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Variation of some mineral elements in plant consecutive administration of different zinc concentrations

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Abstract

In this study we've made quantitative determinations on certain series of metals and their variation depending on the zinc administrated doses, seeking the correlations between the determined elements. We have also studied the reactions of the plants at zinc treatment, on the direction of plants development, following different parameters like the length of the plants or chlorosis.

Keywords: mineral elements, zinc

1. Introduction

Growing of plants is appreciably influenced by several factors, like the climate, the season, the soils, the rainfalls [1]. Given the data existing in the literature about the reaction of several plants to the zinc excess [2, 3, 4], we have chosen to widen this information by studying the effects of maize contamination with large zinc doses.

2. Materials and method

We used plastic recipients having the volume of 250 mL with flowers soil, where we planted maize seeds and soaked them with different solutions for the different samples until their germination. The solutions were prepared with potable water. Thus, we had 33 samples (11 variations each multiplied in 3 copies): 3 samples M with simple drinking water (control samples), 15 samples for Group A treated with $ZnSO_4x7H_2O$ and 15 samples in the Group B treated with $ZnCl_2x2H_2O$. The plants were provided with the same liquid volume. When it was necessary, we administrated supplementary water volumes when the soil was dry. We administrated the solutions at every 3 days during the three weeks until all the maize germinated. At the end of the administration period, the metals doses given to the soil were:

- M - treated cu potable water
- A1 - treated cu $ZnSO_4x7H_2O$ – 125 ppm Zn
- A2 - treated cu $ZnSO_4x7H_2O$ – 250 ppm Zn
- A3 - treated cu $ZnSO_4x7H_2O$ – 500 ppm Zn
- A4 - treated cu $ZnSO_4x7H_2O$ – 1250 ppm Zn
- A5 - treated cu $ZnSO_4x7H_2O$ – 2500 ppm Zn
- B1 - treated cu $ZnCl_2x2H_2O$ – 125 ppm Zn
- B2 - treated cu $ZnCl_2x2H_2O$ – 250 ppm Zn
- B3 - treated cu $ZnCl_2x2H_2O$ – 500 ppm Zn
- B4 - treated cu $ZnCl_2x2H_2O$ – 1250 ppm Zn
- B5 - treated cu $ZnCl_2x2H_2O$ – 2500 ppm Zn

After three weeks, the plants were drawn. We studied their development, following their length and the presence of chlorosis. In the next stage, the plants were prepared for the mineral content determination. We used a spectrophotometer with monofascicle of atomic absorbtion Varain,

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type Spectra AA 110. For each sample we determined the following elements: Na, K, Ca, Fe, Mn, Cu, Zn, Pb, Co, Cr and Ni.

3. Results and discussion

The results of this approach are presented in the table 1 and figures 1-13.

The content of Ca at zinc administrated maize with $ZnSO_4$ method manifested an increasing tendency at the dose A1 (125 ppm) comparing with the control sample, but further increasing the zinc doses we noticed a gradual decrease of the Ca content (fig. 1) – fact correlated with the specialised literature [Hart & col, quoted by 1] being well-known the antagonism Ca-Zn in *Triticum turgidum* plants. For the case of Zn administration under $ZnCl_2$ form we clearly remarqued the direct dependence between Zn and Ca (fig. 2).

The treatment with zinc at maize didn't bring important fluctuations for Na content. However, tow exceptions appeared in the lots A1 and B5.

Table 1. Mineral content of maize plant consecutive zinc treatment (ppm).

