THE INFLUENCE OF ZINC ON SEED GERMINATION AND SEEDLINGS GROWTH OF DIANTHUS CHINENSIS L.

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Abstract: The paper presents the results of a study regarding the influence of treatment with zinc on seed germination and seedlings growth of Dianthus chinensis L. Zinc used were as sulphate solutions in a concentration of 50 mg/l; 100 mg/l; 200 mg/l; 400 mg/l; 600 mg/l and 800mg/l. We analyzed the following indicators: the percentage of germinated seeds in different intervals (24 – 168 hours); the length of root and hypocotyl (at 168 hours). The results underline the specific variations of the analysed indicators, depending on the concentrations used for the seed treatments. The treatments with zinc sulfate delay the growth of the root (with concentration of 100 mg/l; 200 mg/l; 400 mg/l; 600 mg/l and 800mg/l) and hypocotyl (all the concentration used). The delay effect on the hypocotyl and root length growth is very pronounced in the case of variant treated with high concentrations.

Keywords: Dianthus chinensis L., germination, growth of seedlings, zinc.

Introduction

Zinc is an essential microelement for the life of plants. It is a component of some enzymes (carboanhydrase, alcohol dehydrogenase, alkaline phosphatase, hexokinase); it stimulates the activity of certain enzymes (peroxidase, catalase, enolase, etc.) (Sandmann and Böger 1983; Burzo et al. 1999; Davideascu et al. 1988). Zinc is implicated in tryptophan synthesis – a precursor of auxin (Burzo et al. 1999; Davideascu et al. 1988); in proteins and acid nucleic synthesis (Caramete et al. 1974; Davideascu et al. 1988; Jackson et al. 1990; Marschener 2012 and Hänsch and Mendel 2009 quoted by Tsonev and Lidon 2012); in amidon synthesis (Davideascu et al. 1988), in reducing nitrates (Caramete et al. 1974; Davideascu et al. 1988); in glucids and lipids metabolism (Burzo et al. 1999; Marschener 2012 quoted by Tsonev and Lidon 2012); it plays a role in the maintenance of the integrity and stability of cellular structures (Davideascu et al. 1988; Tsonev and Lidon 2012).

According to Aydinalp and Marinova (2009), the zinc (as sulphate of zinc) in concentration of 5 ppm, 10 ppm, 20 ppm, 40 ppm) have positive effects on the growth of the seedlings in alfalfa.

Sharma et al. (2010) noticed the fact that the zinc (as sulphate of zinc) in concentration of 25mM increased seed germination, the growth in length of the root and of the hypocotyl, the chlorophyll content and the fresh weight of Cicer arietinum var. pusa-256.

Although Zn is a microelement with important functions in the life of plants, it can be toxic in high concentrations. Zn toxicity varies depending on many factors: species, age, metal concentration in medium, exposure time, presences of other heavy metals / combination with other heavy metals, etc. It is absorbed as $\text{Zn}^{2+}$.

In plants, the normal content of zinc is 10 - 150 ppm, at 400 ppm it becomes toxic. (Mulligan et al. 2001). The zinc distribution in plants varies according to the species, the
age of the plant, organ and external factors. The concentration of zinc in the young tissues is bigger than in the mature tissues (Caramete et al., 1974).

The presence in excess of the zinc delays the growth of plants (Caramete et al., 1974) and determines the appearance of chloroses (Caramete et al., 1974; Rout and Das, 2003); it decreases the rate of photosynthesis and the activity of some enzymes involved in the process of photosynthesis, it affects the metabolism of the nitrogen (Ali et al. 2000, the authors quoted by Sharma et al., 2010). According to Van Assche and Clijters (1986) quoted by Jackson et al. (1990), zinc in high concentration inhibits the photosynthesys.

Nag et al. (1984), quoted by Nag et al. (1989), reported in the case of the rice seedlings exposed to some toxic concentrations of zinc, the following aspects: the significant slowing down of the seedlings growth; the increase in the activity of ascorbic acid oxidase and IAA oxidase; the inhibition of the activity of some hydrolases.

This paper has as a purpose to investigate the effect of the treatment with zinc on seed germination and seedlings growth of Dianthus chinensis (Carniphylaceae family). Dianthus chinensis is a decorative species of small size, annual, cultivated in the urban green areas and in gardens from rural areas.

In the species Dianthus chinensis there were some studies regarding the potential of phytoremediation of some polluting soils with heavy metals. Cheen and Lee (1997) quoted by Lai and Chen (2005) noticed the fact that this species grown on polluted soils with cadmium in the north-east of Taiwan can accumulate high concentrations of cadmium. Lai and Chen (2004, 2005, 2006, 2009) and Lai et al. (2009) did research regarding the potential of phytoextraction of some heavy metals (lead, cadmium and zinc) in polluting soils in Taiwan (Lai and Chen 2005; Lai et al. 2009).

Materials and methods

As a biological material, we used seeds of Dianthus chinensis obtained from seed retailers (S. C. Unisem S. A). Seven experimental variants have been created: a control variant (with distilled water) (the variant marked C) and six variants of zinc treatments.

Zinc used were as sulphate solutions in a concentration of 50 mg∕l (the variant marked V1); 100 mg∕l (the variant marked V2); 200 mg∕l (the variant marked V3); 400 mg∕l (the variant marked V4); 600 mg∕l (the variant marked V5) and 800mg∕l (the variant marked V6).

