

# Grain Micronutrients and Zinc Efficiency in Wild Emmer Wheat Under Well-Watered and Drought Conditions

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## INTRODUCTION

Wheat is an important staple food for human consumption providing more calories and protein than any other crop. Nearly half of the world's cereal-growing area is affected by Zn deficiency in soils, particularly calcareous soils of arid and semiarid regions. Zinc deficiency in soils causes severe reductions in yield and nutritional quality of grains. Developing new cultivars by combining improved Zn-deficiency tolerance in soils, and increased Zn-grain concentration is a high-priority research topic. This is a promising approach to alleviate Zn deficiency-related problems. The joint effect of domestication and plant breeding have eroded the genetic variation in cultivated crop species compared to their progenitors. Wild emmer wheat (*Triticum turgidum* ssp. *dicoccoides* (Körn.) Thell.), the progenitor of cultivated wheat, offers a valuable source of allelic variation for various important traits including drought resistance (Peleg et al. 2005) and grain mineral concentrations (Cakmak et al. 2004). The aim of this study was to characterize the genetic variation in grain micronutrient concentrations and Zn-efficiency of wild emmer wheat at two levels of water availability.

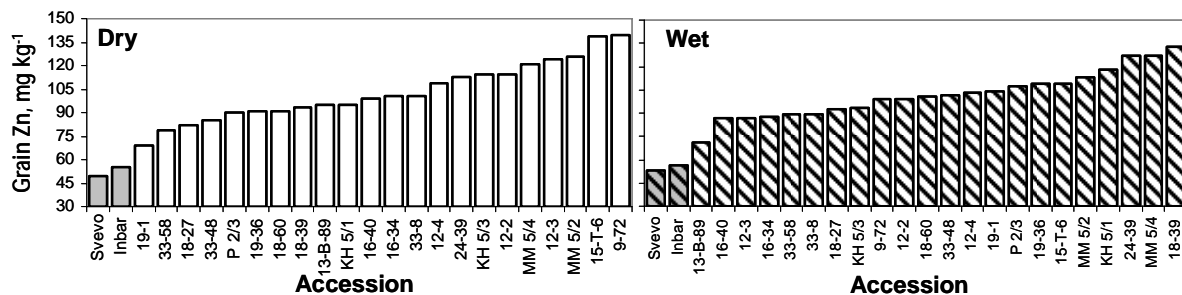
## MATERIALS AND METHODS

Twenty two wild emmer wheat accessions that represent a range of drought resistance capacity (Peleg et al. 2005) and two durum wheat cultivars (Inbar and Svevo) were examined in Israel during the winter of 2003-4. Plants were grown in a rain-out shelter under two irrigation regimes, well-watered (700 mm) and water-limited (250 mm) (termed as "wet" and "dry", respectively). Plants were tested for grain yield (GY), 1000 grain weight (TKW) and grain minerals concentration. Nitrogen in the grain was determined by the indophenolblue procedure following Kjeldahl digestion. Grain N concentration was multiplied by 5.7 to obtain grain protein concentrations (GPC). Grain concentrations of Zn and Fe were determined by Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES) (Varian-Vista-Pro, Australia). The seeds harvested in the field experiment under two water regimes were examined for tolerance to Zn deficiency in Turkey. Pot experiments were carried out in a greenhouse using a Zn-deficient soil from Central Anatolia without or with Zn fertilization (5 mg Zn kg<sup>-1</sup> soil). Plants were harvested after 30 days of growth in the greenhouse. Zn efficiency was expressed as the percentage of dry matter produced under Zn deficiency relative to dry matter produced under Zn fertilization.

## RESULTS AND DISCUSSION

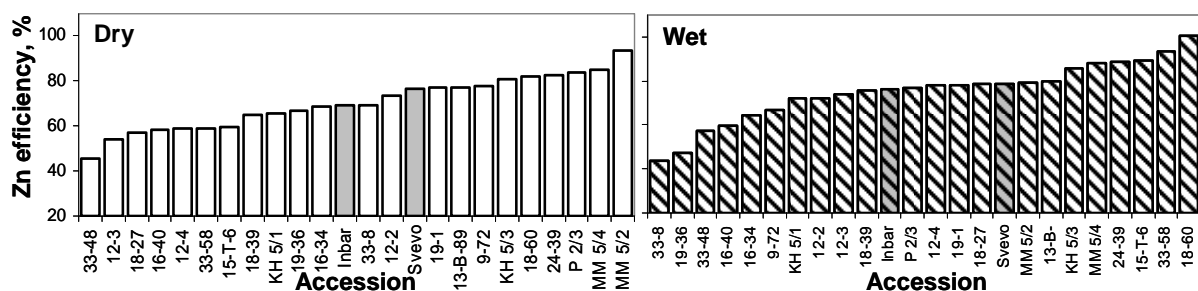
The wild emmer wheat accessions exhibited higher grain Zn concentrations under both treatments (68.8-139.5 mg kg<sup>-1</sup> and 71.1-133.5 mg kg<sup>-1</sup> for dry and wet, respectively) than the durum cultivars (49.4-54.7 mg kg<sup>-1</sup> and 52.6-56.2 mg kg<sup>-1</sup>, respectively) (Fig. 1). Grain Zn concentration was positively correlated with Fe ( $r=0.83^{***}$  and  $r=0.86^{***}$  for dry and wet, respectively) and GPC ( $r=0.65^{***}$  and  $r=0.51^{**}$ , respectively). Analysis of variance showed

highly significant irrigation × accession interactions for grain Zn, Fe and GPC concentrations. While certain accessions exhibited a stable ranking of Zn concentrations across the two treatments (*i.e.* MM5/2), the ranking of other accession was greatly affected by water availability (*i.e.* 18-39).



**Fig. 1.** Grain Zn concentrations of 22 wild emmer wheat accessions and two durum wheat cultivars (with gray) grown under well watered and water limited irrigation regimes.

The wild emmer wheat accessions exhibited also wide range of Zn efficiency in plants grown from seeds originated from both irrigation regimes (45-94% and 44-100% for the dry and wet treatment, respectively (Fig. 2). Zn efficiency was significantly influenced by the interaction between the seed growing environment and genotype. As with Zn concentration, certain accession exhibited a stable ranking for Zn efficiency across treatments (*i.e.* 18-60), while others were greatly affected by water availability (*i.e.* 33-53).



**Fig. 2.** Zn efficiency (%) of 22 wild emmer wheat accessions and two durum wheat cultivars (gray). Seeds were obtained from plants grown under well watered and water limited regimes.

## CONCLUSIONS

A high genetic diversity was found between wild emmer wheat accessions in terms of grain Zn concentration and Zn-efficiency, with a considerable potential to improve both traits in the cultivated wheat grown in zinc poor soils. However, since both traits exhibited genotype × environment interactions, wild accessions showing high stability over various environments should be carefully selected as donor parents for breeding programs.

## ACKNOWLEDGEMENTS

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## REFERENCES

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