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THE INFLUENCE OF CHEMICAL AND ORGANIC FERTILIZERS ON ZINC CONCENTRATION IN WHEAT AND MAIZE SEEDS

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Abstract

The stationary long term field experiments with chemical and organic fertilizers it was founded in 1980 at Agricultural Research and Development Station Oradea, using a unitary scheme designed by to Agricultural Research and Development Institute of Fundulea, Romania.

The concentration of zinc in wheat grains and maize is influenced by doses of fertilizers with nitrogen, phosphorus and manure applied and also the rainfall. In case of the control variant (N_0P_0 + 0 t/ha farmyard manure), the concentration of zinc in wheat grains was 11 825 mg/kg, respectively, 5.353 mg/kg in maize.

Increasing doses of chemical and organic fertilizers resulted the growth in concentration of zinc in beans. In version $N_{100}P_{100}$ + 60 t/ha of manure farmyard the increase was 19.8%, in case of wheat grains, respectively 9.4% in case of maize grains. The difference was statistically recorded in case of wheat grains and not statistically significant in case of maize grain.

Key words: chemical fertilizers, farmyard manure, wheat, maize, grains.

INTRODUCTION

Fertilizers are mineral or organic substances obtained by synthesis by the processing of natural stone or results of waste products from various human activities, particularly from livestock used in agriculture in order to increase the level and quality of production by increasing soil fertility and can be applied in solid, liquid or gaseous (Borlan Z. and Hera Cr., 1984).

Depending on the method of obtaining are two different categories: chemical fertilizers (mineral or industrial) and organic fertilizers (natural).

Mineral nutrients are obtained by processing of natural stone or by synthesis (Ciobanu Gh., 2007). Depending on the nutrients they contain can be: simple fertilizers with azote, with phosphorus, with potassium, second order macronutrients (Ca, Mg, S), with trace (Fe, Mn, Cu, Zn, B, Mo) compound fertilizers containing several elements needed for plant nutrition (complex or mixed fertilizers).

Organic fertilizers include: farmyard manure, urine, sludges from livestock farms, sludges from treatment plants, various composts.

Zinc belongs to the group of trace elements essential for the development of most plants, but in high quantities in the soil can be toxic to many plants (Salwa A.I., 2009).

The concentration of zinc in the soil in the natural state is between 5 and 570 mg/kg, with an average of 66 mg/kg (Lăcătuşu R., 2008). Salminen R. et al. (2005), the soils in Europe have an average zinc concentration of 52 mg/kg.

In soils from complex sulphide mines surroundings, was found a very high concentration of zinc 80.000 mg Zn/kg (US), 66,400 mg Zn/kg (England), 16,000 mg Zn/kg (Greece) (Kabata Pendias A., Pendias H., 2001). In Romania, the highest concentrations of zinc in the soil were determined in the nearness of the processing of non-ferrous ores from Copsa Mica (2010 mg/kg), Baia Mare (1.378 mg/kg), Zlatna (400 mg/kg) (Răuţă C. et al., 1992).

The content of metals (Cd, Cr, Ni and Zn), especially nickel significantly reduces the power of rising of maize and rice (Pandey S. N. et al., 2008).

Accessibility of heavy metals mentioned in plants is not constant, but it varies by species and also by environment conditions: climate, soil (Gyori Z., 2007). Salad opposed with carrots and potatoes, have greater capacity to accumulate heavy metals, zinc, copper and cadmium and clover absorbs copper quicker than gramineae (Karatas M. et al, 2007, Hejcman, M. et al, 2013). Tolerance levels for heavy metals are different in descending order: herbs, gramineae, grains, potatoes and sugar beet. (R. L. Hough et al, 2003).

British regulations predictid for vegetables offered for sale below 1 ppm Pb content in fresh substance, which coincides with approximately 10 ppm in dry matter (Davies, 1990, quoted by Leonard I. et al., 2007); some heavy metals, including cadmium can accumulate to dangerous levels for consumers without affecting plant productivity, leading to a high risk in the food chain; it has been found a direct correlation between peak concentrations of cadmium in the maize kernel and the zinc (Dudka S. et al, 1994). A cadmium concentration of 1 ppm and a content of 40 ppm Zn produce food poisoning in humans (Gao X. et al., 2010).

This study shows the influence of the nitrogen, phosphorus and farmyard manure over zinc concentration in winter wheat and maize grains.

MATERIAL AND METHOD

The samples was harvested in the long term trials at the Agricultural Research and Development Station Oradea, in 2010 – 2012 period.

