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MINERAL COMPOSITION OF WHEAT GRAINS DEPENDING ON NITROGEN AND ZINC FERTILIZATION

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Introduction

Biofortification of cereals is the main strategy in alleviating the deficiencies of micronutrients in the human diet. The simplest and fastest way to increase the concentration of deficient nutrients in grain is agronomic biofortification, where fertilization increases their concentration in the crop.

Considering that the optimal level of certain elements in the diet of animals and humans is necessary for normal growth and development, and that in Serbia there is a limited number of studies examining the mineral composition and agrotechnical measures that contribute to improving the quality of wheat grains, the aim of the study was to examine the effect foliar application of zinc sulfate on the concentration of zinc (Zn) in wheat grain, and to consider the influence of different doses of nitrogen (N) fertilizers on wheat yield and the content of zinc, iron, manganese and copper in wheat grains.

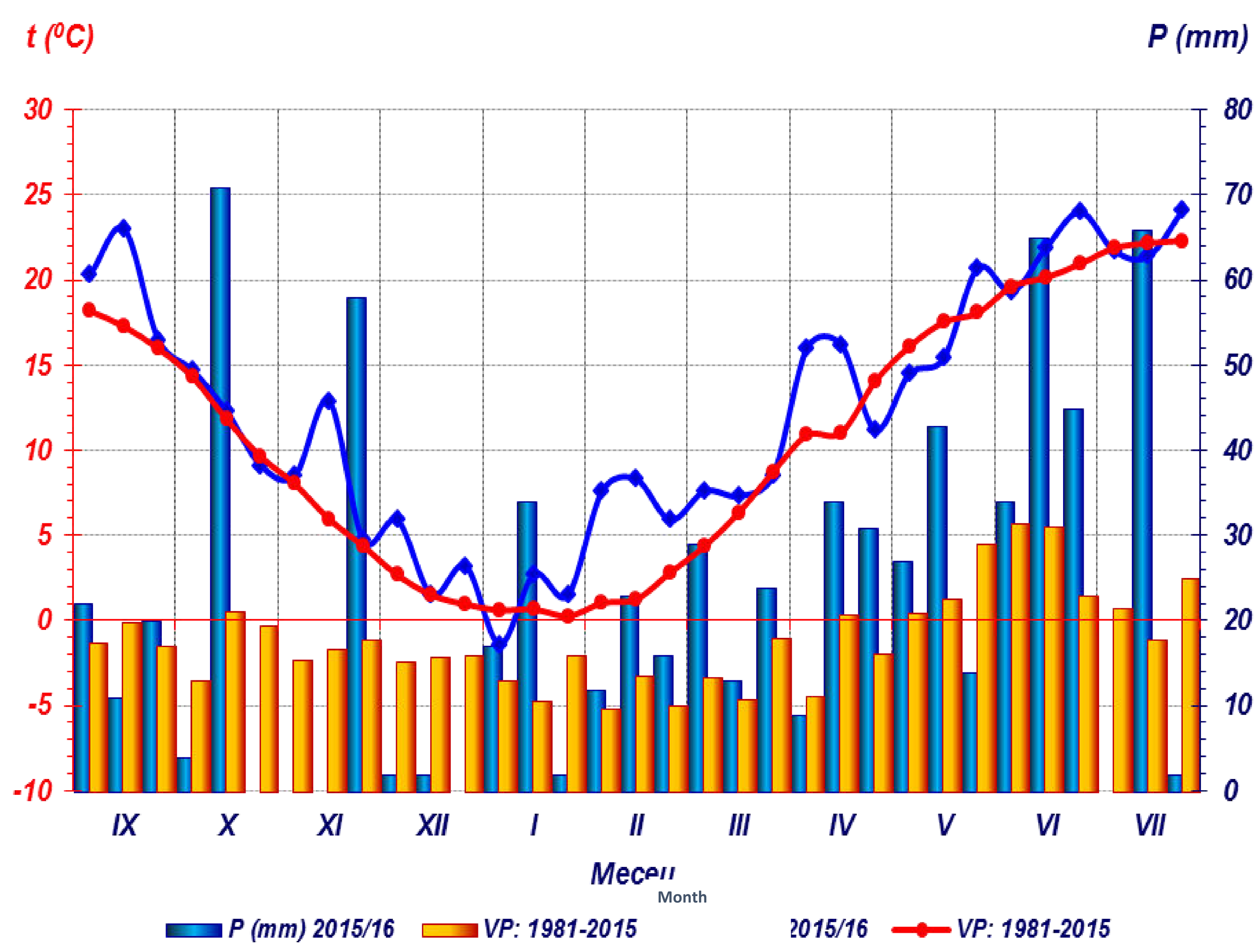
Material and method

