EFFECTS INDUCED FOLLOWING THE TREATMENTS WITH COPPER, MANGANESE AND ZINC ON CORN SEEDS GERMINATION (CARRERA, TURDA 200 AND HD-160)

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Abstract. Due to the human activities (mining, industrial activity, waste disposal, agricultural practice), pollution by copper, manganese and zinc is a major problem. To establish the effects induced by copper, manganese and zinc treatments on germination in corn, we used solution with different concentration for 24 hours. We treated corn seeds with the following solutions: $CuSO_4$ 3 ppm, 30 ppm, 300 ppm, $ZnSO_4$ 3 ppm, 30 ppm, 300 ppm, $MnSO_4$ 3 ppm, 30 ppm and 300 ppm. Control groups were imbued in distillated water. We determined the energy and capacity of germination. Our results showed that copper solutions significantly inhibit germination compared to the untreated control. The toxicity of copper is higher if concentration increases. Zinc solutions also inhibit germination, however their effect highly depend on concentration. The effect of manganese was not so harmful comparatively with control group.

Keywords: copper, manganese, zinc, seeds germination, corn

INTRODUCTION

A commune characterization of copper, manganese and zinc consists in the fact that, even these microelements are absolutely necessary for a good vegetal organism function, in excess they become phytotoxic.

If in the past the science human attention was orientated to study the importance in plant life of these microelements, and especially on the aspects concerning their deficit in plants, in the last years was accorded an increased attention for their toxicity, as result of their concentration in the environmental medium for different causes as: agriculture (fertilizers, natural manures, pesticides, irrigation water), city, industrial sources liberating heavy metals in atmosphere (incineration of domestic rests, engines with internal combustion, metal industry) etc..

This change of research orientation is due to inclusion of respective microelements in the group of phytotoxic heavy metals.

Having in view the relative small number of studies concerning the effect of these microelements in plant growing, and especially in corn, we considered timely the approach of such a study. The suitability of this study results also from the fact that these heavy metals are accumulated in the trophic chain, becoming risky for animal and human health, less sensitive to heavy metal toxicity than plants, but capable to concentrate heavy metals to tissue and organ level.

MATERIALS AND METHODS

The effects of copper, manganese and zinc microelements on the germination of maize seeds were investigated using three concentrations for each microelements. Maize seeds were treated with copper, managanese and zinc solutions in the following concentrations: 3 ppm, 30 ppm and 300 ppm, for 24 hours. Control groups were treated with distillated water. After the treatments application, the capacity of germination was determinated in percentages. All treatments were made in three replications.

Maize (*Zea mays* L. c.v. Turda 200, Carrera and HD-160) was selected for the study, because it has a large biomass and it is among the most important crop used for human and animal consumption in Romania.

We used ANOVA and "t student" test for statistically interpretation.

RESULTS

The experiment concerning the corn seed germination, in Carrera, Turda 200 and HD-160 varieties, puts into evidence the fact that Carrera variety seeds present germinative capacity superior to Turda 200 and HD-160 varieties. The results presented in Figures 1, 2 and 3 confirm this phenomenon obvious in control variants. Thus, it can be taken as conclusion that germinative capacity, in the three studied varieties, increases depending on variety, in this order: HD-160 variety < Turda 200 variety < Carrera variety.

The studied microelements present different degree of toxicity. Copper and zinc have an increased toxicity degree than manganese. The $CuSO_4$ and $ZnSO_4$ solutions, unlike $MnSO_4$ solutions, determine the decreasing of germinated seed percent also in case of average concentration (30 ppm), not only of maximal one (300 ppm). As the microelement solution concentration applied on seeds is greater, there is a more significant decreasing of germinated seed percent given to the control variant.

Thus, the maximal concentrations of $CuSO_4$, $MnSO_4$ and $ZnSO_4$ solutions, and also the average concentrations of $CuSO_4$ and $ZnSO_4$ solutions had an inhibitory effect on germinative capacity in all studied varieties. The most intense inhibitory effect was observed in case of $CuSO_4$ solutions.

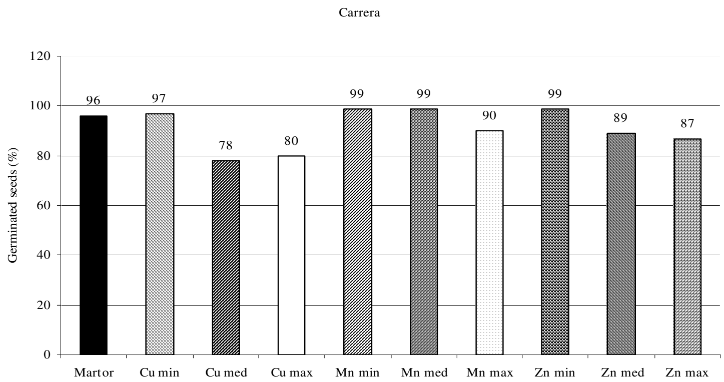

Figure 1. The influence of copper, manganese and zinc, in different concentrations, on maize seeds gemination, variety Carrera. The heavy metals used were applied on seeds before germination, for 24 hours. The control groups were treated with distillated water. Germination was exprimated in percentage of germinated seeds.

