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DEICING REAGENTS IN URBAN ECOSYSTEMS, USING THE EXAMPLE OF MOSCOW

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ABSTRACT

Deicing reagents have an impact on the environment. The composition of the deicing reagents used in Moscow has undergone certain changes. However, the main components of deicing reagents were chlorides, including calcium chloride and (or) sodium chloride. We also conducted research on the effects of sodium chloride and calcium chloride on some urban decorative plants. Soil salinization is a negative environmental impact in urban ecosystems. Deicing reagents affect both plants and the environment in general.

Key words: *deicing reagents, soil, urban ecosystem, sodium chloride, calcium chloride*

INTRODUCTION

Urban plants are sensitive not only to increased soil contamination with heavy metals [1,2], but also to deicing reagents. In the late 1990, relatively high concentrations of sodium chloride were recorded in the soils of the city of Moscow. Sodium chloride affects of plant development including: germination and vegetative growth. Even in Losiny Island, increased concentrations of this anti-icing (deicing) reagent were recorded. In a number of areas of Losiny Island, anti-icing reagent was one of the priority pollutants. According to the literature, salinity the main cause of soil and vegetation degradation in areas adjacent to highways [3,4]. High concentrations of sodium chloride have been noted [3,4].

We have previously investigated various anti-icing reagents; among the relatively safe alternatives to sodium chloride were magnesium chloride and calcium chloride [5,6]. However, even with the correct dosage of these anti-icing reagents, a certain effect on phytocenoses was possible.

We have analyzed reports on the state of the environment in the city of Moscow. In the city of Moscow in 2008 - 2009 (according to a report on the state of the environment in the city of Moscow), the following deicing reagents were used:

- solid deicing reagents:
- deicing reagent based on calcium chloride
- multicomponent reagent based on calcium and sodium chloride compounds
- liquid anti-icing reagents
- reagent based on calcium chloride
- a reagent based on calcium and sodium chloride compounds [7]

In Moscow in the winter period 2009-2010 ("The technology of winter cleaning of the carriageway of highways, streets, driveways and squares (road facilities of the city of Moscow)", also used anti-ice reagents which included chlorides [8],

- for example, solid deicing reagents:
- based on calcium chloride;
- multicomponent reagent based on calcium and sodium chloride;
- as well as a solid multicomponent reagent based on a composition of calcium chloride with other chlorides and sodium formate;
- liquid deicing reagents:
- liquid deicing reagents based on calcium and sodium chloride [9]

The composition and types of anti-icing reagents used in Moscow have undergone certain changes over the years. However, the main components of deicing reagents were chlorides, including calcium chloride and sodium chloride.

In the city of Moscow in 2010-2011 (according to the report on the state of the environment in the city of Moscow), in comparison with the winter period of 2009-2010, the maximum chloride concentrations in the snow cover of the trough part of the roads increased, the average chloride concentration in the snow cover at a distance of 5 meters from the border of the carriageway roads increased by 5,6 times [9].

The effect of sodium chloride on soils is especially manifested in two interrelated processes - soil salinization and the development of their solonchicity [10]. On such soils, alkalinity properties, unfavorable for plants, appear: alkalinity, dispersion of colloids, moisture deficit, swelling, high density [10].

In the autumn-spring period of 2014, an increase in the content of chlorides and sodium in soils was noted [11]. The average content of water-soluble chlorides in roadside soils in the spring of 2016, (according to reports on the state of the environment in Moscow), did not change significantly compared to 2015 (31.5 mg / kg) [12] and amounted to about 30 mg / kg [13].

The average content of chlorides in soil in 2018 (according to the report on the state of the environment in the city of Moscow) was 42.5 mg / kg, sodium - 82.5 mg / kg. The detected concentrations were comparable to those observed in 2014 [14].

In the city, the effect of alkalization of the upper layers of the soil cover is observed, including due to the ingress of calcium and sodium chlorides into the soil through the surface runoff [15].

Salt plays a significant role in the pollution of soil in urban areas, with the least toxic salt being CaCl_2 . [16].

Thus, calcium and sodium chlorides have a significant impact on the environment.

We have conducted research on the effect of sodium chloride and calcium chloride on urban herbaceous plants.

METHODOLOGY OF WORK

The objects of research were lawn grasses (*Agrostis stolonifera* L. [5,6], *Festuca rubra* L.), and ornamental dicotyledonous plants (*Brachycome iberidifolia* Benth., *Trifolium repens*). *Brachycome iberidifolia*, *Trifolium repens* can be used to create a mauritanian lawn and flower beds in urban ecos

We placed 10-30 seeds in Petri dishes on filter paper, depending on the type of plant. The filter paper was moistened with sodium chloride or calcium chloride solutions. We placed 10-30 seeds under control conditions in Petri dishes on filter paper moistened with water. We used at least 4 repetitions

(depending on the plant species). The experiments were carried out in 10 repetitions for *Agrostis stolonifera*. The concentrations used were typical for snow cover near Moscow highways.