Field experiment was carried out in October 2015 at family farm in Bačka Palanka, Serbia. The soil type on which the experiment was set was Chernozem (medium deep form, formed on loess terrace), and the chemical characteristics of the soil were presented in Table 1. The total monthly precipitation and monthly air temperature during experiment are given in Figure 1. The experiment was set up as two-factorial. The first factor was wheat cultivar (Graindor and Simonida), while the second factor was fertilization treatments with nitrogen (as ammonium nitrate) and zinc (as zinc sulphate). In both cultivars, the following fertilization treatments were tested:

1. 70 kg N ha^{-1} applied before sowing;
2. 70 kg N ha^{-1} applied before sowing and 70 kg N ha^{-1} applied in spring;
3. 70 kg N ha^{-1} applied before sowing + foliar application of 1,5 kg Zn ha^{-1};
4. 70 kg N ha^{-1} applied before sowing and 70 kg N ha^{-1} applied in spring + foliar application of 1,5 kg Zn ha^{-1}.

Table 1. Chemical properties of soil.

pH (in H_2O)	7,79
pH (in KCl)	6,99
Humus (%)	1,76
Total N (%)	0,09
AL-P_2O_5 (mg $100g^{-1}$)	24,13
AL-K_2O (mg $100g^{-1}$)	29,30
Fe-DTPA (mg kg^{-1})	7,50
Mn-DTPA (mg kg^{-1})	12,13
Zn-DTPA (mg kg^{-1})	3,21
Cu-DTPA (mg kg^{-1})	2,13



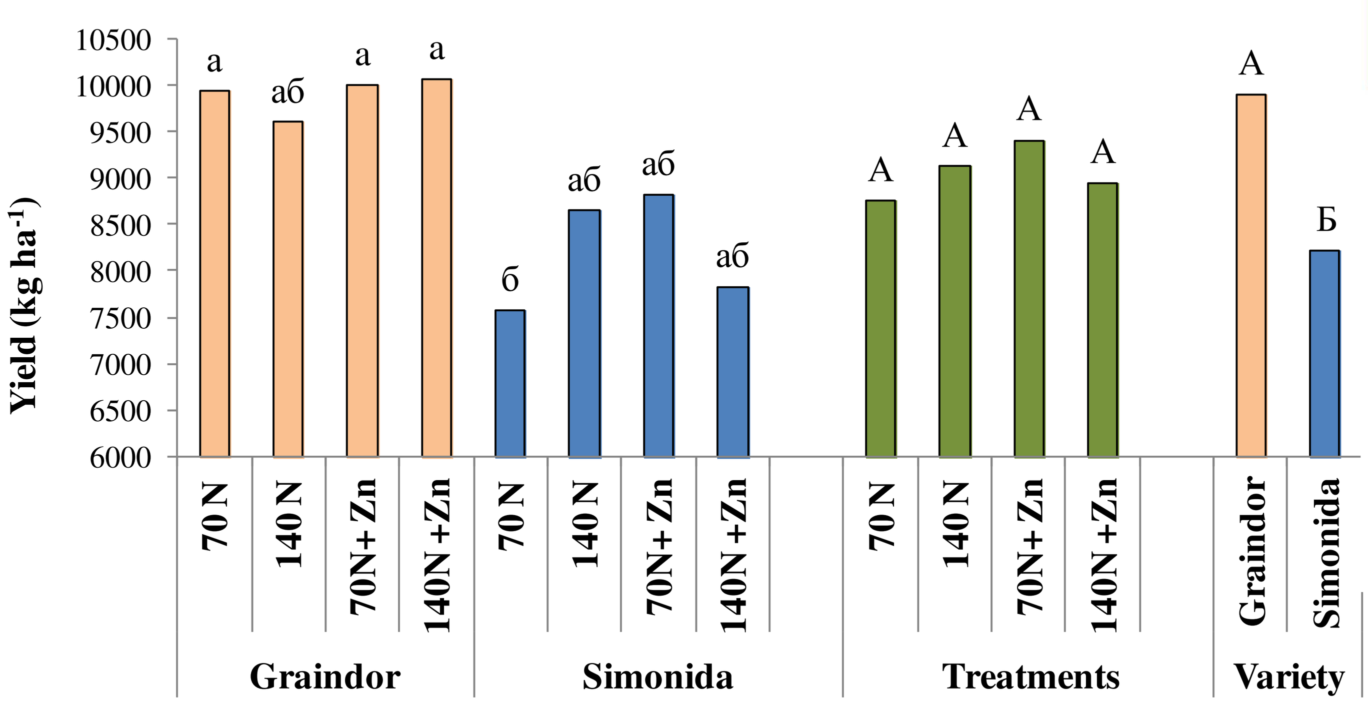
Graph 1. Average air temperatures and precipitation in the production year 2015/16. - meteorological station Backa Palanka (P, precipitation; t, temperatures; VP, long term average).

