UDC 631.03.635.61: 631.5: 631.303 (477.72)

Methods of heightening adaptive abilities of plants of watermelon to negative abiotic factors of south steppe

Naumov A.[1], Lymar A.[2]

South State Agricultural Experiment Station of the Institute of Water Problems and Land Reclamation of NAAS, 71 Chernomorska Str., Hola Prystan, Kherson oblast, 75600, Ukraine; e-mail: [1]anatoliy.naumov.1978@ukr.net, [2]ipoobuaan@gmail.com

The purpose. To justify the selection of effective mechanisms to increase the resistance of watermelon to the action of stress factors of soil and climatic conditions of the Southern Steppe of Ukraine. **Methods.** Field — for determination in the conditions of the southern steppe of Ukraine subject of research in relation to ecological and technological factors; measuring and weighing — to determine the area of the assimilation surface, the mass of the root system, the yield of watermelon; laboratory — for evaluation of various schemes of pre-planting treatment by plant growth regulators of watermelon seeds, determination of content in leaves of watermelon of saline chlorophyll; statistical — for conducting a dispersion analysis of research results. **Results.** On the basis of the conducted laboratory studies, the length of the seedlings, the effective extinctions of soaking the watermelon seeds in the solutions of growth regulators were selected. It was established that due to the influence of growth regulators the physiological processes of the development of watermelon plants are activated, in particular, the index of photosynthetic potential of the sowing increases, the total mass of the root system increases, the chlorophyll content in the leaves increases. The result of stimulating the development of watermelon for the influence of plant growth regulators is to increase the productivity of the crop.**Conciusions.** According to the results of laboratory and field studies, it should be noted that the use of the Quimicas Mepistem SL complex helps to increase the water resistance of the watermelon to unfavorable conditions in the south, in particular, the content of the total chlorophyll in the leaves increases by 41%, the weight of the root system increases by 33% and increases the photosynthetic potential of sowing is 6% in comparison with the control variant and, consequently, yields increase by 18%.

Key words: *watermelon, stress, growth regulators, seed treatment, chlorophyll, yield.*

DOI: https://doi.org/10.31073/agrovisnyk201909-03

Abiotic stress caused by limitation of water intake in a plant causes certain physiological changes in higher plants, slowing their growth, wilting and asbestos of leaves and fruits begins, decreasing the laying of generative organs, hence the productivity [1, 2].

And considering, progressive, global climate change on the planet, the impact of adverse environmental factors (heat and drought) is becoming more and more tangible. As a result, producers of melon products revise the established norms and postulates, before they are increasingly faced with the question of choosing the optimal parameters of the ingredients of cultivation technology aimed at increasing the plant's physiological resistance to adverse environmental conditions by mobilizing and disclosing their potential for guaranteed production of the planned level of crop yield.

The research aimed at increasing the adaptation of melon plants, in particular watermelon, to stress factors of the environment are of particular importance for the domestic producer, since the bulk of the crops of this crop in Ukraine is in the zone of risky agriculture.

To increase the heat resistance of plants P.O. Genkel offered seeds of individual crops (sugar beets, carrots, tomatoes, melons) to be processed before sowing with a 0.2% solution of calcium chloride. The effect of calcium is based on the ability of this element to increase the viscosity of the cytoplasm, which contributes to increasing the resistance of plants to overheating [3]. However, the effectiveness of such treatment was only at the time of germination, in subsequent periods of growth and development it was not confirmed [4].

Studies on cereals, citrus, vegetable crops and fodder grasses have shown that when improving the silicon nutrition of plants, the number of secondary and tertiary roots increases by 20-100% or more. The shortage of silicon supply is one of the limiting factors for the development of the root system of plants. It is established that optimization of silicon supply leads to increase of stability of chlorophyll molecules and the concentration of chlorophyll [5, 6]. In this case, the positive effect of silicon is particularly noticeable in plants under stress conditions [7, 8].

Currently, in the world of agrarian production to increase the yield of a large range of agricultural crops are widely used regulators of growth and development of plants - substances of both natural origin and synthetic nature, which have a specifically directed influence on the processes of growth and development of plants, have a wide range of action. In recent decades, in addition to growth regulators belonging to different classes of phytohormones, widespread ecologically pure natural preparations and synthetic substances possessing high physiological activity have become widespread. These drugs stimulate the growth and development of plants of cereals, fruit and berries, vegetables, and others. cultures, increase their productivity, accelerate the beginning of fruit production, activate immunity and resistance to stress factors of the environment.

In scientific literary sources there is information that the treatment of plants in conditions of drought with solutions of auksina, cytokinina, gibberelina enhances the negative effects of drought. However, the spraying of plants with cytokinin in the period of recovery from drought significantly improves the state of plants. In addition, cytokinins increase the heat resistance of plants (in particular, it improves seed germination). According to L.I. Vigor, this protective effect of cytokinins may be due to their influence on the structural and functional state of macromolecular cell components, in particular on the membrane systems [9].

