Epin phytohormone impact on urban bushes under air pollution conditions

Elena Alaybysheva[1], *Elena* Sarbaeva[1], *Sergey* Smolentsev[1*], *Natalya* Shvetsova[1], *Anastasia* Korotkova[1], *Evgenia* Markova[2], *Igor* Pavlenko[2], *Maria* Zhukova[2], *Natalia* Morozova[3], and *Ilya* Duvanov[3]

[1]Mari State University, 1, Lenin Square, Yoshkar-Ola, 424000, Russia
[2]All-Russian Scientific Research and Technological Institute of Biological Industry, 17, Biocombinat Street, Biocombinat City, 141142, Russia
[3]Federal Research Center «Nemchinovka», 6, Agrochemikov Street, Odintsovo, 143026, Russia

Abstract. Investigated influence of synthetic phytohormone epin on the functional parameters of leaves of three species of bushes (Caragana arborescens Lam., Cerasus vulgaris Mill., Lonicera tatarica L.), which are widely used for urban greening. Plants grew at moderate and strong air pollution by emissions of the motor transport (a recreation zone) and the production enterprises (industrial zone). The rate of ion release from leaf tissues of medium-aged generative individuals was a measure of changings in the permeability of cell membranes. In plants exposed to stress factors, this indicator is used for early diagnosis of functional disorders. It was shown that treatment of fourth-order shoots of plants growing in the recreational and industrial zones of the city with a phytohormone slowed down the rate of release of electrolytes into the aqueous solution. The biggest response to epin treatment had Caragana arborescens Lam., the average reaction for Cerasus vulgaris Mill., and the minimum reaction – Lonicera tatarica L. «Epin-Extra» reduced the negative impact of air pollution with gases (sulfur oxides and nitrogen oxides). When analyzing the functional response to air pollution levels, a shift in the permeability of the leaf cell membrane towards an increase was observed. Treatment of plant shoots exposed to varying degrees of air pollution with epin weakened this effect. The overall resistance level of individual cells and tissues of woody plants as a whole increased in response to epibrassinolide exposure. Investigations allow us to recommend to use phytohormone epine to increase the resistance of shrubs to the negative factors of the urban area.

1 Introduction

The main environmental factors in cities are significantly different from those that affect on plants in a nature. Most often, researchers pay attention to the characteristics of the air environment (pollution and dust), which are most perceptibly perceived for people. However, in urban area, other factors (temperature, light and water regime, soil, etc.) are

* Corresponding author: Smolentsev82@mail.ru

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also highly modified. It's happens, that complex impact of significantly influences the vital activity of plant [1].

Plants haven't enough time for activating their adaptive processes to response to the influence of anthropogenic stressors. To increase plants resistance in the practice of agriculture, phytohormones (regulators of plants growth and development) are often used [2-4]. At present, it is paid a big attention to regulators, based on a chemical structure of steroids. Currently, about sixty brassinosteroids are known. It controls the action of auxins, gibberellins, abscisic acid and ethylene. They are able to stimulate the formation of these hormones, and also enhance the synthesis of main enzymes of nucleic acid metabolism - DNA polymerase, ribonuclease, ATPase. Combined action of brassinosteroids with auxins, gibberellins or cytokinins, tend to demonsrate synergism, that is, a mutual intensification of the effect. In low concentrations brassinosteroids stimulate the growth and development of plants. They promotes to the synthesis of ethylene and epinasties, provides the elongation of shoots of many plants in low concentrations. Brassinosteroids inhibits root growth and it is development and to this situation auxin become antagonists for brassinosteroids [5-8]. At present, epibrassinolide (epin) has been included in the list of permitted preparations for increasing the yields and resistance to diseases of *Hordeum*, *Beta*, *Brassica*, *Capsicum*, *Cucumis*.

