RESULTS REGARDING THE INFLUENCE OF DIFFERENT DOSES OF CHEMICAL FERTILIZERS ON THE CONCENTRATION OF ZINC IN WHEAT GRAINS

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Abstract

Wheat grains analyzed come from long-term experiments with chemical and organic fertilizers. A field experiment was carried out at the Agricultural Research and Development Station Oradea, Bihor County, Romania. Were analyzed the effect of applying different doses of chemical fertilizers with nitrogen, phosphorus and potassium to wheat crop on zinc concentration of wheat grains during three years.

The gradual increase of the doses of chemical fertilizers with nitrogen, phosphorus and potassium led to increase the zinc concentration in wheat grains between 1.023 and 2.318 mg/kg compared with the control variant. At the application of chemical fertilizers with nitrogen and phosphorus the increases compared to the control were not significant, being between 0.525 and 0.930 mg/kg.

Key words: wheat, grains, zinc, doses, chemical fertilizers

INTRODUCTION

Wheat (*Triticum aestivum L.*) is among the top cereal crops cultivated in Romania, together with maize and sunflower.

Zinc is part of the essential metals functioning of animal and vegetable bodies, but beyond certain limits, is carcinogenic and teratogenic potential. Since there is no ability to be absorbed into the digestive tract, zinc has little toxicity, in contrast to its salts, however, are irritating to the mucosa of the digestive tract and high dose toxicity.

Mainly sources of pollution with zinc come from mining, burning of fossil fuels, burning of waste, production of steel, manufacture of paints and tire products (Răuţă C. et al., 1992, Dudka S. et al., 1994).

Irrigation with wastewater increase the concentration of heavy metals (Cu, Cr, Mn, Ni, Pb and Zn) in the roots, stems and seeds of wheat plants, the most significant increase was registered in the case of manganese and zinc (Ramachandran V. and D'Souza T. J., 1998, M. Karatas et al., 2006, Gao X. et al., 2010,).

In case of the roots wheat roots the translocation of heavy metals is performed in the following order: Mn> Ni> Zn> Cd> Co> Cr> with> Pb, respectively wheat plant distribution of heavy metals is as follows: Mn>

Zn> Pb> Ni> Co > Cd> with> Cr (Gyori Z., 2007, B. Lukšienė and M. Račaitė, 2008).

Research by R. Kastori et al. (2006) shows that the translocation in case of triticale the nickel, copper and zinc in the vegetative parts of the seed was intense, while the molybdenum was average.

M. Francois et al. (2008) suspects that zinc interacts with chemical fertilizers with phosphorus so slow down the absorption of zinc by wheat.

The application of foliar fertilizer on the basis of zinc and iron in various concentrations resulted an insignificant increase in the concentration of zinc in the grain of wheat. Zinc applied alone resulted a significant increases in its concentration in wheat grains (E. Niyigaba et al., 2019).

MATERIAL AND METHOD

Laboratory investigations were carried out in the ***"Research Laboratory of risk factors for Agriculture, Forestry and the Environment",*** Faculty of Environmental Protection – University of Oradea.

The samples of the winter wheat grains were harvested, in 2010 – 2012 period, in the long term trials at the Agricultural Research and Development Station Oradea.

Variants studied

Factor A: nitrogen, phosphorus and potassium combination; a1: $N_0P_0K_0$; a2: $N_{80}P_{40}K_{40}$; a3: $N_{80}P_{80}K_{80}$; a4: $N_{160}P_{80}K_{120}$.

Factor B: nitrogen and phosphorus combinations; b1: N_0P_0; b2: $N_{50}P_0$; b3: $N_{50}P_{50}$; b4: $N_{100}P_{100}$

Plant biological material samples were mineralized with a mixture of sulfuric acid (H_2SO_4) and perchloric acid ($HClO_4$) to determine the zinc concentration.

For the determination of zinc concentration in wheat grains, the samples were prepared according to the working methods presented above were analyzed by spectrophotometer with atomic absorption SHIMADZU AA-6300.

Correlations between chemical fertilizers doses and zinc concentrations in wheat grains were calculated using Microsoft Excel and was chosen the function with the highest value of R^2.

RESULTS AND DISCUSSIONS

The average zinc concentration in wheat grains over the three years studied, 2010-2012, in the control variant ($N_0P_0K_0$) was 11.843 mg/kg. In the case of the $N_{80}P_{40}K_{40}$ variant, a concentration of 12.866 mg/kg was

registered, higher by 8.6% compared to the $N_0P_0K_0$ variant, the differences being statistically insignificant. In the $N_{80}P_{80}K_{80}$ variant, the wheat grains had a higher zinc concentration of 14.4% (not statistically significant) compared to the control variant, of 13.553 mg/kg. In the fertilized variant with $N_{160}P_{80}K_{120}$ the increase in zinc concentration was 19.6% (statistically significant) compared to the unfertilized variant, 14.161 mg/kg (Table 1).

