Study of Zinc effects on quantitative and qualitative traits of winter wheat in saline soil condition

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Abstract

An experiment was conducted to optimize consumption of Zinc and evaluate of Zinc effects on quantitative and qualitative traits of winter wheat under saline soil condition. It was done by three replications in randomized complete block design. The experiment had four treatments as Control without Zn, 40 $Kg.ha^{-1}$ Zn as $ZnSO_4$, 80 $Kg.ha^{-1}$ Zn as $ZnSO_4$ in soil and 120 $Kg.ha^{-1}$ Zn as $ZnSO_4$ in soil. Eleven parameters including quantitative parameters and qualitative ones were measured. The highest grain yield (4355 $Kg.ha^{-1}$) and highest Zn concentration in seeds (39.1 $mg.kg^{-1}$) obtained by using of 120 $Kg.ha^{-1}$ Zn as $ZnSo_4$ as soil application. Seed protein content was affected by use of Zinc and significantly increased. The fourth treatment had a significant difference in compare to first and second treatments but didn't a significant difference compared to third treatment. Results showed that protein content in seeds was affected by using of Zinc Sulfate and significantly increased. Use of Zinc Sulfate had not any effects on straw, ear per square meter, number of seed per ear and concentration of Fe, Mn and Cu in seeds. Totally, use of 80 $Kg.ha^{-1}$ Zn as $ZnSo_4$ in soil was recommended to obtain highest grain yield with high quality in saline condition.

Keywords: wheat, Zn, salinity, Iran

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Introduction

Zn is a vital element for wheat growth and it activates some enzymes such as carbonic anhydrase, dehydrogenase, proteinase and peptidase (Marshner 1986). Many experiments have been established to identify the effects of Zinc on wheat improvement and its necessity for important yield quality. (Malakouti 2000, Malakouti and Agha lotfolahi 1999, Shankar and Mehrotra 1987, Amin et al 1989, Chibba et al 1989, Bansal et al 1990, Bernan1992, Miah et al 1992, Sharma and Lal 1993, Gill et al 1994).

It has been shown that availability of micronutrients in saline soils decreases considerably and plants which grown in these soils may show micronutrients deficiency (Page et al 1996). Babaian et al (2003) and El Fouly et al (2001) suggested that in saline soils, some elements such as Mg, Ca and Na have antagonism effects with micronutrients for uptake by roots. Padol et al (1996) reported that in saline soils, uptake of Zn extremely decreased because of salinity. Sharma and Yadav (1999) reported that Zn uptake decreased by increasing in grain increased by adding Zn to saline soils. Chipa and Lal (1986) reported that use of extra application of Zn is necessary to avoid decreasing of low uptakes of micronutrient caused by salinity. It has been suggested that use of Zn in saline condition led to increase in root and shoot growth and improved salinity hazards on root and shoot structure. Francois et al (1986) found that root growth decreased by salinity in saline soils because of looses in sufficient uptake of elements, therefore, the extra application of micronutrients in saline soils are recommended in compare to normal condition. Hemantaranjan and Gray (1988) indicated that using Zn led to increases in leaf chlorophyll and indol acetic acid, so photosynthesis will be improved and then dry mater will be increased.

Materials and Methods

This study was conducted during cropping season 2001-2002 in Eshragh agro-industry complex in 30 Kms south of Varamin. The experiment was laid out in randomized complete block design with four replications. Treatments consisted of control without Zn application, use of 40 $kg.ha^{-1}$ ZnSo4 in soils at preplant, use of 80 $kg.ha^{-1}$ ZnSo4 in soils at preplant and use of 120 $kg.ha^{-1}$ ZnSo4 in soils at preplant. Kavir cultivar (*Triticum aestivum cv Kavir*), which is a well-known winter wheat and widely cultivated in saline condition, were planted with 500 seeds per square meter density.

Each experiment plot was involved in 6 cropping rows and the plot area was 4m*6m equal with $24m^2$. Before experiment, soil was sampled and analyzed (Table1). Irrigation water was supplied of mixing two kinds of water with different electrical conductivity (Table 2).

Each plot was fertilized with N, P, K based on soil test and aiming at high yield (Balali et al 2000). The nitrogen application was divided. One half was mixed with preplant with all of the phosphorous and potassium contents. The other half was applied as urea in three separate applications by topdressing at tillering, shooting and flowering stages. Each plot was irrigated based on soil and water research institute recommendations for wheat irrigation (Farshi et al 1997). Leaching requirement was measured and applied. After harvesting, in each plot, grain sampling was done and analyzed to determine protein content, Fe, Mn, Cu and Zn concentration. Twenty ears of each plots were picked up randomly and mean of ear length and seed per ear were recorded. Data were analyzed by MSTATC software and means were classified with Duncan multiple range test.