The way of action of "Epine-Extra" (0.025 g/l 24-epibrassinolide) is to regulate the synthesis of the plants auxins, gibberellins, cytokinins, abscisic acid and ethylene by themselves. The "Epin-Extra" stimulates the production by plant those phytohormones that are necessary for it at each stage of development under specific growth conditions. "Epin-Extra" is involved in the synthesis of stress proteins, increasing the resistance of plants to according to adverse environmental factors.

The aim of the work was to investigate the influence of synthetic phytohormone epine to the functional parameters of three species of shrubs which are growing in the recreational and industrial zone of the town Yoshkar-Ola.

2 Materials and methods

Yoshkar-Ola is a multifunctional town with a predominance of industry. The ecological situation in different areas of the city is not heterogeneous. The main problem associated with air pollution by industrial enterprises is the unfavorable location of the residential area in according to the main industrial area. A lot of harmful substances ejects to the city's air. Harmful substances such as dust (suspended matter), dioxide and nitric oxide (NO_2, NO), carbon monoxide (CO_2), and various specific substances emitted by various industries and enterprises are emitted everywhere. The researches were carried out in two functional zones Yoshkar-Ola (Republic of Mari El): a recreation zone - Central Park of Culture and Leisure in name of XXX anniversary of the Komsomol and industrial zone near by Joint Stock Company "Contact". Investigated zones of the city were differed in the degree of pollution. So the value of the complex index of atmospheric pollution (KIAP) in the recreational zone was 1.27, and in the industrial zone - 1.38.

Three types of shrubs were used for the investigations: *Caragana arborescens* Lam. - deciduous shrub of the kind *Fabaceae*, *Lonicera tatarica* L. - deciduous shrub of the family *Caprifoliaceae* and *Cerasus vulgaris* Mill. - deciduous shrub of the family *Rosaceae*. *Caragana arborescens* Lam. is salt-tolerant, medium shade-tolerant and medium-resistant to nitrogen oxides and ammonia oxides and is unstable to SO_2 and Cl_2, it doesn't suffer from dust, it tolerates to intensive haircut. *Lonicera tatarica* L. and *Cerasus vulgaris* Mill. are resistant to technogenic pollution of industrial emissions.

In each area of investigation, 5 model medium-aged generative individuals were selected. From the southern outer side of the crown, at a distance of 0.7 m from the soil

level, shoots of the fourth order were noted (control - the probe "without treatment" - 10 pieces, the variant "with processing" - 10 pieces). Next, shoots probe ("with treatment" option) during the growing season were sprayed with "Epin-Extra" (0.005 mg / l 24-epibrassinolide). Sprinkling of bushes shoots was carried out in the morning with a spray gun, evenly wetting the leaves.

Currently, for determining the permeability of cells for ions and organic compounds, a method based on an analysis of the kinetics of the outflow of the investigation compound from cells or tissues previously saturated with this compound is used. For evaluation of the functional state of shrubs, the changes in the rate of electrolyte outflow into water extract were investigated.

The permeability of the cell membranes of leaves was the base for evaluation of the functional state of shrubs according to the changes in rate of electrolyte outflow into water extract. "Anion 4120" it is conductometer with stainless steel. Units of measurement in this gadget are micro-Siemens per cm (mkSm/sm).

3 Results and discussion

The permeability of cell membranes means a set of physico-chemical properties that determine the relationship between the processes of entry of substances from the external environment, into cells it is distribution between individual components of the cell, the accumulation of these substances in the cell and their outflow into the external environment [9].

In addition, the change in the permeability of cell membranes to electrolytes is one of the earliest reactions of the plant cell to extreme effects of a different nature (low and high temperatures, drought, salinity, the influence of heavy metals, etc.), which leads to an acceleration of the escape from the cell of mineral and organic ions and loss of water.

In addition, the changes in the permeability of cell membranes for electrolytes is one of the earliest reactions of the plant cell to extreme effects of environment (low and high temperatures, drought, salinity, the influence of heavy metals, etc.), what leads to acceleration of the outflow of mineral and organic ions and water loss. Thus, for sustainability of plants to environment stress factors, it is important to preserve the continuity of cell membranes. Therefore, the permeability of cell membranes for ions and low molecular substances is an indissolubly connected indicator of the functional statement of plant tissues. This indicator shows the endurance and stability of plants in adverse conditions of growth [10].

