc in qualitative and quantitative characteristics of wheat and especially in wheat flour fortification which in turn affects human health, it is necessary to use varieties with higher Zinc uptake efficiency. The present investigation was conducted during 2006-7 to identify high Zn uptake efficiency wheat lines in a field with moderate texture and insufficient nutrients specially Zinc.

The experiment used a randomized complete block design with 3 replications. Eighteen combinations of 2 factors, including three levels of Zinc applications i.e. 0, 40 and 80 kg ha^{-1} Zinc sulfate and 6 varieties of wheat were the variables in the experiment. Various physiological indices were studied. Result revealed that application of 40 kg ha^{-1}. Zinc sulfate could significantly improve many of these indices including: plant height, test weight, grain and protein yield as well as harvest index. Triticale had significantly higher Zinc uptake efficiency (97%). Durum wheat showed the least (66%). Four bread wheat varieties stand among them. It may be concluded that wheat and rye hybridization could significantly raise Zinc uptake.

INTRODUCTION

Wheat is one of the important agricultural crops in Iran and considered as critical source of food. Wheat consumption per head is estimated to be approximately 400 grams per a day (8). By considering the fact that wheat is a main source of food, it is essential to enhance the quality and the quantity of this product. Enriching of wheat by Zinc application is crucial as it is effective for both wheat agronomic enhancement and human health. The accessibility of a plant to soil nutrient mainly depends on soil type, climate, irrigation and chemical fertilizers, particularly plants ability to absorb them (2). Research has indicated that there are great distinctions in micro-nutrients such as Zn and their absorptions by plants, even between the varieties of a plant. Hence, it has been recommended to apply especial fertilizer model for any single variety or genotype (8). On the other hand the majority of Iranian wheat lands are suffering from high lime and high pH; the low levels of organic materials plus bi-carbonated water is threatening the plant yield and reduces the amount of Zinc in the soil. More than 40 percent of lands in Iran are poor in Zinc. As a result it is important to solve the problem and eliminate the disadvantages of chemical fertilizers. Our goal in this trial was to experiment the different wheat varieties reactions to Zinc. We studied four varieties of bread wheat and Durum wheat plus a Triticale.

MATERIAL AND METHODS

The experiment was conducted at 2006-7 in Mashhad which is located on north east of Iran. According to soil classification the field soil was sandy-skeletal, mixed, mesic fin-loamy and sub order of Xeric Haplo Cambids. The chemical analysis of the surface soil is shown in table 1. Water analysis showed that there were no restrictions due to salinity and alkalinity, but bi-carbonate ion was about five meq/ lit.

The experiment was laid out in complete randomized block design with three replications and 18 treatments based on from complete factorial of 3 amount of Zinc sulfate (0, 40 and 80 kg ha^{-1}) and 6 varieties of wheat (Alvand, Toos, OmidBakhsh, Falat, Durum and Triticale). Many indices were studied such as plant height, grain yield, test weight, protein content, and harvest index, amount of Zinc in the leaves at three different stages (including tillering, stem extension, and ear appearance) and also Zinc content of grains.

Table 1 chemical soil analysis Mashhad 2006-7

Zn $mgkg^{-1}$	O.C. %	T.N.V. %	EC $ds\ m^{-1}$	PH	Texture
0.52	0.84	18.7	1.4	8.1	loam

RESULT

The result showed that there were clear distinctions between the six varieties of wheat. There were critical differences in grain yield, test weight, ear length, plant height, total biomass, harvest index and also the amount of Zinc and protein in grain. By considering plant height and grain yield and ear length Triticale was better than others, while Durum (based on grain size, protein percent and also harvest index) was better than the other varieties (Table 2).

Application Zinc Sulfate up to 40 kg ha^{-1} improved the number of seeds per ear and also their sizes as result it caused grain yield about 12, 12, and 15 percent respectively The results obtained were exactly the same as other scholars such as Cakmak, Yilmaz and his colleagues, Slafer and Kashirad and other scientists (Ref: 4, 6, 10, and 11). Interestingly it is reported grain yield increased on calcareous soils which are suffering from Zinc shortage. Also we found out that Zinc sulfate increased amount of grain Zinc and protein content within 16 and 10 percent respectively (table-2). Sedry and Malakoti, Brown and his Colleague, Marschner and Hemantarangan had the same results (Ref: 9, 3, 7 and 5). Zinc is known as a stimulant factor which affects the Indoleacetic Acid, and it causes the change in Amino Acids to Protein.

In this investigation we also found that Zinc can have different effects on quality and quantity characteristics. For instance harvesting index and especially Zinc absorption can be different between varieties as a result of interactive effects between Zinc availability and plant uptake. Among the varieties studied Toos was the most sensitive one to Zinc while Durum was not. Zinc efficiency and Zinc absorption were highest in Triticale followed by the bread wheat varieties, while Durum had least Zinc efficiency (Fig 1).