	M	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5
Ca	199,05 ±15,75	295,48 ±22,14	153,53 ±12,81	120,68 ±13,72	122,53 ±10,68	104,93 ±9,02	37,35 ±6,59	50,33 ±8,21	90,93 ±5,64	101,99 ±8,15	109,16 ±6,11
Fe	17,03 ±2,53	17,40 ±2,36	13,78 ±1,87	13,06 ±2,06	11,60 ±2,58	9,08 ±2,41	19,46 ±2,85	15,31 ±1,94	11,18 ±2,33	9,158 ±1,52	8,53 ±1,67
K	225,00 ±12,11	741,14 ±84,52	453,04 ±58,16	519,11 ±53,87	637,60 ±27,3	344,09 ±18,54	50,18 ±4,25	47,53 ±2,68	51,76 ±1,57	92,64 ±11,46	181,39 ±5,18
Mg	110,31 ±8,74	82,22 ±3,21	66,64 ±1,43	56,68 ±4,03	66,68 ±3,72	54,02 ±2,16	50,81 ±2,33	55,81 ±1,64	37,52 ±0,83	60,68 ±2,49	37,08 ±1,12
Na	183,08 ±10,86	464,54 ±19,41	177,56 ±13,34	215,90 ±11,81	182,68 ±8,19	169,53 ±12,63	93,39 ±13,2	101,62 ±5,61	123,21 ±10,08	179,50 ±9,33	564,53 ±15,89
Ni	0,20 ±0,03	3,67 ±0,56	1,45 ±0,02	0,89 ±0,14	0,65 ±0,12	0,75 ±0,11	0,69 ±0,08	0,54 ±0,13	0,93 ±0,16	0,44 ±0,03	0,42 ±0,02
Pb	0,40 ±0,13	1,44 ±0,12	2,95 ±0,06	3,40 ±0,01	1,23 ±0,15	2,80 ±0,13	0,21 ±0,04	0,19 ±0,02	0,17 ±0,03	0,15 ±0,01	0,13 ±0,01
Zn	7,09 ±1,3	6,58 ±0,53	5,88 ±2,06	8,97 ±1,25	11,90 ±2,46	23,75 ±4,13	7,89 ±1,86	7,96 ±2,33	13,77 ±2,54	14,02 ±3,06	14,39 ±1,57

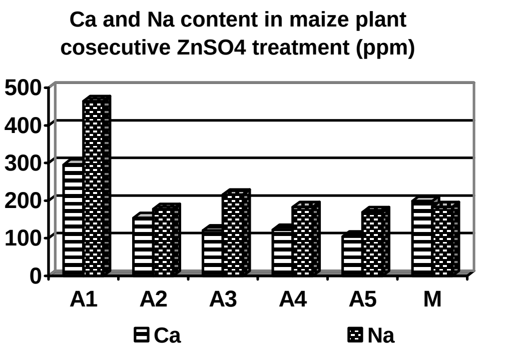

Fig. 1 - Ca and Na content in maize plant cosecutive $ZnSO_4$ treatment (ppm)

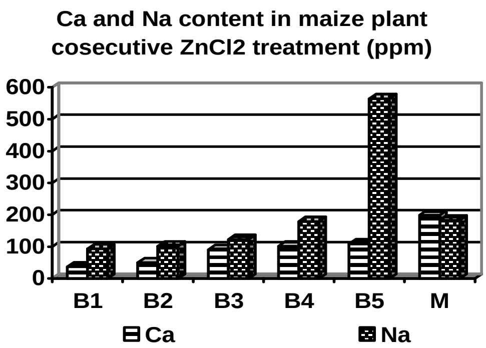

Fig. 2 - Ca and Na content in maize plant cosecutive $ZnCl_2$ treatment (ppm)

Zinc solutions administrated to the maize determined the following variations: on the treatment with $ZnSO_4$ we found increases of the K concentration over the control samples in every situation. And yet the values for K couldn't be correlated with the zinc doses administrated (fig. 3). For the situation of Zn administration as $ZnCl_2$ (Figure 4) we have found a reverse variation comparing with the previous case, K found being under the value of K determined at M lot. K content presented a direct correlation with the Zn administrated, this fact being signaled in the literature by Market (1997) quoted by Paivoke (2003) for the plants of Pisum Sativum. Thus, $ZnSO_4$ stimulates K asimilation in the maize plants, since $ZnCl_2$ slows down the process of K asimilation.

The Zn treatment determined the reducing of the Mg concentration in all experimental lots under the values from control samples. This fact was in concordance with the info from the specialised literature which indicates the reducing of clorophyl by treating plants of *Pisum Sativum* with Zn [1]. Higher values for the Mg were observed to the plants treated with Zn as $ZnSO_4$ (fig. 3), comparing with those treated with $ZnCl_2$ (fig. 4).