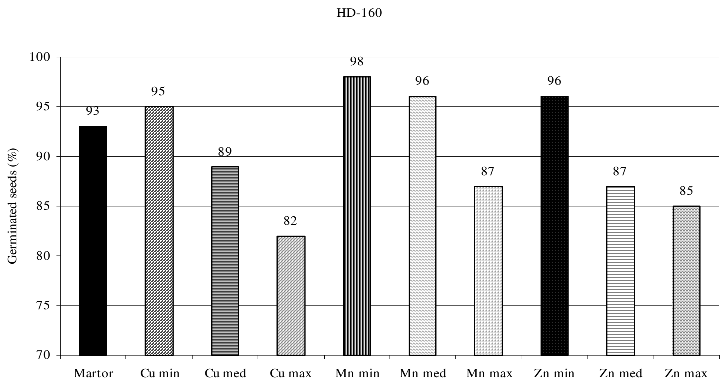

Figure 2. The influence of copper, manganese and zinc, in different concentrations, on maize seeds gemination, variety HD-160. The heavy metals used were applied on seeds before germination, for 24 hours. The control groups were treated with distillated water. Germination was exprimated in percentage of germinated seeds.

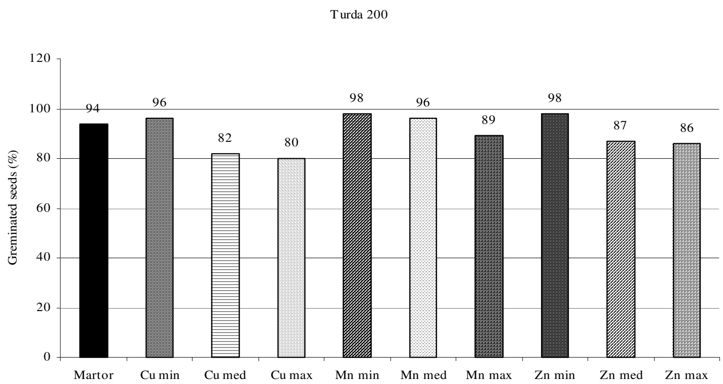

Figure 3. The influence of copper, manganese and zinc, in different concentrations, on maize seeds gemination, variety Turda 200. The heavy metals used were applied on seeds before germination, for 24 hours. The control groups were treated with distillated water. Germination was exprimated in percentage of germinated seeds.

DISCUSSIONS

The obtained results following the effect study of copper, manganese and zinc on germinative capacity of some corn varieties are in accordance with the data from specialty literature.

A lot of studies showed that the inhibitory effect of heavy metals on seeds germination is in in corelation with the species, the nature of heavy metal and with the concentration of heavy metals. Generally, the effects on seeds germination are less pronounced comparatively with the influences on other physiological and metabolical processes [5, 6, 7, 10, 11, 12].

Pandya et al (2004) [13] observed a decrease of seeds germination of cultivated plants, as result of heavy metals presence in rain water.

Slaton et al. (2001) [16] observed the stimulation of seeds germination of *Oryza sativa*, after the treatment of the seeds with small concentrations of zinc. The stimulative effect was in dependence with the concentration of soil in zinc and with pH of the soil.

Geiger et al (1993) [5] observed that copper and zinc, in some concentrations, did not inhibate the germination of seeds from *Lepidum sativum* and *Lactuca sativa*. The heavy metals did not decreased the seeds germination but the plantlets were very small and thin, and the aerian organs presented chlorosis.

Ouzounidou (1995) [11] observed a strong inhibition of seeds germination of *Minuartia hirsuta, Silene compacta* and *Alyssum montanum,* following the treatments with copper (80 and 160µM).

Ayaz and Kadiodlu (1996) [1] observed that the seeds of *Lens esculenta*, treated with 10-100mg/l Cu, Cd, Hg and 50-200 mg/l Zn, presented a semnificative decreased of germination. The authors observed the presence of some new peroxidases which did not exist in control lots.

The inhibitory effect of heavy metals on seeds germination could be the result of heavy metals toxicity or it could be the result of osmotic effect produced by the heavy metals [2, 3, 14, 15, 17, 18]. The small rate of germination it is possible to be the result of the reduced water availability [4, 8, 9].

Our research results concerning the influence of some microelements (copper, manganese and zinc) on germination process in different corn varieties prove that the tested microelements affect the followed parameter. In general, their effect was directly proportional with the concentration used for seeds treatment.

Per general, it can be affirmed that the plants of experimental variants treated with $CuSO_4$ solutions were more intense negatively affected than the plants of variants treated with $ZnSO_4$ and $MnSO_4$ solutions. As concerns the three experimental corn varieties, among them were not be observed significant differences, although Turda 200 variety was in general more sensitive comparatively to the other two varieties, HD-160 and Carrera.

The results of researches lead to subsequent general conclusions:

There are differences concerning the germination capacity depending on variety with which we work. These differences are smaller in control variants and increase depending on applied microelement treatment.

The treatments with minimal concentration (3 ppm) of $CuSO_4$, $MnSO_4$ and $ZnSO_4$ solutions stimulate the germinative capacity, both in Turda 200 variety and also in HD-160 and Carrera varieties.

The average (30 ppm) and maximal (300 ppm) concentration of $CuSO_4$ and $ZnSO_4$ solution inhibit the germinative capacity in the three varieties, while the $MnSO_4$ solution in average concentration (30 ppm) stimulates easy the germinative capacity and produces inhibition only in maximal concentration (300 ppm).

Copper and zinc have a bigger toxicity degree than manganese.

Between germinative capacity of corn seeds and concentrations of $CuSO_4$, $MnSO_4$ and $ZnSO_4$ solutions, with which were treated the seeds before germination, it was established a negative correlation.

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