Consequently, analyzing all the above, it can be noted that a promising approach to study the mechanisms that provide the adaptability of watermelon plants to water shortages and elevated air and soil temperatures is to find effective technological solutions that increase their drought tolerance and thermotolerance, one of such solutions is seed treatment growth regulators with креопротекторными properties.

The purpose of the research is to find effective ways to increase the water resistance of the watermelon to the action of stress factors of the soil and climatic conditions of the southern Steppe of Ukraine.

Research methodology. The research was carried out on the lands of the State Enterprise "Grand Clines" of the South State Agricultural Experiment Station of the Institute for Water Problems and Land Reclamation, which is located in the village. The Great Klyn of the Holoprysstansky district of Kherson oblast, during 2016-2018. The experimental area belongs to the dry steppe zone of Ukraine characterized by hot dry climates. Vegetation periods of 2016-2018 were characterized by dry conditions (rainfall ranged from 45 to 75% of average annual variables) and increased average daily temperatures (up to 5 ° C) relative to average annual values, indicating a generally accepted trend towards climate change in the direction of warming.

The scheme of the experiment to determine the effect of drugs to increase the water resistance of the water to the stress factors of the soil and climatic conditions of the Dry Steppe of Ukraine provided the following options: **Option 1**. Control. **Option 2**. Treatment with the complex of preparations of «Ecoorganic»: pre-sowing treatment of seeds with the drug Ecoline universal seed, processing of vegetative plants into the phase of the chamber Ekoline Universal start and the phase of the firing of the Ecoline Universal growth. **Option 3**. Treatment with preparations of «Rodonit»: pre-sowing treatment of seeds with the preparation of Lignogumat, processing of vegetative plants in the stages of firing, flowering and fruit-forming with the complex of drugs Lignogumat + Albit. **Option 4**. Treatment with the drug firm «Osipenko S.B.»: pre-sowing treatment of seeds and vegetative plants in the stages of firing and flowering with Bio-gel. **Option 5**. Treatment with «Quimicas Mepistem SL» preparations: pre-sowing seed treatment with Vigortem-S preparation, treatment of vegetative plants in the phase of the chamotte with the preparations STA-Stimulant and Aminomax N, coherent extra-root processing into the phase of the

firing with Etaboro and Aminomax Ca preparations and the treatment of plants in the phase. Preparation of fruits with Kafom Zn-Mn + Kafom K + Kafom Ca.

The soil of the experimental site is represented by black soil southern, solitary, suppository. The relief is equal. The area of the experimental field is 1 hectare. repeat the experiment 4-time. Watermelon grade - Wizard.

The research was carried out according to the generally accepted method for melon cultures [10].

Research results. At the initial stage of conducting research in laboratory conditions for the length of seedlings (for 48 h), we selected the most effective method of seed treatment in solutions of growth regulators and pre-assessed the effect of these growth regulators (Table 1)

1. Length of seedlings of watermelon at different exposures of soaking the seeds in solutions of growth regulators, mm

Version	Regulators growth	Seed treatment															
		half-valued	soaking, year hours														
			1	6	12	13	14	15	16	17	18	19	20	21	22	23	24
1	Control	3,4															
2	Ecoline Universal Seed	5,1	8,3	10,1	10,5	-	-	-	-	-	11,2	13,3	**14,8**	14,2	14,0	13,8	13,7
3	Lignogumate	4,7	7,9	10,2	10,8	10,9	11,5	11,7	12,6	13,7	**14,1**	14,0	-	-	-	-	12,9
4	Bio-gel	4,9	6,4	9,5	7,3	8,4	10,2	10,2	10.8	11,2	**12,4**	11,7	-	-	-	-	12,0
4	Vigortem-S	4,6	12,3	12,4	12,9	13,6	13,8	14,8	16,2	**17,5**	15,8	15,5	-	-	-	-	15,5

As can be seen from the data obtained, the effectiveness of the semi-volatile method of cultivating seeds by studying growth regulators is small, due to the presence of a thick shell in the seeds of melons, which, when germinating, is applied to the soil surface together with cotyledon leaves and dumped. An effective way of treating seeds is soaking in solutions of growth regulators, while it should be noted that for each drug effective exposure to soaking the seed is different. The following schemes were distinguished: soaking the seeds in the solution of "Vigortem-S" for 17 hours (the length of seedlings for 48 hours germination was 17.5 mm), soaking in a solution "Ecoline universal seed" within 20 hours (14.8 mm). The best exposure (18 hours) was for both the Bio gel (12.4 mm) and for the Lignugamate variant (14.1 mm). In the control variant, the length of the seedlings was 3.4 mm.

