

# Variation of Zinc and Iron Content in Wheat Grain in Tajikistan

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## INTRODUCTION

Wheat production in Tajikistan has drastically increased after the country became independent in 1991. Annual production of grain comprises about 900-950 thousand MT with 80% being wheat grain. However, the yield of grain produced in Tajikistan is very low (average 1,5-1,6 t/ha). Therefore, the main objective of the national wheat breeding program is to develop new wheat varieties with high grain yield, resistance to diseases, good baking quality and nutrient content. Regional and international cooperation has been established with the objective of strengthening national breeding programs by exchanging information and breeding materials. Wheat research was substantially influenced by the development of international linkages, especially in breeding. The center CIMMYT and ICARDA established germplasm exchange networks through the TURKEY-CIMMYT-ICARDA Winter and Facultative Wheat Improvement Program located in Turkey. Several wheat lines from this program were tested in different agro-climatic conditions of the country and 6 of them were submitted for official testing to be released (Morgounov et al. 2006).

Nutritional problems related to cereal-based diets throughout the country, especially those linked to vitamin and mineral deficiencies in vulnerable groups, such as children under five years and women in reproductive age, are national concerns. In Tajikistan, as in large parts of the developing world, micronutrient deficiencies are widespread. High and monotonous consumption of cereal-based foods has been shown to be a major reason for such widespread occurrence of micronutrient deficiencies in the developing world. Cereal grains are inherently poor in concentration of micronutrients and rich in compounds depressing the bioavailability of micronutrients. In Tajikistan, as in other Central Asian countries, wheat is the most important staple food contributing greatly to daily calorie intake. Up to 65% of daily calorie intake comes solely from wheat and this rate can be greater than 75% in rural regions.

The objectives of the study were to (i) determine the levels of Zn and Fe in the grain of current wheat lines and cultivars used in breeding programs in Tajikistan, (ii) analyze the genotype x environment (GE) interactions and relationships with other traits, and (iii) identify promising lines with higher Zn and Fe concentrations in the grain.

## METHODS

Grain from 22 winter wheat varieties from trials conducted at four locations in Tajikistan in 2005 were analyzed for micro- (Fe, Mn, Zn) and macroelements (Mg, P, S) at Sabancı University, Istanbul, Turkey. Nutrients were measured using Inductively Coupled Plasma Optical Emissions Spectrometry (ICP-OES) after digesting samples in a closed microwave system (Zarcinas et al. 1987, Ryan 2005). Grain yield data were collected from testing sites. Data were evaluated statistically using one-way analyses of variance; means were compared using a least significant difference (LSD) procedure. The GE interaction was analyzed independently using Additive Main Effects and Multiplicative Interactions (AMMI) analysis. All calculations were performed with IRRISTAT 4.3 software (International Rice Research Institute 2003).

## RESULTS AND DISCUSSION

The genotypes Navruz, Tacikar, Alex, Ormon, NA160/HEINEVII/BUC/3/F59.71//GHK and JUP/4/CLLF/3/II14.53/ODIN//CI13431/WA00477 had higher Zn contents among the genotypes tested. Data on micro- and macronutrient concentrations in grain allowed analyzing correlations between several traits.

Analysis showed differences in mean concentrations of Zn and Fe in mature grain from 22 winter wheat genotypes grown in different agro-climatic conditions in Tajikistan. The amount of Zn in the grain varied largely among genotypes and ranged from 27 to 39 mg kg<sup>-1</sup> (mean 29 mg kg<sup>-1</sup>). As with Zn, the concentration of Fe varied among genotypes and ranged from 33 to 43 mg kg<sup>-1</sup> (mean 34 mg kg<sup>-1</sup>). Significant positive correlation coefficients were found between Fe and Zn, S, and Mg; between Zn and S; and between Mg, Mn and P. Therefore, our findings support the findings that it is possible to combine high-Fe and high-Zn traits during breeding (Monasterio and Graham 2000, Cakmak et al. 2004).

The AMMI analysis of variance of Zn-grain concentrations revealed that genotype (G) was the most and only important source of variation accounting for 35.13% of the G + L + GL variation. The genotypic effect was minor for the other trials explaining 4 to 9% of the G + L + GL variation. The genotype x location (GL) effect was important for Fe and Zn. For Fe, GL ranged from 17.6 to 48.64% across the trials and for Zn from about 7.3 to 48.77%.

## CONCLUSIONS

The strong positive correlations among grain-Fe, grain-Zn and grain-S together with high concentrations of each (Navruz, NA160/HEINEVII/BUC/3/F59.71//GHK, Tacika, DUCULA//VEE/MYNA, and JUP/4/CLLF/3/II14.53/ODIN//CI13431/WA00477) should be important for the development of new breeding populations targeting the enhancement of Fe and Zn bioavailability by increasing the concentration of promoters such as S-containing amino acids (i.e., methionine, histidine, and lysine). Regarding to GE interactions, grain-Fe concentration was controlled by genotype effects to an important extent, whereas grain-Zn concentration was almost completely dependent on location. Thus, genotypes having a greater genetic ability for root uptake of Fe and Zn could be important sources of germplasm for increasing micronutrient concentration in Tajikistan's wheat.

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