Table 2. Content of Cu, Fe and Mn in wheat grain depending on the treatment of fertilization and variety.

Variety/treatments	Cu (mg kg^{-1})				
	70 N	140 N	70N+ Zn	140N +Zn	Average
Graindor	4,00 b	3,78 b	3,68 b	3,73 b	**3,80 B**
Simonida	4,06 b	4,12 b	4,86 a	4,85 a	**4,47 A**
Average	**4,03A**	**3,95 A**	**4,27 A**	**4,29 A**	
	Fe (mg kg^{-1})				
	70 N	140 N	70N+ Zn	140N +Zn	Average
Graindor	44,20 v	52,27 v	45,12 v	75,35 b	**54,23 B**
Simonida	69,37 bv	43,38 v	58,73 bv	103,11 a	**68,64 A**
Average	**56,79 B**	**47,82 B**	**51,93 B**	**89,23 A**	
	Mn (mg kg^{-1})				
	70 N	140 N	70N+ Zn	140N +Zn	Average
Graindor	22,68 a	20,68 a	24,04 a	23,13 a	**22,63 A**
Simonida	23,05 a	23,42 a	23,81 a	24,50 a	**23,69 A**
Average	**22,87 A**	**22,05 A**	**23,92 A**	**23,82 A**	

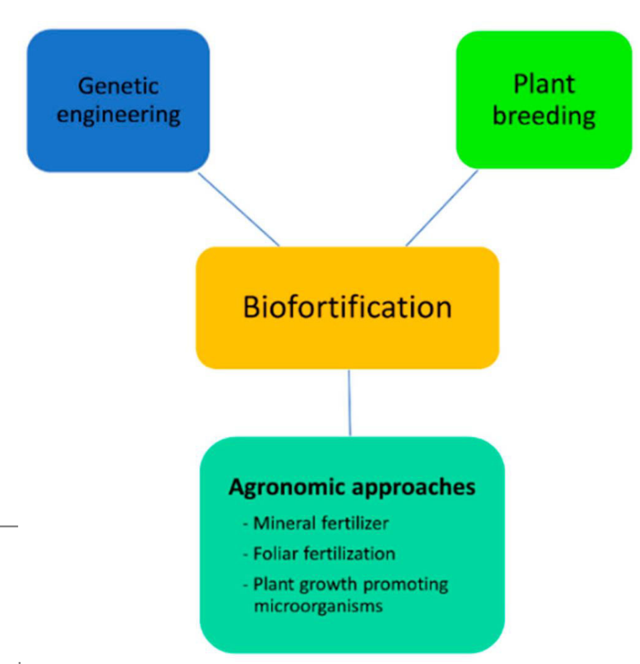
* values followed by different upper- (averges) and lowercase (interaction: fertilization x variety) letters are statistically significantly different at $p < 0.05$.