Data from laboratory studies have been confirmed in field conditions. So in particular, in our field experiment, variants with the exposure of soaking the seeds in solutions of studying growth regulators, which had the greatest influence on the germplasm length index, were laid. Thus, in particular, the duration of the onset of complete stairs from the time of sowing was 2 days less in the variant with the use of growth regulators "Ecoline Universal seed and Vigortem-C knife in other experimental variants of the experiment where the figure was 14 days.

Different physiological-biochemical and anatomic-morphological mechanisms are used in the adaptation of plants to external conditions. In particular, the study of the characteristics of the pigment apparatus of plants with different tolerance is of great importance for the elucidation of the mechanisms of adaptation to the conditions of existence.

The amount of chlorophyll is one of the main adaptation factors [11]. The content of the total chlorophyll, depending on the variant of application of growth regulators of plants, was in the range of 1.7-2.7 mg / g of crude mass (Table 2). At the same time, it should be noted that in the process of growing from the younger leaves to the older content of chlorophyll decreases. Thus, in the phase of the chamfer the content was depending on the variant within the limits of 1,8-2,7 mg / g of crude mass, at the same time, already in the flowering phase the content of total chlorophyll dropped in all variants to the values of 1,7-2,4 mg / g of raw mass.

2. The content of chlorophyll (a and b) in the leaves of plants of watermelon, depending on the applied complexes of plant growth regulators, mg / g of crude mass (average for 2016-2018 years)

Version	Regulators growth	Vegetation phase	
		3-5 sheets	flowering
1	Without processing (control)	1,8	1,7
2	Treatment with "Ecoorganic"	2,5	2,2
3	Treatment with drugs "Rodonit"	2,0	1,9
4	Treatment with "Osipenko S.B."	2,4	2,2
5	Treatment with "Quimicas Mepistem S.L."	2,7	2,4

It was established that the maximum effect on the content of chlorophyll leaves was with the use of Quimicas Mepistem S.L. for the treatment of seeds and plants, the increment to control ranged from 0.7 to 0.9 mg / g of crude mass, depending on the phase of plant monitoring.

One of the main indicators that characterizes the drought-tolerance of the plant is the development of its root system. The analysis of the influence of various variants of processing of seeds and plants indicates that the bulk of the root system of watermelon (about 90%) in the fruit production phase is located in a layer of soil from 11 to 40 centimeters. It should be noted that the option with a compatible seed treatment Vigortem-C, in conjunction with the non-root nutrition of STA-Stimulant, Etaboro, Aminomax N, Aminomax Ca, Kafom Zn-Mn, Kafom K, Kafom Ca, provided a root mass increase of 33% compared to control. Positive influence on the mass of the root system is noted for the treatment of watermelon seeds and plants with the drugs "Ecoline Universal Seed, Starting and Growing" - 366 g / 1-plant (increment to control +70.4 g / 1-plant). At the same time, insufficient efficiency of the other studied variants of cultivation of seeds and plants was recorded.

Leaves, as is known, are the main organ of photosynthesis - the main source of biomass formation of plants, and therefore it is one of the determining factors for the formation of high yields [12]. Given this situation when growing watermelon it is necessary first of all to create favorable conditions for the formation of a greater number of them. Since the maximum leaf area characterizes the state of crops for a short period of the life of plants, for assessing the productivity of crops, it is necessary to determine the total work of the leaf area throughout the growing season, using the index of photosynthetic potential (PP), which is an integral index of plant photosynthesis and an important sign, with a harvest.

In the analysis of the influence of various schemes for the treatment of seeds and plants on the PP index, there is a tendency to increase this indicator in comparison with the control variant (Table 3). The maximum value is 120.24 thousand m^2 days / ha, it is obtained when applied to the processing of seeds and plants products of the company "Quimicas Mepistem S.L." (increase to control + 6,62 thousand m^2 days / ha).

3. Interphase photosynthetic potential of watermelon cultures, depending on applied complexes of plant growth regulators, thousand m2 days/ha (average for 2016-2018 years)

Version	Regulators growth	Interphase period		PP 3-5 leaves-achievement
		3-5 litters-the beginning of flowering	flowering-achievement	
1	Without processing (control)	24,34	89,28	113,62
2	Treatment with "Ecoorganic"	24,44	95,20	119,64
3	Treatment with drugs "Rodonit"	25,09	94,05	119,14
4	Treatment with "Osipenko S.B."	24,63	92,73	117,36
5	Treatment with "Quimicas Mepistem S.L."	23,88	96,36	120,24

High rates were also recorded in the processing of seeds and plants by the drug complex "Ecoorganic", where on average the experimental index of PP was 119.64 thousand m^2 days / ha, which is 6.02 thousand m^2 days / ha higher than at control.

