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На основании вышеизложенного можно сказать, что использование искусственного инфекционного фона позволило выявить наиболее эффективные в отношении гриба *Fusarium subglutinans* препараты – Премис двести КС и Триактив КС. Результаты исследования могут быть использованы при отборе препаратов для полевых испытаний и применения в производстве.

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INFLUENCE OF THE GROWTH REGULATOR MARS EL ON HYBRIDS OF RED BEETS

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Abstract

The analysis of these studies presents the morphometric parameters of leaves, yield and marketability of root hybrids of red beet, using the plant growth regulator Mars EL. The article scientifically substantiates and proves, that the use of Mars EL is an effective measure to protect cultivated plants from difficult conditions during the growing season. It was found, that pre-sowing treatment with red beet seed growth regulator helped to increase its field germination by 9,0-9,5%. The use of Mars EL for seed treatment and three spraying of cultivated plants during the growing season (with an interval of 10 days) provides an increase in the number and area of beet leaves, increasing the yield of roots of early ripening hybrid Vodan by 12,2% and medium-ripening hybrid Pablo by 12,8%, compared to the control version, and their marketability increased by 3 and 4%, respectively.

Keywords: red beet, hybrids, plant growth regulator, yield, marketability of root crops.

Formulation of the problem. Among the great variety of vegetable crops, red beets are in demand all over the world. Beetroot (*Beta vulgaris*) is a biennial plant of the Orach family (*Chenopodiaceae*). On the territory of modern Ukraine it began to grow in the tenth century. But even today it is in great demand: in terms of the area grown and consumption in our country, it ranks the second among all root vegetable crops.

Analyzing the data on the areas, that were set aside for growing vegetables in Ukraine, we see their decrease from 489 thousand hectares in 1995 to 440,3 thousand hectares in 2018. The yield of vegetable crops in 1995 was only 120 quintals per hectare, and in 2018 it was 214,3 quintals per hectare. That is, the supply of vegetables in our country is achieved by increasing the yield of these crops and exports.

The area, from which red beets were harvested, increased from 36.9 thousand hectares in 1995 to 42,8 thousand hectares in 2013, but in the subsequent years it decreased. And in 2018 it was 37,9 thousand hectares. Characterizing the dynamics of domestic vegetable yields, it should be noted some increase in this indicator in recent years in all categories of Ukrainian farms.

Thus, the yield of red beets increased from 149,5 quintals per hectare in 1995 to 210,8 in 2012 and to 213,6 quintals per hectare in 2016 [13]. In 2018, it was 214,5 quintals per hectare [16]. But the potential of red beets in this regard is much higher. That's why, both scientists and practitioners are looking for different opportunities to realize the genetic potential of modern varieties and hybrids in the field in order to form a high yield of roots and to reduce the negative impact of difficult weather conditions on beet plants. During the solution of these problems there are certain difficulties, which are caused by search of ways to increase the quantity of production and growth of its quality with simultaneous compliance of all hygienic standards for safety of consequences from the use of chemicals.

Growth regulators provide stimulation of growth and development of cultivated plants, increase of their resistance to negative action of adverse factors; do not lead to a significant increase in the cost of crop production and do not harm the environment.

The use of the growth regulator Mars EL during the cultivation of red beets is insufficiently studied. Thus, in the "List..." it is indicated, that in addition to

seed treatment, only one-time spraying of vegetable plants by foliar application is possible [14].

And the manufacturer of PE VKF "Imp-torgservice" recommends during the growing season of plants two or three such treatments.

Analysis of recent research and publications.

The problem of increasing yields and improving the quality of beet roots is relevant for the vegetable industry of Ukraine.

Implementation and implementation of efficient resource-saving technologies in production will ensure the competitiveness of the vegetable industry and increase the efficiency of vegetable production in the future [4, 7, 17, 21].

The use of plant growth regulators for growing vegetables allows to optimize the sowing rate of seeds by increasing its germination; to increase the yield of vegetable crops, quality and safety of products, to improve the phytosanitary conditions of agrocenoses [5, 8].

