STUDY OF THE STABILITY OF *CUCUMIS SATIVUS* L. TO THE OSMOTIC STRESS UNDER THE ACTION OF SYNTHETIC GROWTH REGULATOR ZIRCON

Chmeleva S. I., Pavlyuchenkova O. A.

V. I. Vernadsky Crimean Federal University, Simferopol, Russian Federation
E-mail: chmeleva-s@mail.ru

Currently, due to changes in climatic conditions, as well as to increasing anthropogenic impact, the problem of salt tolerance of cultivated plants is topical in the Republic of Crimea. Soil salinity and inadequate water supply lead to a decrease in the productivity of agro- and biocenosis, fall of biodiversity and limits the possibility of obtaining high yields of various agricultural crops. In conditions of chloride soil salinity, cellular division and stretching are inhibited, which leads to the formation of small cells. As a consequence, the growth of the plant itself, especially the leaves and stems, is delayed. Thus, soil salinity causes significant and gradually increasing changes in the majority of physiological processes in the plant organism.

The study of the mechanisms of plant resistance to the damaging effect of abiotic factors is one of the fundamental problems of modern plant physiology. To increase the salt tolerance of cultivated plants, growth regulators are used in agriculture, the effect of which is directed to increase the yield and increase the resistance of plants to extreme environmental conditions of different nature. Zircon is a physiologically active analogue of endogenous phytohormones. At the same time, being a natural compound, it is directly involved in the metabolism of plants, without adverse effect to the soil and the environment.

The effect of this drug on the growth and development of *Cucumis sativus* L. in the early stages of ontogenesis under the influence of chloride salinization has not been studied at the present time, which served as the purpose of our studies.

The object of the study was the seeds and plants of *Cucumis sativus* L, sort Phoenix 640.

Sampled on average size and etched in a weak solution of potassium permanganate, seeds were placed in Petri dishes on filter paper of 50 pcs. in triplicate. When modeling

osmotic stress, various concentrations of NaCl salts (50 mM, 100 mM, 150 mM and 200 mM) were tested, and the control was distilled water. To study the effect of Zircon on the germination of cucumber seeds under osmotic stress, the above concentrations of NaCl were used with the addition of 0.025 % of the growth regulator. The seeds were germinated in a TS-80 M-2 thermostat according to GOST 12038 – 84. The seedlings were transferred to an aqueous culture (Knop substrate) while maintaining the appropriate concentration of the NaCl solution and grown under natural illumination in 0.5 l growth pots. In 7–21-day plants, the value of morphometric parameters (plant height, root length, mass of raw and dry matter) was established according to the methods generally accepted in plant physiology to assess the effect of different concentrations of the drug on increasing the resistance of *Cucumis sativus* L. to osmotic stress.

The water deficiency (WD) of plants and the relative water content (RWC) were determined by calculating the following formulas:

RWC = 100 * (MF-MD) / (MT-MD),

WD = 100 * (MT - MF) / MT,

where MF is the mass of the leaves before saturation; MT – mass of leaves after saturation; MD is the dry weight of the leaves.

Statistical processing of experimental data was carried out by calculating the arithmetic average and standard error of the arithmetic average. To determine the reliable differences in the distribution of biometric data, Student's t-test was used.

As a result of the conducted studies, it was found that the use of the Zircon growth regulator had a positive effect on seed germination rates under conditions of osmotic stress caused by chloride salinization. The optimal concentration of the synthetic growth regulator, at which the germination energy and laboratory germination of seeds reaches the highest values, is set at 0.025 %. Germination of seeds using the preparation with this concentration leads to increasing of seed germination energy from 53.3 % in control 1 to 80.3%, and germination – from 60.8 % to 83.8 %.

When using the optimal concentration of the growth regulator, the morphometric parameters of the experimental plants of *Cucumis sativus* L. exceed those of the control variants. The average length of the root system of experimental 11-day plants reached 9.44 cm, which is 1.2 cm more than in control plants grown in modeling osmotic stress. The length of the shoot of experimental plants exceeded the control ones by an average of 1.7 cm. At the same time, as the concentration of the growth regulator increases, as shown by the data obtained by us, the stimulating effect decreases, and in the variants with the use of Zircon 0,075 %, the length of the root and shoot is significantly lower compared with the options grown in chloride salinity.

Our investigations revealed a decrease in the relative water content in the leaves of the Phoenix 640 cucumber plants under the influence of an excess of salt in comparison with plants grown under optimal conditions. All used concentrations of the preparation Zircon (0.0125 %, 0.025 %, 0.05 % and 0.075 %) have a positive effect on reducing the water deficit in cucumber leaves under conditions of osmotic stress, on average, in 2.9–4.5 times.