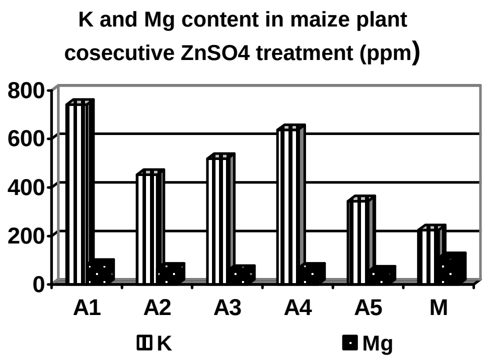

Fig. 3 - K and Mg content in maize plant cosecutive $ZnSO_4$ treatment (ppm)

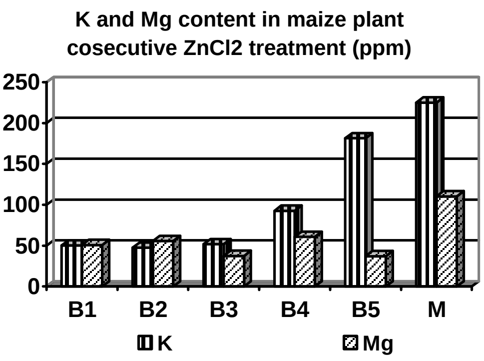

Fig. 4 - K and Mg content in maize plant cosecutive $ZnCl_2$ treatment (ppm)

The iron contained in the maize plants treated with zinc was in indirect correlation in both cases: Zn as $ZnSO_4$ or Zn as $ZnCl_2$ (fig. 5 and 6). After the administration of zinc compounds, as it was expected, the zinc content in the plants was increased comparing with the lot M for both zinc compounds mentioned above. The zinc content in the plants receiving $ZnSO_4$ grew progresively with the increasing of the administrated dose. The best was asimilated the zinc as $ZnSO_4$.

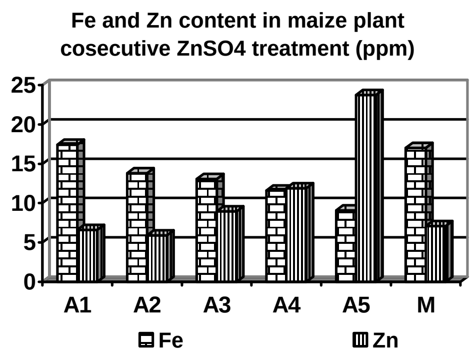

Fig. 5 - Fe and Zn content in maize plant cosecutive $ZnSO_4$ treatment (ppm)

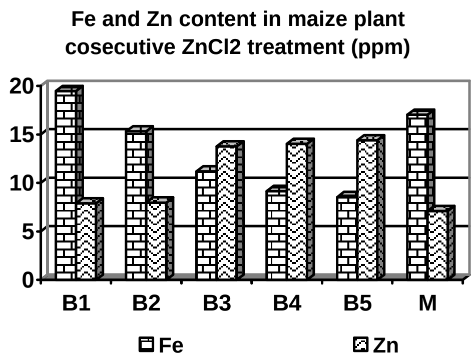

Fig. 6 - Fe and Zn content in maize plant cosecutive $ZnCl_2$ treatment (ppm)

The administration of Zn determined an increasing of Ni level in plants comparing with the value found to the lot M. At the treatment with $ZnSO_4$ (fig. 7) was observed a negative correlation between Zn and Ni in plants. Nevertheless, the Ni quantity present in the plants from the lot A was bigger than the Ni quantity in the lot B - plants treated with $ZnCl_2$ (fig. 8).

The Zn – as antagonist of Pb - acted the same way in this experiment. The Pb content decreased by giving increasing Zn doses to the plants in both forms: $ZnSO_4$ (fig. 7) and $ZnCl_2$ (fig. 8). A higher eficiency in reducing the Pb accumulation in the maize plants had the Zn as $ZnCl_2$.