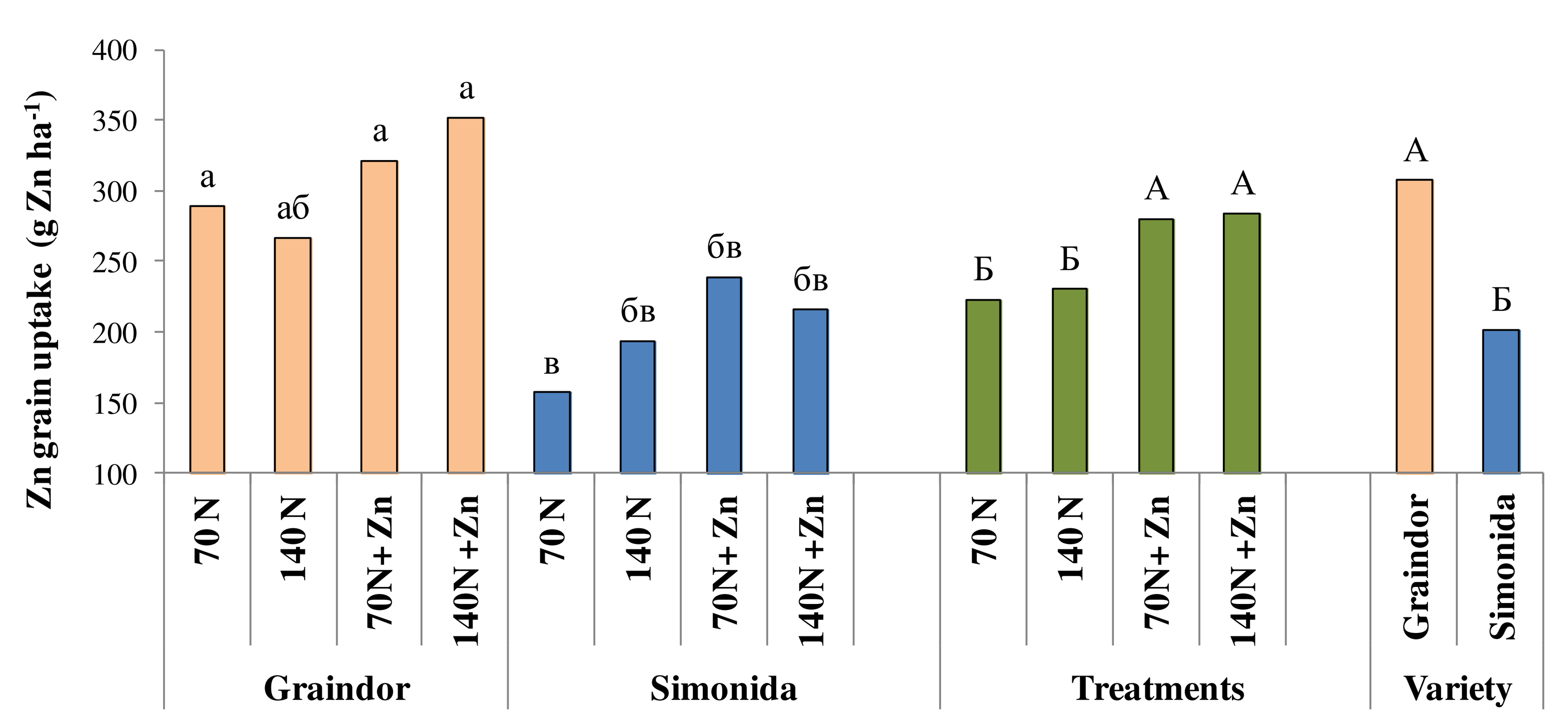
Results



* Column followed by different upper- (averges) and lowercase (interaction: fertilization x variety) letters are statistically significantly different at $p < 0.05$.