RESEARCH RESULTS

The studied plants have shown sensitivity to sodium chloride. In aqueous solutions, inhibition of shoot growth of no more than 30% was observed at 0.5% sodium chloride in lawn grasses. The growth of flowering plants, depending on the type of plants, was 56-58% (Fig. 1).

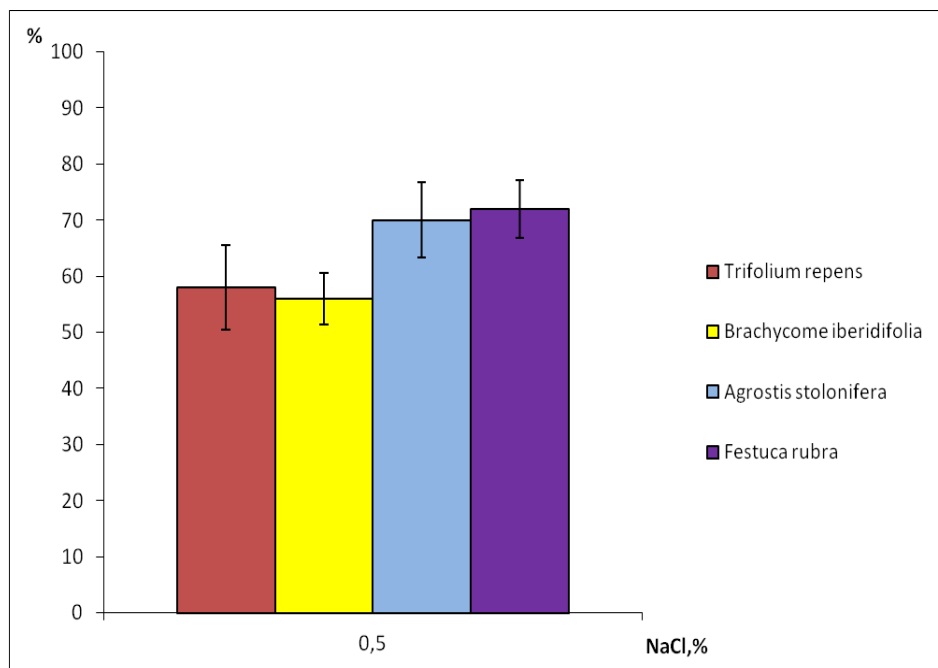


Figure 1. Influence of 0,5 % sodium chloride on the growth of shoots of ornamental plants

All studied plant species showed high sensitivity to 1% sodium chloride (Fig. 2).

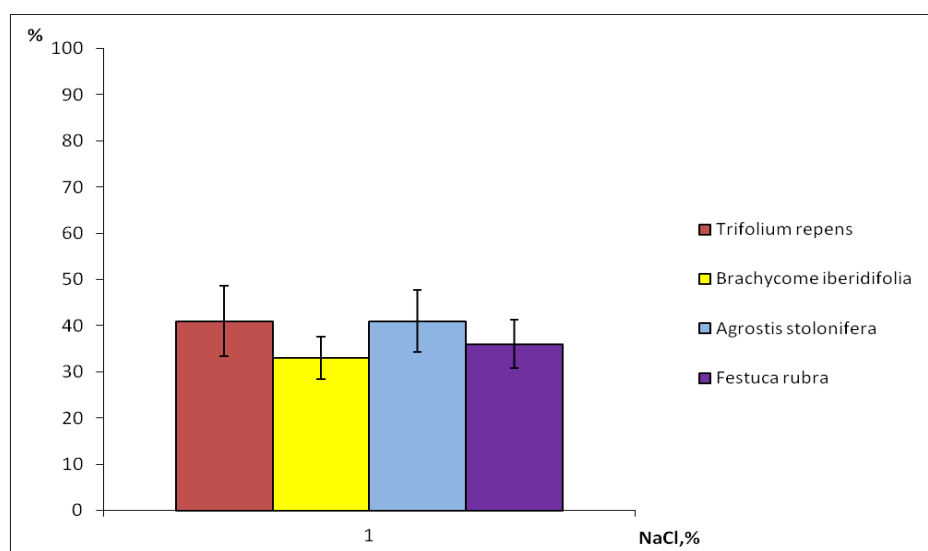


Figure 2. Influence of 1 % sodium chloride on the growth of shoots of ornamental plants

Calcium chloride also showed relative toxicity to the studied plant species (Fig. 3). *Brachycome iberidifolia* has shown the highest sensitivity to calcium chloride. Shoot growth of *Brachycome iberidifolia* was 2 times less than in the control at a concentration of 0.5% calcium chloride. Lawn grasses (*Agrostis stolonifera* , *Festuca rubra*) were more tolerant than *Brachycome iberidifolia* and *Trifolium repens* [17,18]..