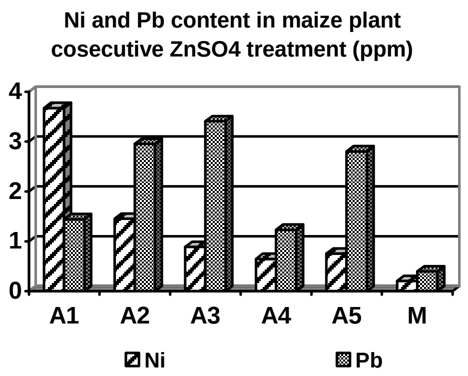

Fig. 7 - Ni and Pb content in maize plant cosecutive $ZnSO_4$ treatment (ppm)

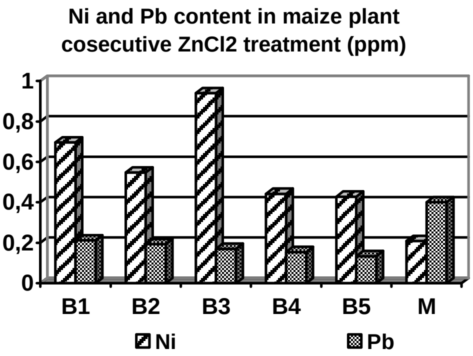

Fig. 8 - Ni and Pb content in maize plant cosecutive $ZnCl_2$ treatment (ppm)

We attempted also the determination of Cd, Co, Cr, Cu and Mn from these maize plants, but all these minerals were situated under the detection limit of the device.

The main relations established between the determined minerals after the administration of Zn in these two combinations - $ZnSO_4$ and $ZnCl_2$ – are presented in the figures 9, 10, 11 and 12.

The relations between the elements in the maize plants treated with $ZnSO_4$ are presented in the figures 9 and 10. We observed a positive correlation between the content of K and the content of Na, Ca, Fe, Mg and Ni and a reverse correlation between Zn and Pb.

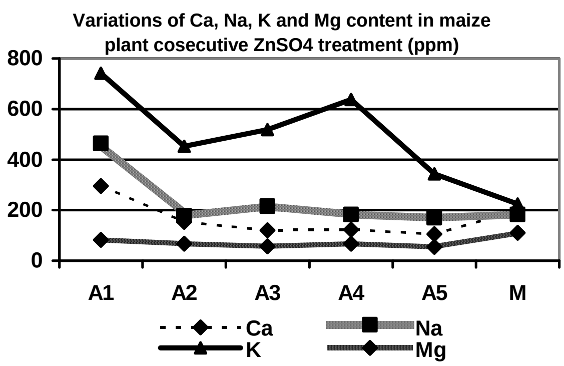

Fig. 9 - Variations of Ca, Na, K and Mg content in maize plant cosecutive $ZnSO_4$ treatment (ppm)

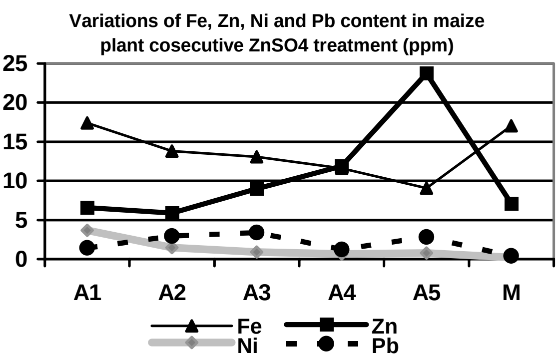

Fig. 10 - Variations of Fe, Zn, Ni and Pb content in maize plant cosecutive $ZnSO_4$ treatment (ppm)

After adding the Zn as $ZnCl_2$ – you can find the variations of the analized metals in the Figures 11 and 12. In this case the elements Na and K had also the same variation, but the carriage was different comparing with the case presented before. A reverse correlation was established between the variations of Ca and Fe, while Ca, K and Na were in direct correlation. In reverse correlation was Pb with Fe and Ca, while Zn was directly correlated with Na, K and Ca.

