Variation of Zinc and Iron Content in Wheat Grain in Central Asia

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INTRODUCTION

The Central Asia region comprises five countries (Kazakhstan, Kyrgyzstan, Turkmenistan, Tajikistan and Uzbekistan), which grow a total of more than 15 million ha of wheat (*Triticum aestivum*). Throughout the southern region (36-44° N), occupying 5-6 million ha, winter or facultative wheat is grown primarily under irrigation (60-70%). Rain-fed wheat is planted on the remaining 30-40% of the area, mostly on hillsides or in mountainous areas where irrigation is impossible (Morgounov et al. 2001).

Forty-one winter wheat genotypes from Central Asian breeding programs were evaluated for micro- (Fe, Mn, Zn) and macroelement (Mg, P, S) concentrations in the grain. The objectives of the present study were to (i) determine the levels of Zn in the grain of current wheat lines and cultivars used in breeding programs in Central Asia, (ii) analyze the genotype x environment (GE) interactions and relationships with other micro- and macroelements, and (iii) identify promising lines with higher Zn concentrations in the grain.

METHODS

Grains from field trials that were grown at nine locations in Kazakhstan, Kyrgyzstan and Tajikistan in 2005 were analyzed for micro- (Fe, Mn, Zn) and macroelements (Mg, P, S) at Sabanci University, Istanbul, Turkey. Nutrients were measured using Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES) after digesting samples in a closed microwave system (Zarcinas et al. 1987). Data were evaluated statistically using one-way analyses of variance; means were compared using a least significant difference (LSD) procedure. Associations among variables were evaluated using Pearson correlation technique. The GE interactions were analyzed independently by trials and country using Additive Main Effects and Multiplicative Interactions (AMMI) analysis.

RESULTS AND DISCUSSION

The concentrations of Zn varied among genotypes between 20 and 39 mg kg^{-1} (mean 28 mg kg^{-1}). In this study, Zn-grain and S-grain, and Fe-grain and S-grain concentrations were significantly and positively correlated, suggesting a possible positive correlation between high micronutrient and high S-containing amino acid concentrations in the grain. Nine of the 12 genotypes with the highest S-grain content ranging from 1140 to 1558 mg kg^{-1} were among the top 12 Zn-grain genotypes (Navruz, NA160/HEINEVII/BUC/3/F59.71//GHK, Kauz, DUCULA//VEE/MYNA, JUP/4/CLLF/3/II14.53/ODIN//CI13431/WA00477, Atilla, Krasnodar 99, MV 218-98, and Tacika), and 7 were among the top 12 Fe-grain genotypes (Navruz, Naz, DUCULA//VEE/MYNA, NA160/HEINEVII/BUC/3/F59.71//GHK, Norman, JUP/4/CLLF/3/II14.53/ODIN//CI13431/WA00477, and Tacika). Five genotypes with high S-grain concentrations were also found in high Zn-grain and Fe-grain groups.

Thus, the development of new winter wheat genotypes with higher Zn-grain and Fe-grain concentrations and with promoters that affect Zn and Fe bioavailability appears feasible. On the contrary, Mn and P were negatively correlated with Zn (Table 1).

The AMMI analysis of GE interactions for grain Zn concentrations showed that Zn concentration was almost totally dependent on location effects.

Table 1. Pearson correlation coefficients among grain Fe, Mg, Mn, P, S and Zn content of 42 winter wheat genotypes across locations in central Asia in 2005.

	Zn	Mn	Mg	P	S
Fe	0.79***	-0.46***	0.29*	-0.18	0.67***
Zn		-0.46***	0.16	-0.11	0.71***
Mn			0.31*	0.59***	0.05
Mg				0.50***	0.47***
P					0.04

* Significant at *P* = 0.05; ** Significant at *P* = 0.01; *** Significant at *P* = 0.001.

CONCLUSIONS

Genotypes Navruz, NA160/HEINEVII/BUC/3/F59.71//GHK, Tacika, DUCULA//VEE/MYNA, and JUP/4/CLLF/3/II14.53/ODIN//CI13431/WA00477, are promising materials for increasing Fe and Zn concentrations in the grain, as well as enhancing the concentration of promoters of Zn bioavailability, such as S-containing amino acids (i.e., methionine, histidine, and lysine).

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