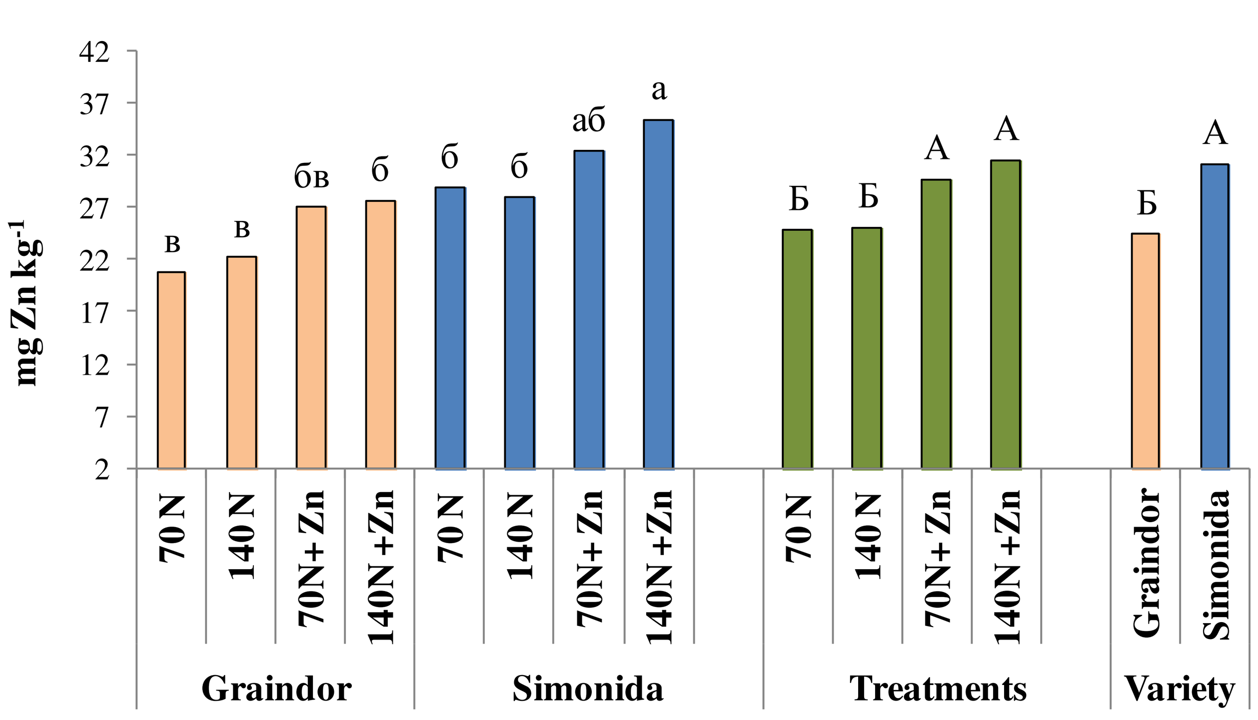
Graph 2. Wheat yield depending on fertilization treatment and variety.





* Explanation under Graph. 2..

Graph. 3. Zinc uptake by wheat grain depending on the treatment of fertilization and variety.



* Explanation under Graph. 2..

Graph. 3. Zinc content in wheat grain depending on the treatment of fertilization and variety.

Conclusion

Favorable agro-ecological conditions in the experimental year (higher amount of precipitation and temperatures above the long-term average) led yields that are significantly higher than the long-term average at the level of the Republic of Serbia, for both wheat varieties. Wheat yield did not differ significantly depending on the applied fertilization treatments.

Foliar application of zinc sulfate led to a significant increase in the concentration of zinc in wheat grain, whereas the interactions between fertilizer treatment and variety were not statistically significant. Also, foliar application of zinc and a higher dose of nitrogen fertilizer led to a significant increase in iron in wheat grain. On the other hand, the application of nitrogen and zinc did not affect the manganese and copper content in wheat grain. The results suggest that foliar application of zinc sulphate is a suitable method for biofortification of wheat with zinc in our agroecological conditions.