Table 1: Results of soil analysis

Cu mg.kg^{-1}	Zn mg.kg^{-1}	Mn mg.kg^{-1}	Fe mg.kg^{-1}	K mg.kg^{-1}	P mg.kg^{-1}	Texture	OC %	T.N.V %	EC dS.m^{-1}	pH	Depth	year
0.51	0.9	12.2	1.8	228	27.5	CL	0.72	19.1	10.2	7.2	0-30	2001
0.46	0.43	5.4	2.2	268	14.4	L	0.81	17.6	12.2	7.6	0-30	2002

Table 2: Results of water analysis

Class	SAR	%SSP	Na^+	Mg^{2+}	Ca^{2+}	$So4^{2-}$	Cl^-	$Hco3^-$	pH	EC dS.m^{-1}	TDS mg.l^{-1}	Treatments
			Cmol.m^3									
C_4S_1	3	29.3	11	12.6	13.9	14.2	17	6.5	7.1	3.4	1770	No 1
C_5S_1	7.8	44.3	38.2	25.7	22.4	36.8	41	8.1	7	7.3	3870	No 2
	5.9	36.6	26.7	19.7	17.9	30.1	29	5.3	7.1	5.6	2890	Mixed

Results and Discussion

The means of quantitative parameters included of grain yield, straw, ear per square meter, seed per ear, 1000 seed weight and length of ears are summarized in table 3. The means of qualitative parameters such as protein content are demonstrated in table 4.

Table3: Effects of Zn on Yield and its components

Treatment (ZnSo4 $kg.ha^{-1}$)	*Ear length mm	**1000 seed weight gr	$Seed.Ear^{-1}$ ns	$Ear.M^{2-}$ ns	Straw Yield $Kg.ha^{-1}$ ns	*Grain Yield $Kg.ha^{-1}$
0	84.1b	27.5b	37a	395a	8653a	3313b
40	91.5a	28.6ab	27.8a	386a	9600a	3725b
80	92.3a	31.7a	29.1a	400a	9810a	3914ab
120	94.8a	31.4a	40.6a	370a	10539a	4355a

Means with the same letter are not significantly different.
* Means $p<0.05$
** Means $p<0.01$

Table4: Effects of Zn on protein content and concentration of Fe, Zn, Mn and Cu in seeds

Treatment (ZnSo4 kg.ha-1)	Cu mg.kg-1	*Zn mg.kg-1	Mn mg.kg-1	Fe mg.kg-1	**Protein
0	17.6a	20b	20a	72a	12.7b
40	18.1a	31.5a	22a	62a	14a
80	18a	33.1a	25a	75a	14.6a
120	18.6a	39.1a	25a	63a	14.2a

Means with the same letter are not significantly different.
* Means $p<0.05$
** Means $p<0.01$

Data showed that the grain yield, ear length, 1000 seed weight, seed protein content and Zn concentration in seeds were significantly affected by Zn application. Use of Duncan multiple range test about 1000 seed weight and grain yield showed that the best treatment for these parameters is to use of 120 kg.ha-1 ZnSo4. The length of ear was affected by use of Zn and increased, but not significant. Use of Zn had a positive effect on Zn concentration and protein content in seed and increased significantly but rates of ZnSo4 application hadn't any effects on Zn concentration and protein content in seeds.

Conclusion

Data indicated that some parameters such as grain yield, 1000 seed weight and ear length were increased by use of Zinc (Figures 1 and 2). Khoshgoftarmanesh et al (2001) reported that use of Zinc in saline condition increased salt tolerance in wheat and yield. They indicated that micronutrients use efficiency in saline soils was low and yield could be increased by extra use of Zn. The result of our study is compatible with khoshgoftarmanesh et al results. Data of table 3 indicated that grain yield, 1000 seed weight and ear length were increased by increasing application of Zn. It has been shown that Zn use efficiency in saline soils was low, caused by land leveling, lime and deficiency of organic matters and there weren't any effects by low using of Zn fertilizers in saline condition. Hemantaranjan and Gray (1988) also reported that in saline soils, yield and its component would be increased by using Zn. They indicated that by using Zn, leaf chlorophyll and indol acetic acid were increased and by this, photosynthesis improved and then dry mater increased. It has been also reported that yield increased by use of 90 kg.ha-1 ZnSo4 in alkaline soil. Extra use of ZnSo4 hadn't any effect on grain yield.

In our study, qualitative parameters include protein content and Zn concentration in seeds were affected by Zn application and improved. Results of Ziaian (1999) research accepted these results. He reported that Zn concentration in seeds was increased by Zn application from 25 to 39.8 mg.kg-1. Hemantaranjan and Gray (1988) reported that Zn concentration in seeds was increased by Zn application. Other scientists reported that by Zn application, seed protein content was increased by 20 percent. It has been shown that in Zn deficiency condition, activity of RNA polymerase enzyme and protein synthesis enzyme are extremely decreased and rate of amino acids transformation declined. So by applying Zn, seed protein content will be increased due to increasing the activity of RNA polymerase enzyme and protein synthesis enzyme (Marshner 1986).

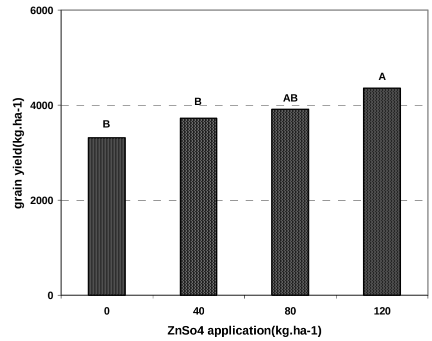

Figure 1:Effects of different rates of ZnSo4 on grain yield

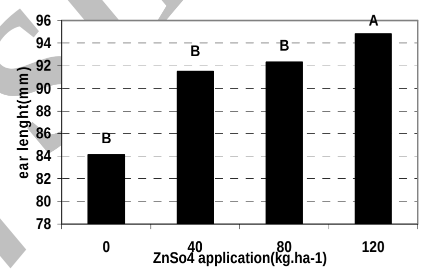

Figure 2: Effects of different rates of ZnSo4 on ear length

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