Variants studied:

- V_1 - N_0P_0 + 0 t/ha farmyard manure,
- V_2 - $N_{50}P_0$ + 20 t/ha farmyard manure,
- V_3 - $N_{50}P_{50}$ + 40 t/ha farmyard manure,
- V_4 - $N_{100}P_{100}$ + 60 t/ha farmyard manure.

The vegetal biological material studied was the wheat variety Crişana and hybrid maize Fundulea 376.

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

Mineralization of plant biological material samples in order to determine the zinc was done with a mixture of sulfuric and perchloric acids.

For the determination of zinc under study, samples of vegetal biological material prepared according to the working methods presented above were analyzed by spectrophotometer with atomic absorption SHIMADZU AA-6300.

Correlations between doses of organo fertilizer – minerals (NP + farmyard manure) and zinc in wheat and maize grains were calculated using Microsoft Excel; of the 5 types of functions available on the program (linear, exponential, logarithmic, polynomial and power) was chosen the function with the highest value of R^2.

RESULTS AND DISCUSSIONS

From a climate point of view, the research has been conducted in three years totally different in terms of rainfall, in 2010 their amount being 869.0 mm in 2011 was 569.7 mm, and respectively in 2012 were recorded 418.9 mm.

In the table 1 presented the average concentration of zinc in the wheat grains harvested from variant N_0P_0 + 0 t/ha of farmyard manure (control) was 11.825 mg/kg. In variant $N_{50}P_0$ + 20 t/ha farmyard manure was 9.8% higher (12.988 mg/kg), in variant $N_{50}P_{50}$ + 40 t/ha farmyard manure, 13.595 mg/kg (15% higher compared to the control) and the variant $N_{100}P_{100}$ + 60 t/ha farmyard manure 14.163 mg/kg, 19.8% higher compared to the control variant. The differences compared to the control, in the studied variants of experiments with nitrogen, phosphorus and manure were insignificant in the fertilized version $N_{50}P_0$ + 20 t/ha farmyard manure and $N_{50}P_{50}$ + 40 t/ha farmyard manure, respectively statistically significant in the fertilized version $N_{100}P_{100}$ + 60 t/ha manure.

Regarding of mathematical modeling of results of the concentration of zinc in wheat grains harvested from the experiences with NP and farmyard manure rum 5 functions tested (linear, exponential, logarithmic, polynomial and power), the power type function, $R^2 = 0.998$, is the best quantified link between doses of fertilizers with NP + farmyard manure and zinc concentration in wheat grains (Fig. 1).

Table 1

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

Variant	Zn concentration		Difference		Statistical significance
	mg/kg	%	mg/kg	%	
N_0P_0 + 0 t/ha farmyard manure	11.825	100	-	-	Control
$N_{50}P_0$ + 20 t/ha farmyard manure	12.988	109.8	1.163	9.8	-
$N_{50}P_{50}$ + 40 t/ha farmyard manure	13.595	115.0	1.770	15.0	-
$N_{100}P_{100}$ + 60 t/ha farmyard manure	14.163	119.8	2.337	19.8	*
		LSD 5%	1.847		
		LSD 1%	2.380		
		LSD 0.1%	2.893		

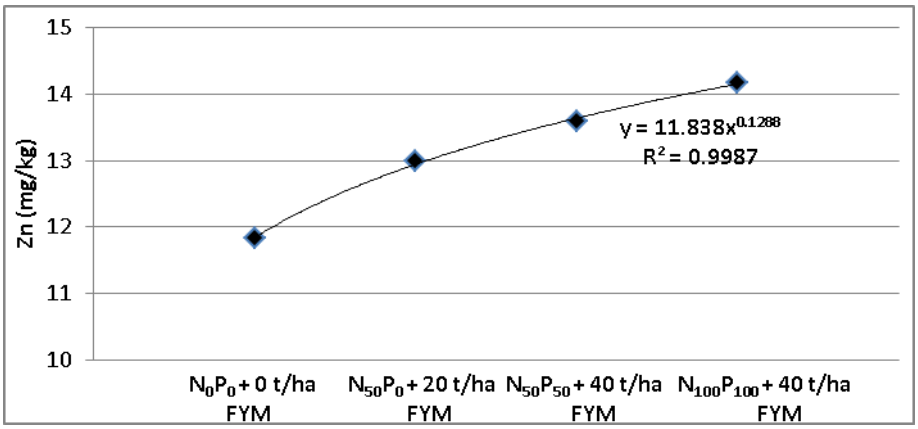

Fig. 1. Correlation between doses of NP fertilizers and manure and zinc concentration in wheat grains