Table 1

The influence of doses and combinations of NPK fertilizers on zinc concentration in winter wheat grains, average data, (2010-2012)

Variant	Zn concentration		Difference		Statistical significance
	mg/kg	%	mg/kg	%	
$N_0P_0K_0$	11.843	100	-	-	Control
$N_{80}P_{40}K_{40}$	12.866	108.6	1.023	8.6	-
$N_{80}P_{80}K_{80}$	13.553	114.4	1.710	14.4	-
$N_{160}P_{80}K_{120}$	14.161	119.6	2.318	19.6	*
		LSD 5%	1.81		
		LSD 1%	3.44		
		LSD 0.1%	6.07		

Regarding the mathematical modeling of the results regarding the concentration of zinc in the wheat grains collected from the 4 studied variants of the experiment with nitrogen, phosphorus and potassium, it shows that the power type function best quantifies the connection between the doses of fertilizers with NPK and zinc concentration from wheat grains, $y = 11.81x0.127$, $R^2 = 0.984$ (Figure 1).

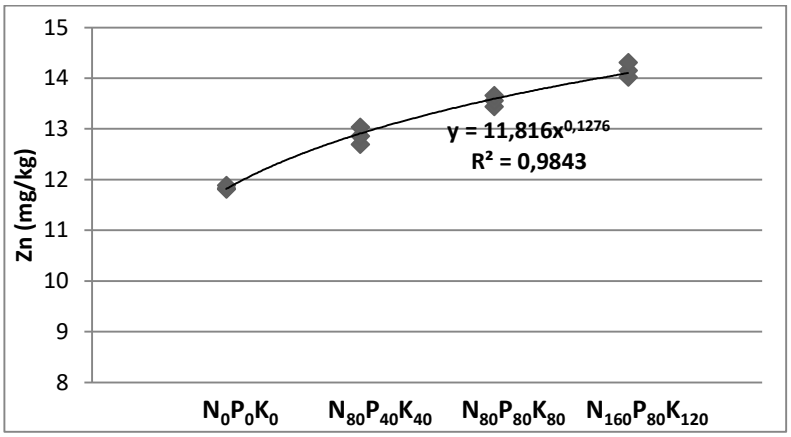

Fig. 1. Correlation between doses of NPK fertilizers and zinc concentration in wheat grains

The average zinc concentration in wheat grains harvested from variant N_0P_0 (control) was 11.826 mg/kg. In the case of variant $N_{40}P_{40}$ there

was a higher zinc concentration in wheat, by 4.4%, 12.351 mg/kg, than the variant N_0P_0, being statistically insignificant. The wheat grains harvested from the fertilized variant with $N_{80}P_{80}$ had a zinc concentration of 12.686 mg/kg, higher by 7.3% compared to the control, the difference being statistically insignificant. The zinc concentration determined in the wheat grains harvested from variant $N_{160}P_{160}$, was 7.9% higher than the unfertilized variant, not being statistically assured, registering the value of 12.757 mg/kg (Table 2).

Table 2

The influence of doses and combinations of NP fertilizers on zinc concentration in winter wheat grains, average data, (2010-2012)

Variant	Zn concentration		Difference		Statistical significance
	mg/kg	%	mg/kg	%	
N_0P_0	11.826	100	-	-	Control
$N_{40}P_{40}$	12.351	104.4	0.525	4.4	-
$N_{80}P_{80}$	12.686	107.3	0.859	7.3	-
$N_{160}P_{160}$	12.757	107.9	0.930	7.9	-
		LSD 5%	0.942		
		LSD 1%	1.253		
		LSD 0.1%	1.772		

The mathematical modeling of the obtained results shows that the polynomial type function, y = -0.113x2 + 0.879x + 11.05, R^2 = 0.998, best quantifies the link between fertilizer doses with nitrogen and phosphorus and the zinc concentration in the wheat grains harvested from experience (Figure 2).

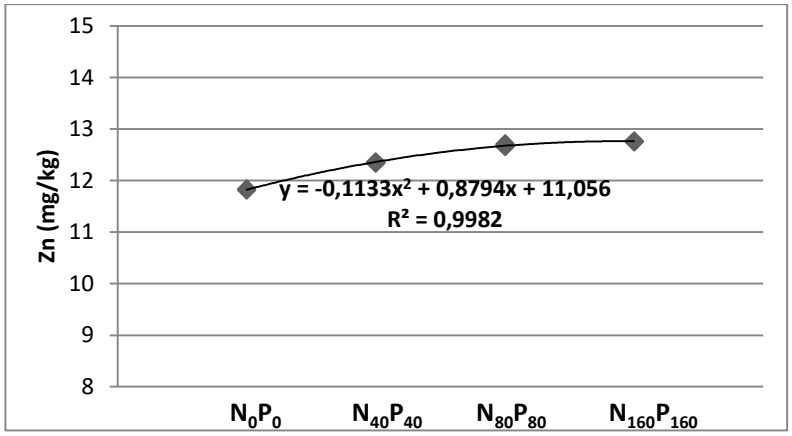

Fig. 2. Correlation between doses of NP fertilizers and zinc concentration in wheat grains

CONCLUSIONS

The zinc concentration of wheat grains increased with increasing fertilizers doses with nitrogen, phosphorus and potassium.

Differences from the control variants were statistically ensured in the highest doses versions, taking values in the case of wheat 14.161 mg/kg in the variant $N_{160}P_{80}K_{120}$ and 12.757 mg/kg in the fertilized version with $N_{160}P_{160}$.

It is noted, that in the NP experience, the lowest concentration of Zn was recorded compared to the other experience, this fact being explained by the lack of precipitation, the amount of phosphorus remaining in the soil was higher leading to the immobilization of zinc to the plants.

Zinc concentrations did not exceed the maximum permitted limit of 15 mg/kg, according to ORDER (EC) No. 1881/2006.

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