Zinc, Iron and Nitrogen Accumulation in Alloplasmic Wheat Lines

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INTRODUCTION

Despite increasing evidence about parameters that determine wheat seed quality, the practical use of this knowledge is complicated due to some important factors. First of all, there are multiple components, and as a consequence, that would require the polygenic control of many reserve proteins. In addition, high energy consumption required for the synthesis of reserve proteins can result in the reduction of other economically important traits, including primarily productivity parameters such as total and productive tillers and weight of 1000 seeds. Thus, it is very important to find approaches that influence the expression of not only single genes, but gene complexes that are involved in the genetic control of the investigated parameters. In this respect, the utilization of nuclear-cytoplasmic effects is a promising approach. In this case, the improvement of not only single traits, but trait complexes may be facilitated. It has been shown that the substitution of cytoplasm with foreign cytoplasm can improve the parameters that characterize plant productivity, the resistance to fungal pathogens (Palilova 1986) and low temperatures, the rate of separate developmental phases (Orlov 2001) and more. There are only single publications that are concerned with the influence of cytoplasm on the expression of genes and determining isozymes and structural proteins (Palilova 1986). There is no information on the reservation of micronutrients in alloplasmic lines. Our main goal was to study major peculiarities that characterize Zn, Fe and N accumulation in alloplasmic wheat lines with cytoplasms of hard wheats *T. durum* and *T. turgidum.*

METHODS

For estimating cytoplasmic effects on the accumulation of micronutrients, the following plant material was used: donor of nuclear genome of *Triticum aestivum*, variety Mironovskaya 808, alloplasmic line with *Triticum aestivum* genome and cytoplasm of *Triticum durum*, alloplasmic line with Triticum aestivum genome and cytoplasm of *Triticum turgidum*, two dihaploid lines, obtained by culturing anthers of (durum) x *T. aestivum* line and two dihaploid lines, obtained by culturing anthers of (turgidum) x *T. aestivum*.

The plants were grown under field conditions at the Biological Research Station of NASB near Minsk. Sowing was carried out in randomized blocks with 5 replications.

The Zn, Fe and N content of wheat seeds was estimated using Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES, Varian) according to Ozturk et al. (2006).

The statistical evaluation of the results was performed with "Excel 2002".

RESULTS AND DISCUSSION

The obtained and analysed data shows that Fe concentrations in investigated wheat lines varied from 33 to 50 mg kg^{-1} seed for DH (turgidum) x T. aestivum and the alloplasmic line (turgidum x T. aestivum), respectively. The highest average Fe concentration was found in the variety Mironovskaya 808 (42.6 mg kg^{-1}). Iron concentration decreased in the alloplasmic line (turgidum) x T. aestivum (mean 36.6 mg kg^{-1}).

The average Fe concentration in seeds of a nuclear genome donor (T. aestivum, Mironovskaya 808) was 22.6 mg kg^{-1}. In the alloplasmic line (turgidum) x T. aestivum, the changes in Zn concentration were insignificant (mean 23.6 mg kg^{-1}). In the line with T. durum cytoplasm, this Zn concentration was higher and reached 25.8 mg kg^{-1}.

The highest N concentration was detected in seeds of wheat alloplasmic lines with T. durum cytoplasm. In some replications, the N level reached 3 % with a mean of 2.97 %, and N concentrations were higher than in the nuclear genome donor Mironovskaya 808 (2.74 %) and in all other lines.

The substitution of T. aestivum cytoplasm by foreign cytoplasm influenced the studied parameters differently. Simultaneously, the data analysis applying one-way variance analysis showed a reliable cytoplasmic effect on N concentrations. However, this was insignificant with respect to Fe and Zn (Table 1).

Table 1. One-way variance analysis of cytoplasmic effects on Zn, Fe and N concentration in alloplasmic wheat seeds

Source of variation	Sum of squares	DF	Mean square	F-value	P-value	F-value critical
Fe concentration	181,926	6	30,321	1,63	0,177	2,453
Zn concentration	134,637	6	22,440	1,54	0,204	2,445
N concentration	0,270	6	0,045	4,47*	0,003	2,445

When evaluating our data, it should be noted that the variance analysis makes it possible to reveal only the total effect of cytoplasm. In particular, it is evident that single alloplasmic lines exist in which values of the investigated parameters differ from the nuclear genome donor. In this study, these lines were, for example, forms (durum) x T. aestivum and their dihaploid lines with respect to Zn concentration. Mechanisms of cytoplasmic effects on the accumulation of Fe, N and Zn are unknown, and further investigations are necessary. In the future, special attention will be paid to the effects of grain yield on grain concentrations of Fe, N and Zn in alloplasmic wheat lines.

CONCLUSIONS

The reliable involvement of the cytoplasmic effect on N concentrations in seeds of alloplasmic wheat lines was shown. The substitution of T. aestivum cytoplasm with cytoplasm of T. durum resulted in an increased Zn accumulation in the alloplasmic line and its dihaploid derivatives.

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