The average concentration of zinc in maize grains in the three years studied (2010-2012), the experiments with chemical and organic fertilizers was of 5.353 mg/kg in control variant, 5.679 mg/kg (6.1% higher than the control variant) for variant $N_{50}P_0$ + 20 t/ha farmyard manure, 5.767 mg/kg (7.7% higher compared to the control) in the variant fertilized with $N_{50}P_{50}$ + 40 t/ha farmyard manure, respectively 5.856 mg/kg (9.4% higher compared to variant N_0P_0 + 0 t/ha farmyard manure) in variant $N_{100}P_{100}$ + 60 t/ha farmyard manure, the differences were not statistically insured (Table 2).

Mathematical modeling of the results on the concentration of zinc in maize grains from variants of experience with NP + farmyard manure, shows that the function of type polynomial, R^2 = 0.9802, is the best quantified link between doses of fertilizers with nitrogen, phosphorus and farmyard manure and zinc concentration in maize grains (Fig. 2).

Table 2

The influence of NP fertilizers and manure on zinc concentration in maize grains, average data, (2010-2012)

Variant	Zn concentration		Difference		Statistical significance
	mg/kg	%	mg/kg	%	
N_0P_0 + 0 t/ha farmyard manure	5.353	100	-	-	Control
$N_{50}P_0$ + 20 t/ha farmyard manure	5.679	106.1	0.327	6.1	-
$N_{50}P_{50}$ + 40 t/ha farmyard manure	5.767	107.7	0.414	7.7	-
$N_{100}P_{100}$ + 60 t/ha farmyard manure	5.856	109.4	0.503	9.4	-
		LSD 5%	0.531		
		LSD 1%	0.713		
		LSD 0.1%	0.879		

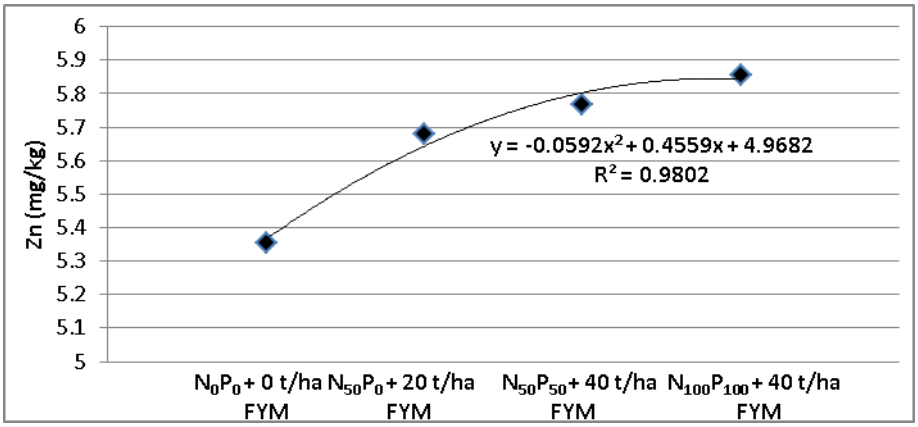

Fig. 2. Correlation between doses of NP fertilizers and manure and zinc concentration in maize grains

CONCLUSIONS

By applying the chemical and organic fertilizers of wheat and maize crops it can be noted an increase of zinc concentration in grains.

In grains of wheat the increases were not statistically significant in variant $N_{50}P_0$ + 20 t/ha farmyard manure (+9.8%) and $N_{50}P_{50}$ + 40 t/ha farmyard manure (+15.0%) comparative with control. In variant $N_{100}P_{100}$ + 60 t/ha farmyard manure the increase of zinc concentration was with 2.337 mg/kg, respectivelly with 19.8% comparative with control (11.825 mg/kg), differences being statistically insured.

In the case of maize grains zinc concentrations had higher values by applying the mineral and organic fertilizers. Zinc concentration was 5.679 mg/kg in variant $N_{50}P_0$ + 20 t/ha farmyard manure, 5.767 mg/kg in variant

$N_{50}P_{50}$ + 40 t/ha farmyard manure and 5.856 in variant $N_{100}P_{100}$ + 60 t/ha farmyard manure.

In none from variants taken in study, the maximum allowed limit (15.0 mg Zn/kg) was not exceeded.

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