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# COPPER RESISTANCE OF LAWN GRASS AND CHRYSANTHEMUM CARINATUM PLANTS

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ABSTRACT

Condition and quality of the lawn grass and flowering plants is important indicators of the level of landscaping and the urban environment. Copper ions significantly reduce the quality of ornamental plants. The aim of this study was to assess phytotoxicity of copper for *Chrysanthemum carinatum, Festuca rubra* and *Agrostis stolonifera*.

High contamination of copper significantly limits the spread of *Chrysanthemum carinatum* and lawn grass. *Chrysanthemum carinatum* was less resistant than lawn grass to copper. *Chrysanthemum carinatum* can grow only with a low level of soil contamination with copper.

Key words: *Agrostis stolonifera, Chrysanthemum carinatum, copper, grasses, ornamental plants, urban ecosystem.*

## INTRODUCTION

Plants help to reduce the level of pollution and the effect of adverse environmental factors on urban ecosystems. Condition and quality of the lawn grass and flowering plants are important indicators of the level of landscaping and the urban environment. *Agrostis stolonifera* and *Festuca rubra* forms the highest quality lawn. *Chrysanthemum carinatum* used for decoration of the flower beds. *Chrysanthemum carinatum* , *Festuca rubra* and *Agrostis stolonifera* are very sensitive to pollution of urban soil.

Heavy metals are priority pollutants soil of cities [1,2,3,4,5,6,7,8,9,10,11]. Copper among heavy metals is one of the main pollutants of urban soil. Among the most dangerous pollutants for plants are ions copper [12,13,14]. Copper has an adverse effect on plants [15]. Cu-stress caused a small decrease in the efficiency of photosystem 2 photochemistry, but its primary effect was on growth [16]. Copper ions reduce the quality of ornamental plants [17]. The aim of this study was to assess phytotoxicity of copper for *Chrysanthemum carinatum* and lawn grass.

## MATERIALS AND METHODS

The object of our study were *Agrostis stolonifera* L. and *Chrysanthemum carinatum* Schousb.
Also the object of our study was to lawn grass - *Festuca rubra L.*

*Agrostis stolonifera* L. is a perennial grass in the Poaceae family. This grass has an advantage over many other lawn grasses because it is capable of vegetative reproduction and permits to create lawn for different purposes only from it, Figure 1.

*Festuca rubra* is perennial bunchgrass. It thrives under a wide range of conditions and has resistant to dry poor soil, frost and drought, Figure 2.

Figure 1. Agrostis stolonifera

Figure 2. Festuca rubra

*Chrysanthemum carinatum* Schousb. is annual plant in the Asteraceae family. This plant is widely used in urban landscaping, in prefabricated and single plantings, Figure 3.

Figure 3. Chrysanthemum carinatum

Evaluation of phytotoxicity of copper on Petri dishes.

The seeds of *Chrysanthemum carinatum* Schousb. (variety Radost, variety Eldorado) were germinated on Petri dishes with filter paper with $CuSO_4$ x $5H_2O$ in concentrations 20, 30, 50, 100 mg/l (data are presented in terms of pure metal).

The seeds of *Agrostis stolonifera* L. and *Festuca rubra* L. were germinated on Petri dishes with filter paper with $CuSO_4$ x $5H_2O$ in concentrations 30-150 mg/l (data are presented in terms of pure metal). Measurements of the height of seedlings and the length of the roots were carried out with for 14 days. Each variant of the experiment was carried out in 5 times. Water was taken as a control medium.

Evaluation of phytotoxicity of copper in soil.

The seeds of *Agrostis stolonifera* and *Chrysanthemum carinatum* were germinated in pots with $CuSO_4$ x $5H_2O$ with concentrations of 10, 20, 30, 50, 100 mg/kg. Plants were grown in vessels in a greenhouse with natural light at a temperature of 20-25 °C.

RESULTS AND DISCUSSION

Experiments in aqueous solutions showed phytotoxicity of copper at relatively low concentrations for plants of *Agrostis stolonifera* 30 mg/l of copper retarded of growth, but the level of inhibition was not significant and does not exceed 25%. When the concentration of copper was 50 mg/l more significant growth inhibition was detected, Figure 4. In soil conditions, the inhibitory effect was similar. Growth inhibition at 50 mg/kg was more than 30%.

Significant inhibition of plant growth *Festuca rubra* was observed at 50 mg / l of copper in aqueous solutions. Growth inhibition at 30 mg / l copper was about 25%. Copper toxicity in aqueous solutions was comparable for both species of lawn grass, Figure 4, 5.

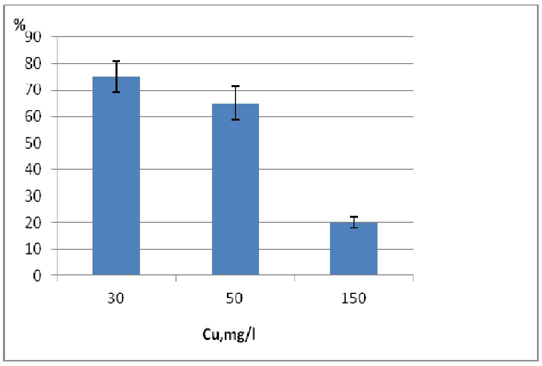


Figure 4. The influence of copper on the height of seedlings of Agrostis stolonifera

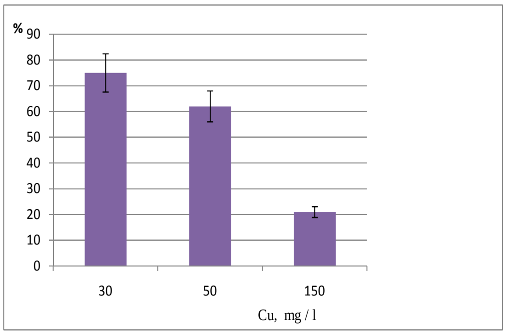


Figure 5. The influence of copper on the height of seedlings of Festuca rubra

Thus, lawn grass showed a relatively low degree of resistance to copper.