As can be seen from the presented data, in the probe without treatment with epine, in plants, growing in the recreation zone of Yoshkar-Ola (a slight air pollution), the intensity of the electrolyte outflow in the solution, varied from 28.43 to 48.90 mkSm / sm. At comparing changes of this parameter, the was revealed species-specific: the biggest stability of cell membranes was recorded by *Lonicera tatarica* L., and the smallest by *Caragana arborescens* Lam. ($P < 0.001$) (Table 1, Figure 1-3).

Depending on the cell internal state of and influence of different natural and artificial factors, the cell membranes permeability can be very differ. So, if the level of atmospheric pollution increased, that statistically significant increase in the rate of electrolyte outflow solution in *Caragana arborescens* Lam was registered - by 61% ($p = 0.002470$) and *Cerasus vulgaris* Mill. - 15% ($p = 0.036175$).

It is known that the effect of a some pollutants, especially sulfur dioxide, leads to violation of the permeability of the plasmalemma. When it contacts with lipoproteins membranes, free-radical oxidation processes are amplified. It leads to changings in their molecular structure and functions, also it become cause of disturbance in the main regulatory function - permeability. Increase of permeability means that significant

disruption of membranes structure and its function, that can lead to interruption of osmotic properties of cell, to its dehydration and death.

Increase of the flow of electrolytes from plant tissues indicates degree of cell membranes damage with influence of bad environmental factors, so the most stable, less damaged species was *Lonicera tatarica* L. (Δ = 3,27 mkSm / sm).

With treatment shoots of bushes with epine in moderate contamination zone, the synthetic phytohormone the rate of electrolyte yield decreased: in *Caragana arborescens* Lam. by 42.5% (p = 0.000190), *Lonicera tatarica* L. - by 34.5% (p = 0.000125), *Cerasus vulgaris* Mill. - by 73.2% (p = 0.000111).

Experimental evidence of increase of resistance of shrubs grown in conditions of severe contamination during the treatment of shoots with «Epin-Extra» had a statistically significant decrease in the electrical conductivity of plant tissues extract: in *Caragana arborescens* Lam. by 32.6% (p = 0.006826), *Cerasus vulgaris* Mill. - by 60.2% (p = 0.000074).

At the same time, in conditions of high air pollution, in the probe with treatment of shoots of *Lonicera tatarica* L. with phytohormone, the permeability of cell membranes decreased only by 9.7%.

Table 1. Change in permeability of cell membranes, mkSm/sm.

Species	Zones of the city	without processing «Epin-Extra»	after processing «Epin-Extra»	The difference in values
Caragana arborescens	recreation zone	48.90±1.510	28.08±1.530	20.82
	industrial zone	78.73±4.390	53.10±2.180	25.63
Lonicera tatarica	recreation zone	28.43±0.270	18.60±0.610	9.83
	industrial zone	31.70±1.210	28.60±1.160	3.10
Cerasus vulgaris	recreation zone	33.60±1.400	9.00±0.750	24.6
	industrial zone	38.73±1.390	15.40±0.260	23.33