***Keywords*:** salt tolerance, chloride stress, *Cucumis sativus* L., plant growth regulator, Zircon preparation.

References

1. Henkel P. A., Main ways of studying salt tolerance of plants, *Agricultural biology*, **2**, 292 (1970).
2. Henkel P. A. Salt tolerance of plants and ways of its directional increase, *XII Timiryazevskaya reading*, 84 (Publishing house of the USSR Academy of Sciences, Moscow, 1954).
3. Udovenko G. V., *Diagnostics of plant resistance to stress factors (methodological instructions)*, 228 (VIR, Leningrad, 1988).
4. Udovenko G. V., Semushina L. A., Sinelnikova V. N., Peculiarities of different methods of evaluation of salt resistance of plants. *Methods for assessing plant resistance to adverse environmental conditions*, 228 (Kolos Publishing House, Leningrad 1976).
5. Belovolova A. A., Bezgina J. A., Gromova N. V., Salt tolerance of agricultural crops and their yield in saline drained Chernozem, *Polythematic network electronic scientific journal of the Kuban State Agrarian University*, **74**, 676 (2011).
6. Efimova M. V., Khasan D. A. K., Kholodova V. P., et al., Influence of brassinosteroids on seed germination and rape growth in the initial stages of ontogenesis in chloride salinization, *Vestnik Peoples' Friendship University of Russia*. *Series: Agronomy and animal husbandry*, **3**, 12 (2012).
7. Belozerova A. A., Bome N. A., Study of the reaction of spring wheat on salinity by variability of morphometric parameters of seedlings, *Fundamental research*, **12-2**, 300 (2014).
8. Petrova A. A., Belozerova A. A., The effectiveness of the use of PABA in improving salt tolerance of spring wheat, *International Student Scientific Bulletin*, **2-3**, 262 (2015).
9. Chmeleva S. I., Kucher E. N., Ryzhikh T. M., Adaptogenic effect of Zircon growth regulator on seed germination and growth processes of *Glycine max* L. in the background of chloride salinity, *Actual problems of botany and nature protection*, *Collection of scientific articles of The international scientific-practical conference dedicated to the 150th anniversary of Professor G. F. Morozov*. (Edited by S. F. Kotov), 212 (2017).
10. Chmeleva S. I., Kucher E. N., Solovey J. N., The use of the drug Zircon for enhance of the cold resistance of wheat (*Triticum aestivum* L.), *Scientific Notes of V. I. Vernadsky Crimean Federal University*, *Series "Biology. Chemistry"*, **1 (67), 3**, 73 (2015).
11. Prusakova L. D., Malevannaya N. N., Belopukhov S. L., Vakulenko V. V., Plant growth regulators with antistress and immunoprotective properties, *Agrochemistry*, **11**, 76 (2005).
12. Malevannaya N. N., Dilovska N. T., Seregina I. I., Productivity, growth and development of cucumber depending on presowing treatment of seeds by Zircon, *Proceedings of the international Conference "Problems of the North"*, 121 (Petrozavodsk, 2004).
13. Seregina I. I., Comparative evaluation of growth regulators action on cucumber plants, *Vegetable growing and greenhouse economy*, **3**, 20 (2008).
14. Malevannaya N. N., Alekseeva K. L., Zircon as a drug of new generation, *Protection and quarantine of plants*, **8**, 28 (2006).
15. Voronina L. P., Duration of treatment of seeds of radish, cucumber, oats with Zircon preparation in various concentrations, *Reports of Russian Academy of Agricultural sciences*, **3**, 13 (2003).
16. State standard GOST 12038–84. Seeds of agricultural crops. Methods for determining germination (with Changes No 1, 2), [Electronic resource], Mode of access to the article: http://docs.nevacert.ru/files/gost/gost_12038-1984.pdf (accessed 14.02.2018).
17. Tretyakov N. N, Karnaukhova T. V., Panichkin L. A., *Workshop on Plant Physiology*, 271 (Agropromizdat, Moscow, 1990).
18. Sinelnikova V. N., Smirnova E. I., *Methodical instructions for determining the salt tolerance of vegetable crops by germination of seeds in saline solutions. Tomatoes*, 18 (VIR, Leningrad, 1975).
19. Viktorov D. P., *Small workshop on physiology of plants*, 135 (High school Publishing House, Moscow, 1983).
20. Pavlenko V. B., *Analysis of experimental data on a computer. Textbook for students of the Faculty of Biology*, 43 (Simferopol, 2007).
21. Protasov K. V., *Statistical analysis of experimental data*, 232 (Mir Publishing House, Moscow, 2005).
22. Munns R., Tester M. Mechanisms of salinity tolerance, *Annu. Rev. Plant Biol*, **59**, 651 (2008).

23. Guimarães F. V. A., de Lacerda C. F., Marques E. C., de Miranda M. R. A., de Abreu C. E. B., Prisco J. T., Gomes-Filho E. Calcium can moderate changes on membrane structure and lipid composition in cowpea plants under salt stress, *Plant Growth Regul*., **65**, 55 (2011).
24. Udovenko G. V., Semushina L. A., Sinelnikova V. N., Peculiarities of different methods of evaluating salt tolerance of plants, *Methods for evaluating the resistance of plants to adverse environmental conditions*, 228 (Kolos Publishing House, Leningrad, 1976).
25. Zhuk O. I. Formation of adaptive reaction of plants on water deficiency, *Physiology and biochemistry of cultivated plants*, **43, No. 1**, 26 (2001).
26. Maximov N. A., *Selected works on drought resistance of plants. Water regime and drought resistance of plants*, 476 (Science Publishing House, Moscow, 1952).