The presence of copper ions in the environment had a negative impact on the growth of shoots and root formation of *Chrysanthemum carinatum,* Figure 6.

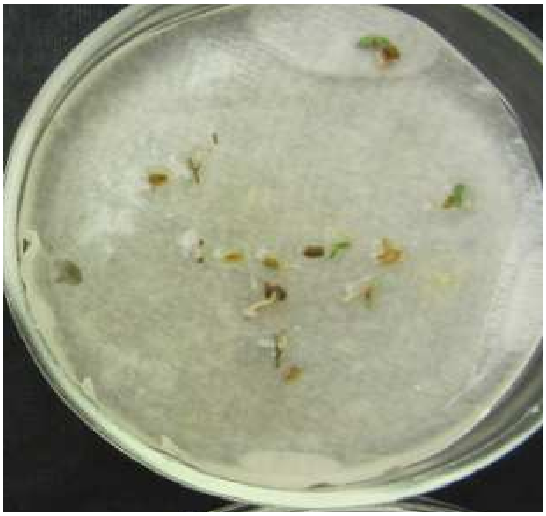

Figure 6. Chrysanthemum carinatum (cv. Eldorado) on Petri dishes $CuSO_4 \times 5H_2O$

On Petri dishes slight inhibition of shoot growth was observed already at a concentration of 30 mg/l Cu Figure 7. At this concentration, the height of the seedlings was less than 80% Figure 7. Inhibition of growth of *Chrysanthemum carinatum* was observed at 30 mg/kg in soil. The average copper content in Moscow is about 30 mg/kg. In some areas, the copper content in the soil reaches 132 mg/kg and more [5].

Two varieties of *Chrysanthemum carinatum* demonstrated different resistance to copper variety Eldorado was more resistant to copper than variety Radost (Figure 7, 8). At high concentrations of copper (50 and 100 mg/l), growth inhibition of the variety Eldorado was less than Radost. However, both varieties showed a low degree of resistance to copper.

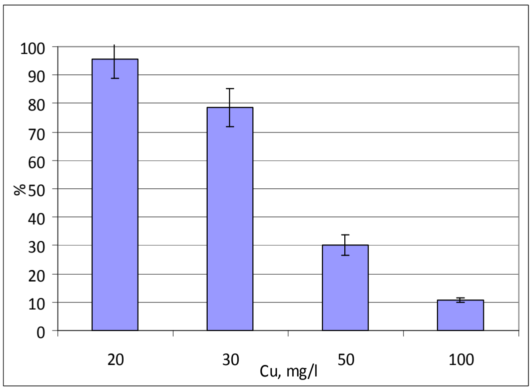


Figure 7. The influence of copper on the height of seedlings of Chrysanthemum carinatum (cv. Radost) on Petri dishes (% relative to the control)

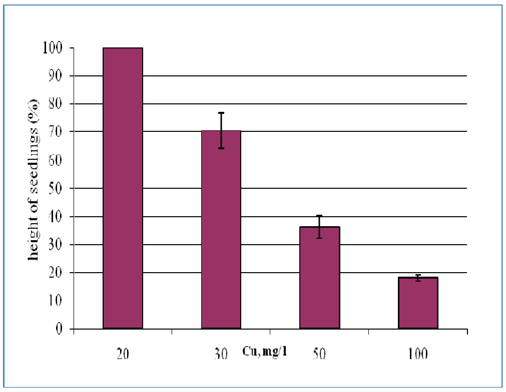


Figure 8. The influence of copper on the height of seedlings of Chrysanthemum carinatum (cv. Eldorado) on Petri dishes (% relative to the control)

Thus, the copper limits the use of many ornamental plants.

## CONCLUSION

The high copper content in the environment significantly limits the distribution of *Agrostis stolonifera*, *Festuca rubra* and *Chrysanthemum carinatum*.

High toxicity of copper is consistent with the literature data, copper is one of the most toxic metals for plants [12]. The different resistance of species and varieties of ornamental plants to copper is shown. Significant differences were observed between species, in terms of tolerance. It also correlates with literature data. Results indicated that tomato is more tolerant than lettuce to Cu-contaminated soils [18]. Different degrees of resistance of chrysanthemum varieties to copper correlate with literature data for other plants. For example, different resistance to metals in strawberry varieties is shown [19].

*Chrysanthemum carinatum* was less resistant than *Agrostis stolonifera* and *Festuca rubra* to copper. *Chrysanthemum carinatum* can grow only with a low level of soil contamination with copper.

*Agrostis stolonifera* and *Festuca rubra* can grow with an average level of soil contamination with copper.

One approach to solve this problem is to create plants resistant to adverse environmental factors using environmental biotechnology (for some ornamental cultures, technologies of introduction into cell culture have been developed [20], for further use of cell selection) [21,22,23,24,25,26]. Plants with greater resistance to copper were obtained [23,25,26].

On the other hand, it is important to evaluate the varieties and species of plants used in urban greening according to the degree of resistance to copper.

According to the degree of resistance to copper, it is possible to form an assortment of plant species and varieties, depending on the degree of contamination. This will be of great ecological importance, since copper has a very high toxicity for plants.

COMMENT

Part of the work was done at Moscow State University of Mechanical Engineering (earlier - Moscow State University of Environmental Engineering, Department of Ecological and Industrial Biotechnology), which is currently reorganized.

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