Effect of Zinc-fortified Seed on Tiller Number and Wheat Grain Yield

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INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the strategic crops for Iran. Zinc is the most important nutrient for improving wheat yield. Rengel and Graham (1995) indicated that Zinc-fortified wheat seeds resulted in better vegetative growth than seeds poor in Zinc. Similar results were obtained for the Mn content of seed (Moussavi Nik et al. 1997). Yilmaz et al. (1997) concluded that Zn sulfate improved yield and Zn concentration in seeds. According to Welch (1993), about 50% of the world grain producing areas contain low levels of available Zn. According to Malakouti (2000 and 2003) this percentage is even higher in areas with calcareous soils. The over use of P-fertilizers has resulted in even lower levels of Zn in wheat grain and human diets. This study was carried out in the greenhouse to evaluate the effect of seed fortification with Zn on wheat tiller number and grain yield.

METHODS

A greenhouse experiment was conducted at the Karaj Soil and Water Research Station during 2005-2006 to study the effect of Zn-fortification of seeds on wheat yield. Wheat seeds (Shiraz cultivar) were grown in a soil with a low Zn level (0.70 mg kg^{-1} DTPA-extractable). The experimental design was factorial in seeding rates (3, 6, 9, 12, 15 seeds per pot) comparing seeds with a low Zn content (< 30 mg kg^{-1}) and seeds fortified with Zn (>40 mg kg^{-1}). The seeds were planted on November, 30th in 2005 at a depth of 1.5 cm. Water was added to the soil surface two times per week to maintain moisture at field capacity. The air temperature in the greenhouse ranged from 20 to 25 ˚C during the crop growth cycle. The number of tillers was counted on January, 23rd in 2006. At the maturity stage (April, 26th in 2006), plants were cut at the soil surface level, dried at 80˚C, and seeds were separated. Roots were washed with tap water, dried at 80˚C and weighted. The statistical analyses were performed using MSTATC software and Duncan tests.

RESULTS AND DISCUSSION

The effect of seed fortification was significant for all studied traits. The tiller number per pot increased from 24 for normal seeds to 27 for fortified seeds translating into an 1.25% - increase due to fortification. The root, shoot and grain weight was not significantly higher for plants from fortified seed compared with normal seed (Table1).

Table 1. The effect of Zn seed fortification on the tiller number, root, shoot and grain weight (g pot^{-1}).

Seed Zn	Tiller number	Root weight	Shoot weight	Grain weight
Normal	24.00 b	4.00 a	20.70 a	5.9 a
Fortified	27.00 a	4.70 a	20.70 a	6.1 a

The results revealed that grain yields were higher when fortified seeds were used. This effect can be explained by stronger seedlings with better developed root systems that absorbed more Zn from the fertilized soil. Rengel and Graham (1995) and Malakouti (2000 and 2003) also observed differences between fortified and normal seeds similar to our results. The interactive effect of seed fortification and seed rates on tiller number was significant ($p<0.01$) showing that raising the seed rate from 3 to 15 seeds per pot increased the tiller number from 13.63 to 33.63 and 14.88 to 36.25 per pot for normal and fortified seed, respectively (Table 2).

Table 2. The interactive effects of seed rate and seed type on tiller number of wheat.

		Seed rate (number per pot)				
		3	**6**	**9**	**12**	**15**
Seed Zn	Normal	13.63 e	19.13 de	22.75 cd	29.63 ab	33.63 a
	Fortified	14.88 e	22.13 cd	26.88 bc	34.13 a	36.25 a

The highest grain weight (8.01 g pot^{-1}) was obtained from pots with 6 fortified seeds (Table 3) indicating the importance of Zinc-fortified seed. Our results are corresponding with findings of Rengel and Graham (1995), Yilmaz et al. (1997) and Malakouti (2000, 2003).

Table 3. The interactive effects of seed rate and seed type on grain weight of wheat.

		Seed rate (number per pot)				
		3	**6**	**9**	**12**	**15**
Seed Zn	Normal	5.40 ab	6.00 ab	6.86 ab	6.00 ab	5.40 ab
	Fortified	5.70 ab	8.01 a	6.53 ab	5.78 ab	4.30 b

CONCLUSIONS

It can be concluded that fortified seeds would improve the grain yield in poor soils by producing stronger seedlings than those produced by normal seeds. The stronger seedlings would absorb more Zn from the soil or fertilizer and yield more grain. In this study, the fortified seeds had higher tiller numbers and grain yield.

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