The increase in the area of the leaf surface in the end results in increasing the yield of watermelon crops (Table 4).

4. Influence of the application of complexes of growth regulators on the yield of watermelon varieties Wizard

Version	Regulators growth	Yield t / ha			Average yield, t / ha	Yield increase	
		2016 y.	2017 y.	2018 y.		t / ha	%
1	Without processing (control)	18,4	16,5	17,2	17,4	-	-
2	Treatment with "Ecoorganic"	23,1	18,4	18,2	19,9	2,5	14,3
3	Treatment with drugs "Rodonit"	20,8	17,4	17,8	18,6	1,2	6,9
4	Treatment with "Osipenko S.B."	20,5	17,2	17,6	18,4	1,0	5,7
5	Treatment with "Quimicas Mepistem S.L."	24,2	19,1	18,9	20,7	3,3	18,9
The least significant difference $_{05}$ t / ha		0,24	0,32	0,26			

According to the results of the research, we can conclude that the application of complexes of plant growth regulators influenced the increase in yield of watermelon fruits. At different test options, the increment was from 1.0 to 3.3 t / ha in relation to control – 5.7-18.9%. At the same time, it is necessary that the maximum yield level is fixed on the variant using the complex of growth regulators "Quimicas Mepistem SL", the increase to the control variant was 3.3 t / ha or 18.9%, somewhat lower were given yields for the use of drugs Ltd. "Eco-organik" - the increase to the control variant amounted to 2.5 t / ha, or 14.3%.

Conclusions

Under the influence of growth regulators, the physiological processes of the development of watermelon plants are activated, which have a direct impact on the resistance to stress stress factors in the soil-climatic conditions of the south. In this case, watermelon forms a more advanced root system, increases the index of photosynthetic potential of sowing, increases the content in leaves of chlorophyll. The result of stimulating the development of watermelon under the action of a complex of plant growth regulators is to increase the yield of an agricultural plant.

References

1. Sukiasyan, A.R., Tadevosyan, A.V., Simonyan, G.S., & Pirumyan, G.P. (2016). Vliyanie abioticheskogo stressa na rost rasteniy [Viyanie abioticheskogo stress on plant growth] *Successes of modern natural science*, *7*, 168-172. [In Russian].

2. Doang X. J., & Tokhtar V.K. (2011). Issledovanie zasukhoustoychivosti perspektivnikh dlya introduktsii vidov Momordica Charantia L. i M. Balsamina L. [Cucurbitaceae] [Study of drought tolerance of promising species for introduction of Momordica Charantia L. and M. Balsamina L. [Cucurbitaceae]]. *Scientific statements*, *9* (104); 15, 43-47. [In Russian].

3. Goryshina, T.K. (1979). *Ekologiya rasteniy* [Plant Ecology]. Account manual for universities. Moscow: Vishcha school. [In Russian].

4. Fedulov, Yu.P., Kotlyarov, V.V. & Dotsenko, K.A. (2015). Ustoychivost rasteniy k neblagopriyatnym faktoram sredy [The resistance of plants to adverse environmental factors]. Account. manual for universities. Krasnodar: KubSAU. [In Russian].

5. Volodko I.K. (1983). *Mikroelementy i ustoychivost rasteniy k neblagopriyatnym usloviyam* [Trace elements and plant resistance to adverse conditions]. Minsk: Science and technology. [In Russian].

6. Wang S.Y., & Galletta G.J. (1998). Foliar application of potassium silicate induction metabolic changes in strawberry plants. *Journal of Plant Nutrition*, *21* (1), 157-167.

7. Ma, J.F., & Yamaji, N. (2006). Silicon uptake and accumulation in higher plants. *Trends Plant Sci.* Aug; *11* (8), 392-397.

8. Maghsoudi, K., Emam, Y., & Ashraf, M. (2015). Influence of foliar application, photosynthetic pigments, and tolerance of tolerance in drought tolerance. *Turkish Journal of Botany*, 39, 1-10.

9. Vigor, L.I. (1961). Praktikum po fiziologii drevesnykh rasteniy [Workshop on the roslin village physiology]. Moscow: Vishcha School. [In Russian].

10. Bondarenko, H.L., & Yakovenko, K.I. (Ed.). (2001). *Metodyka doslidnoi spravy v ovochivnytstvi i bashtannytstvi* [Methodology of help in the field of ivivinnittvi i bashtannittvi] 3rd view. Kharkiv: Osnova. [In Ukrainian].

11. Gorshkova, A.A., & Zverev, G.K. (1988). *Ekologiya stepnykh rasteniy Tuvy* [Ecology of steppe plants of Tuva]. Novosibirsk: Science. [In Russian].

12. Javaid, F., & Mahmood, N. (2010). Growth Pakistan. *J. of Botany, 42*, 863-871.