In selecting the concentrations used for the experiment we started from the critical concentration of zinc in soil (400 mg∕l) (according to Alloway, 1990; Beckett and Davis 1979, quoted by www.cprm.gov.br/).

The seeds were placed to germinate in Petri dishes, on a filter paper humidified with distilled water (a control variant) and sulphate of zinc solutions (a treatment variants), in laboratory conditions (with the temperature varying between 24-26°C and a photoperiod according to the time of the experiment – June, 2013). The initial volume of distilled water or sulphate of zinc solutions (at placing the seeds) was of 4 ml. During the experiment, germination substrate was wetted with distilled water (control variant) and sulphate of zinc solutions (treatment variants).

For each variant, three replicas (each with 50 seeds) were used.

The following indicators have been analyzed: the percentage of germinated seeds in different intervals (24 - 168 hours); the length of the root and hypocotyl (at 168 hours after
the beginning of the experiment). The measurements (the length of the root and hypocotyl) were performed at 25 seedlings for each experimental variant.

All the results presented in figures were expressed as mean value ± standard deviation.

The data obtained from the length of the root and of hypocotyl were interpreted statistically. It was used the unifactorial Anova test and in order to test the difference between averages the Tukey test was used (Zamfirescu and Zamfirescu, 2008; Microsoft Excel program).

**Results and discussions**

*The germination of seeds.* At *Dianthus chinensis* germination is epigenous. 24 hours after assembling the experiment, there were noticed germinated seeds only in the treatment variants where there were used concentrations of 50 mg/l; 100 mg/l; 200 mg/l. 48 hours after assembling the experiment, the percentage of germination has average values between 71.10 – 97.77 % in case of the treatment with zinc. In the control, it was recorded an average value of 83.32 % (Figs. 1; 2).

During the analysed period, the percentage of the germinated seeds grows progressively, at the end of the experiment it has values between 96.66 % and 100 % in the treatment variants. In the control, the percentage of the germinated seeds presented an average value (98.88%) close to the maximum value recorded (Figs. 1; 2).

Zinc in form of sulphate, in concentration of 50 mg/l; /100 mg/l and 200 mg/l presents a tendency to stimulate the germination, obvious 24 hours after assembling the experiment and that is maintained during the whole period analysed (the case of the concentrations 50 mg/l; /100 mg/l), respectively up to 120 hours after assembling the experiment (the case of the concentration 200 mg/l). The results obtained could be explained by taking into account the important role of the zinc in the process of growth of the plants by the control on the tryptophan synthesis (Amberger, 1974 quoted by Davidescu et al., 1988).

168 hours after the assembling of the experiment, the *length of the root* and of the *hypocotyl* in the control presented average values (12.36 mm - length of the root; 7.08mm-length of the hypocotyl) bigger than in the treatment variants (2.28 – 11.56mm - the length of the root; 2.48 – 4.88 mm - the length of the hypocotyl), with only one exception (12.92 mm – V1 variant, the case of the root). The treatments with zinc sulphate delay the growth in length of the root (the concentrations of 100 mg/l; 200 mg/l; 400 mg/l; 600 mg/l; 800mg/l.) and of the hypocotyls axis (of all the concentration) (Figs. 3; 4).

The effect of delaying the growth in length of the root and of the hypocotyls axis is more pronounced in the case of the treatment variants with high concentrations.

According to Van Assche F. (1973) quoted by Rout and Das (2003), zinc in high concentrations inhibits the metabolic activity. The authors quoted by Rout and Das (2003), noticed the fact that the zinc toxicity is associated with alteration of root physiology (Woolhouse, 1983) and growth inhibition of root (Backer, 1978; Bradshaw and McNeill, 1981).

The statistics of Anova unifactorial test (F calculated: 94.81 - length of the root; 38.04 - length of the hypocotyl) was higher than the critical value (2.15 for length of the root and the hypocotyl); p<0.001. This fact indicates that the zinc concentration have a
significant influence (unfavourably) on the growth in length of the root and of the hypocotyl.

The results of the Tukey Test indicate the fact that: the control differs significantly from the variants V3, V4, V5 and V6 – for the length of the root; the control differs significantly of all the variants of treatment with zinc - for the length of the hypocotyl.


The research done by Nag et al. (1989) underline in the case of high concentrations of zinc sulphate (40mM) an inhibiting effect on the growth of the root and hypocotyls of the seedlings in the species *Vigna radiata*; the zinc sulphate in concentration of 10mM, 20
mM and 40 mM decreases the intensity of the respiration and the content of total nitrogen in the seedlings in the species mentioned.

Also, Nag et al. (1989) underline an intensification of the activity of the peroxidase in the seedlings with reduced growth (after the treatment) and associate these affects to a low level of endogenous auxin.

Sharma et al. (2010), noticed a reduction of the length of the root and hypocotyls of the seedlings of Cicer arietinum var. pusa-256, 15 days after the treatment, in the case of the concentrations of zinc of 75 mM and 100 mM.

Stratu et al. (2013) noticed the fact that the treatment with zinc (zinc sulphate) in a concentration of 400 mg/l, 600mg/l and 800mg/l delays the seed germination and the growth of the root and of the hypocotyl of Ageratum houstonianum (96 hours after the beginning of
the experiment); the effect is very pronounced in the case of high concentrations (600mg/l and 800mg/l).

Conclusions

The concentrations used in the treatment of the seeds do not present an unfavourable influence on the germination of the seeds, but delay the growth in length of the root and hypocotyl.

The delay effect of growth in length of the root and hypocotyls, it is more pronounced in the case of high concentrations.

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