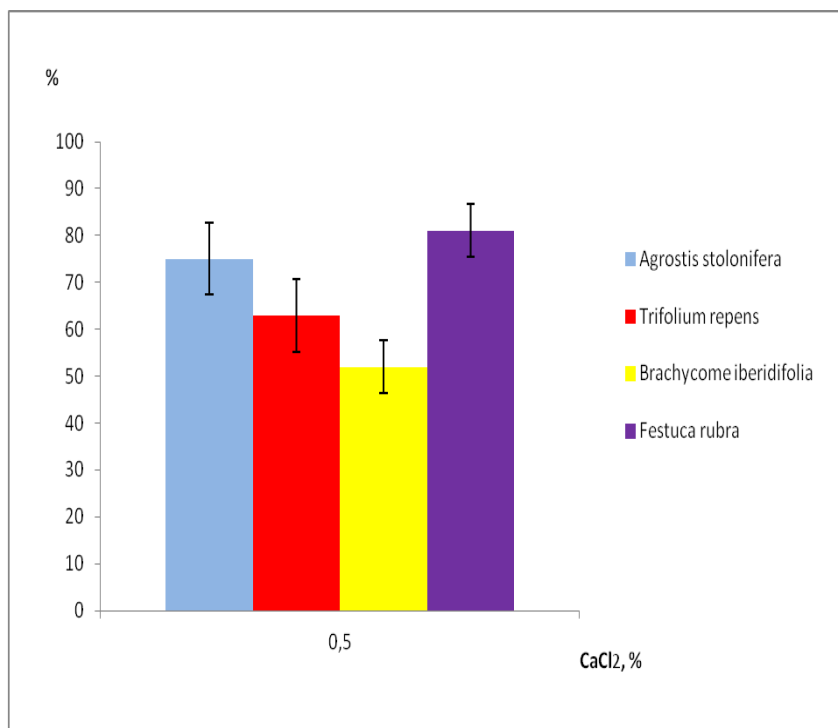


Figure 3. Influence of 0,5 % calcium chloride on the growth of shoots of ornamental plants

All studied plant species showed high sensitivity to 1% calcium chloride (Fig. 4).

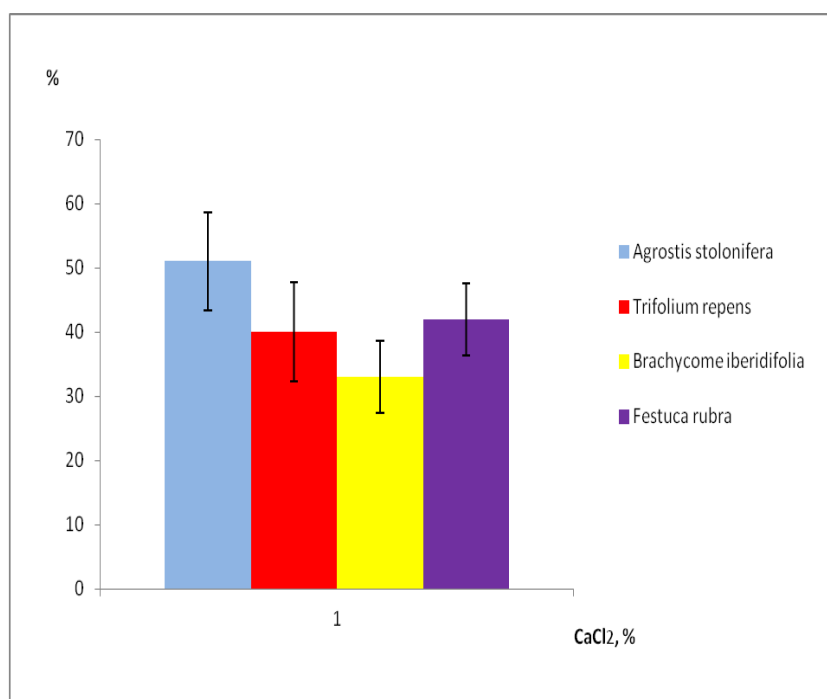


Figure 4. Influence of 1 % calcium chloride on the growth of shoots of ornamental plants

DISCUSSION

Thus, the salinization of soils and snow cover with deicing reagents is still an unfavorable environmental factor for urban ecosystems, affecting both plants and the entire environment.

All chlorine-containing deicing agents used are toxic to plants.

Deicing reagents limit the spread of ornamental plants. An inhibitory effect is observed at a concentration of 0.5% calcium chloride or sodium chloride for plants.

All studied plant species demonstrated high sensitivity to the content of 1% deicing agents in the medium. Calcium chloride was less toxic than sodium chloride for ornamental plants.

CONCLUSION

Deicing reagents are one of the priority pollutants of the soil cover. Calcium chloride and sodium chloride have the greatest effect on plants among deicing reagents.

Therefore, it is necessary to assess the resistance of ornamental plants to calcium and sodium chloride. Deicing reagents are phytotoxic at low concentrations. Therefore, it is necessary to control the use of deicing reagents. It is advisable to use salt-tolerant varieties of ornamental plants in urban greening.

The use of urban biotechnology methods can increase the resistance of plants to deicing reagents.

Comment. Part of the work was done at the department of environmental and industrial biotechnology, Moscow State University of Mechanical Engineering (earlier - Moscow State University of Environmental Engineering), which is currently reorganized.

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