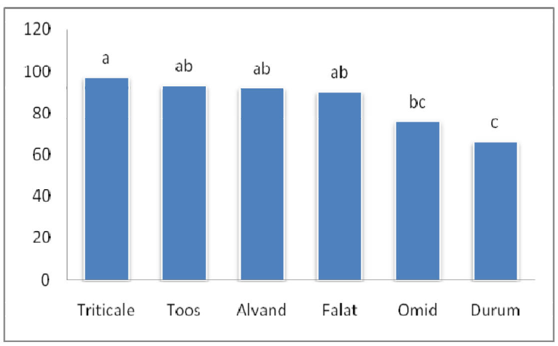

Fig 1 Zinc uptake efficiency in wheat varieties Mashhad 2006-7

CONCLUSION AND RECOMMENDATIONS

According to the results it can be concluded that 40 kg per ha Zinc sulfate was sufficient and helpful to improve the indices of the six varieties studied, although the reactions to this chemical fertilizer are different. As it was mentioned before Toos was identified as the most sensitive one to Zinc while Triticale showed the least demand on Zinc, because it can attracts this nutrient element through the soil even though it has high grain yield. The observations allow more suitable varieties to be selected for planting in order to reduce input chemicals.

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Table 2 The effect of Zinc sulfate application on grain yield and yield components of six wheat varieties Mashhad 2006-7

treatment	grain Zinc content mg kg^{-1}	leave Zinc content mg kg^{-1}			grain weight in ear gr	test weight gr	ear no. per m^{-2}	grain yield kgha^{-1}
		ear appearance	Stem extension	tillering				
Zn_0V_1	99.9^{bc}	22.3^{bc}	34.0^{cd}	67.0^{b}	1.2^{bc}	33.0^{bcd}	600^{ab}	4566^{cde}
Zn_0V_2	97.7^{bc}	26.3^{b}	26.0^{d}	38.6^{cd}	1.1^{c}	30.9^{cd}	660^{ab}	4396^{cdef}
Zn_0V_3	82.7^{c}	23.3^{bc}	30.6^{cd}	71.0^{ab}	1.1^{c}	32.7^{cd}	560^{b}	3402^{fg}
Zn_0V_4	101.5^{bc}	21.6^{bc}	27.3^{cd}	45.0^{c}	1.2^{bc}	29.0^{d}	540^{b}	4663^{cd}
Zn_0V_5	83.8^{c}	18.3^{c}	21.3^{d}	32.0^{d}	1.1^{c}	35.4^{bcd}	540^{b}	3536^{cfg}
Zn_0V_6	128.0^{ab}	27.3^{b}	32.6^{cd}	38.0^{cd}	1.5^{abc}	40.6^{ab}	617^{ab}	6260^{ab}
mean	98.9	23.2	28.6	48.6	1.2	33.6	586	4470
$Zn_{40}V_1$	118.3^{ab}	22.6^{bc}	53.3^{b}	57.3^{bc}	1.6^{b}	38.7^{abc}	653^{ab}	5024^{c}
$Zn_{40}V_2$	112.7^{b}	22.3^{bc}	57.3^{ab}	48.3^{c}	1.3^{abc}	37.2^{abc}	740^{a}	4724^{cd}
$Zn_{40}V_3$	99.4^{bc}	32.0^{a}	52.0^{b}	68.6^{ab}	1.2^{bc}	34.6^{bcd}	663^{ab}	4468^{cdef}
$Zn_{40}V_4$	122.5^{ab}	22.0^{bc}	38.6^{c}	75.0^{a}	1.6^{ab}	32.0^{cd}	587^{ab}	5165^{c}
$Zn_{40}V_5$	122.2^{a}	18.3^{c}	42.6^{bc}	41.0^{c}	1.5^{abc}	44.5^{a}	670^{ab}	5330^{bc}
$Zn_{40}V_6$	157.4^{a}	30.3^{b}	36.6^{cd}	37.0^{cd}	1.5^{abc}	40.8^{ab}	680^{ab}	6552^{a}
mean	122.1	24.6	46.7	54.5	1.5	38.0	665	5211
$Zn_{80}V_1$	110.1^{b}	30.3^{ab}	54.0^{ab}	57.6^{b}	1.4^{abc}	34.4^{bcd}	563^{b}	4574^{cde}
$Zn_{80}V_2$	101.4^{bc}	23.3^{bc}	50.0^{b}	68.0^{b}	1.5^{abc}	31.8^{cd}	653^{ab}	3812^{defg}
$Zn_{80}V_3$	89.7^{bc}	23.3^{bc}	34.6^{bc}	29.0^{d}	1.3^{abc}	38.4^{abc}	600^{ab}	3895^{g}
$Zn_{80}V_4$	140.7^{ab}	27.6^{b}	32.3^{bc}	46.0^{cd}	1.6^{ab}	31.0^{cd}	547^{b}	4843^{cd}
$Zn_{80}V_5$	88.1^{bc}	22.0^{bc}	66.0^{a}	71.3^{ab}	1.3^{abc}	34.5^{bcd}	590^{ab}	3211^{g}
$Zn_{80}V_6$	144.7^{ab}	26.3^{b}	38.3^{c}	47.0^{cd}	1.7^{a}	33.4^{bcd}	557^{b}	5294^{bc}
mean	112.5	25.5	45.9	53.1	1.5	37.9	585	4271
mean	111.2	24.4	40.4	52.1	1.4	35.2	612	4651
cv %	23.3	22.2	29.1	30.4	18.6	11.4	13.4	14.2

v_1 up to v_6 are Alvand, Toos, Omid, Falat, Durum and Triticale respectively.