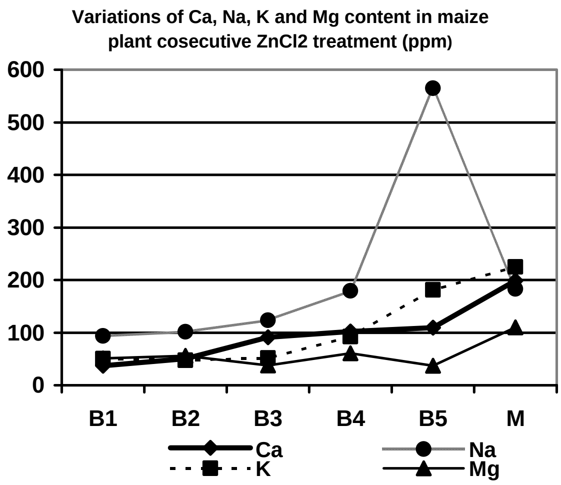

Fig. 11 - Variations of Ca, Na, K and Mg content in maize plant cosecutive $ZnCl_2$ treatment (ppm)

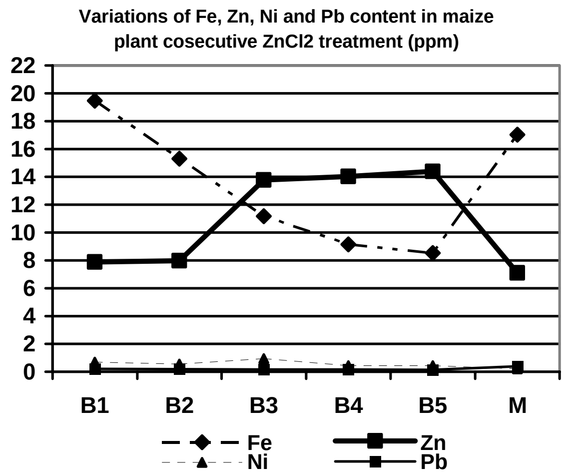

Fig. 12 - Variations of Fe, Zn, Ni and Pb content in maize plant cosecutive $ZnCl_2$ treatment (ppm)

The length of the maize plants after zinc administration are presented in figure 13.

From fig. 13 it shown that maize plants which treated with $ZnSO_4$ were development very good at medium doses (A3 and A4 group – 500 respectively 1250 ppm Zn in soil). The A1 and A2 group plants had smaller length, maybe these doses of zinc are favourized accumulation of other minerals as Ni and Pb, thus the development of these plant are inhibated. The bad development of these plants is explained by high content of these havy metals. Except group A4 plants, all plants are smaller than control group (M).

After treating of the plants with $ZnCl_2$, the plants length were higher than control group, except B4 group. In these cases.

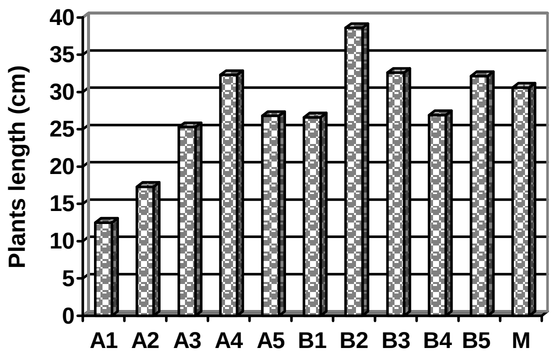

Fig. 13 – Plants length at different zinc doses treatment

4. Conclusions

The main conclusions after this study were:

- Concentration variations of some minerals from maize plants are according with zinc chemical form; the zinc administration by $ZnCl_2$ was directly correlated with calcium content, while calcium variation was reverse ratio by $ZnSO_4$;
- Zinc levels accumulated in maize plants were in reverse raport with administration

doses, remarking again variations dependent to the zinc forms of administration;

- Zinc is necessary to the plants development, but is very important chemical forms of zinc treating;

The interrelations between the minerals, vitamins etc. are very important for development of plants. The presence of zinc can have a positive direct influence in the physiology of plants and may also play a protection role, through antagonist mechanisms like the competition with other minerals (e.g. lead, which is reduced by zinc).

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