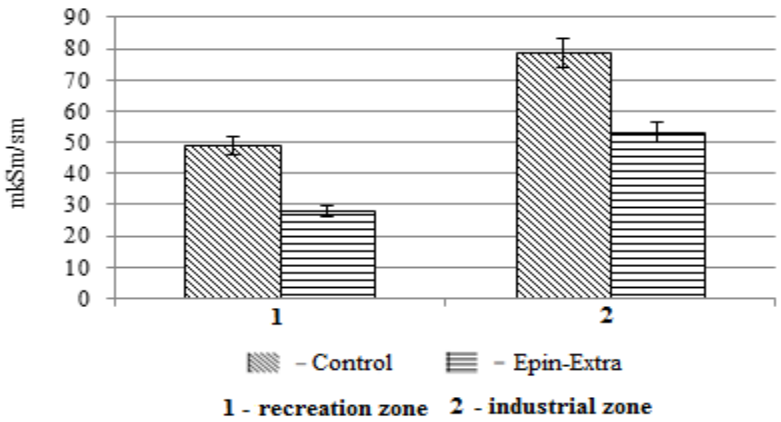

Fig. 1. The rate of outflow of electrolytes from the cells of the leaves tissues *Caragana arborescens* Lam.

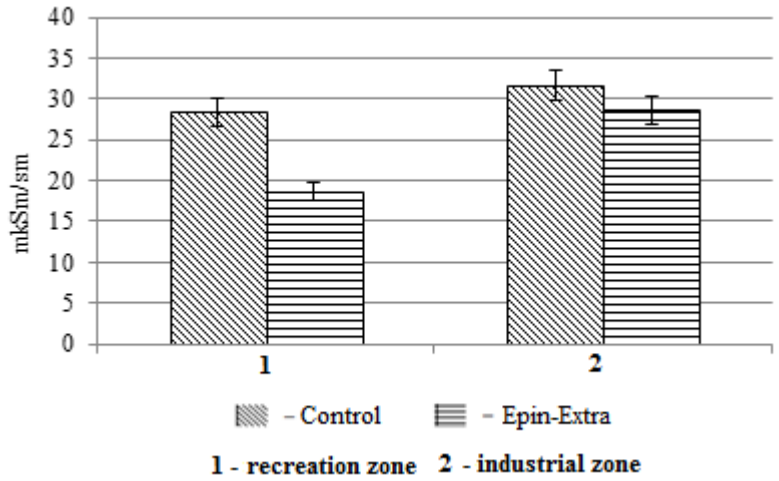

Fig. 2. The rate of outflow of electrolytes from the cells of leaf tissues *Lonicera tatarica* L.

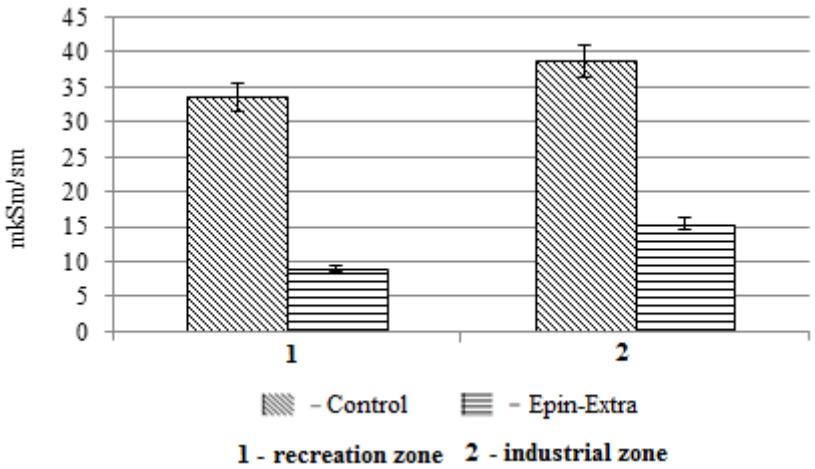

Fig. 3. The rate of outflow of electrolytes from the cells of the leaves tissues *Cerasus vulgaris* Mill.

4 Conclusion

Thus, according to results of analysis of the functional reaction of bushes on the level of air pollution, it was a shift in the permeability of the cell membrane of the leaves to direction of increase. Treatment with phytohormones epine made this effect less effective. The overall level of resistance of individual cells and tissues, and of woody plants increased in response to the action of epibrassinolide.

In result, we can recommend "Epin-Extra" for use in municipal organizations in Yoshkar-Ola in arm of to stimulating of adaptive capabilities of woody plants in conditions of anthropogenic influence.

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