Increased interest in growth regulators is due to their wide range of effects on plants, the ability to influence certain stages of growth and development in order to mobilize the potential of the plant organism. Analysis of the mechanisms of action of retardants and ethylene producers, as well as the synthesis of new drugs with a similar type of physiological activity, creates a reliable scientific basis for improving the efficiency and environmental safety of synthetic plant growth regulators, which determines the need deepen research in this direction [19].

The introduction of plant growth regulators in agricultural practice is impossible without a deep and comprehensive study of their effect on the processes of metabolism, growth and development of the plant. Such an action depends not only on the type of drug, but also on its dose, processing time, varietal characteristics of the culture and other factors. The data, obtained, are also necessary for understanding the mechanisms of action of growth regulators [18].

Plant growth regulators are used for pre-sowing treatment of seeds and plants during the growing season. According to the research of Konovalenko L.I., Morgunov V.V., Petrenko K.V. the most effective was compatible application of pre-sowing treatment of seeds with foliar feeding of plants [3].

As a powerful leaf apparatus of agrophytocenosis can provide high-performance use of solar energy in the process of photosynthesis, then, accordingly, we should expect the formation of higher yields of roots. That's why, it is necessary to pay attention to the development of the aboveground part of beets during research. According to Palamarchuk I.I. the largest area of leaves was formed by plants in the phase of intensive root growth [12].

Yields of beet roots vary widely, because it depends on the choice of varieties or hybrids, sowing dates, temperature of both soil and air, the presence of sufficient moisture in the soil, fertilizer...

The results of research Ketskalo V.V. proved, that the cultivation of hybrids allows to obtain more marketable products per unit area, compared to varieties [2].

Our research in previous years has shown that the use of growth stimulants leads to increased yields and marketability of beet roots [9, 10, 11].

It is important to obtain information on the influence of growth regulators on the yield and marketable characteristics of root crops not only varieties but also hybrids of red beets, as they are more productive.

The main direction of solving fundamental problems is the study of plant growth and development under the influence of physiologically active substances [20].

The use of modern restrictive drugs in the cultivation of crops requires strict compliance with toxicological and hygienic requirements [15].

The purpose of the article. Study of the influence of the growth regulator Mars EL during seed treatment and foliar application on plants during the growing season on the morphometric parameters, yield and marketable characteristics of beet roots of Vodan and Pablo hybrids, which belong to different groups according to the duration of the growing season.

Materials and methods of research. To study the effect of the growth regulator Mars EL on beet plants, early-ripening hybrid Vodan (vegetation duration 90-95 days) and medium-ripe hybrid Pablo (vegetation duration 90-110 days) were grown. The object of the study was the growth processes in red beet plants. During the experiment, comprehensive studies were conducted, using conventional methods: laboratory, field, calculation, analytical and method of systematic generalization of the results.

Presentation of the main material. In recent years, due to difficult weather conditions, crop plants are increasingly affected by factors that can mitigate and reduce the negative effects of special substances-growth regulators. These drugs take an active part in metabolism and activate the basic biochemical processes of plant life. As a result, there is a significant acceleration of the growth process, improves the intensity of photosynthesis, improves the processes of respiration and nutrition. The process of transporting nutrients is much faster and their accumulation in the storage organs of plants is activated.

Soil cover of the experimental field - gray forest, humus content – 2,5%; Provision of nutrients: nitrogen – 7,0 mg/100 g of soil; phosphorus – 8,5 mg/100 g of soil; potassium – 8,8 mg/100 g of soil. The reaction (pH) of the salt extract is 5,5. The methodology of the research is generally accepted. Repetition in the experiment is three times. Harvesting was carried out in sections with simultaneous sorting of root crops into marketable and non-marketable products. The technology of growing beets on the experimental plots was in accordance with DSTU 6014-2008 [6]. Although the weather conditions in 2019 and 2020 were difficult, they were generally favorable for growing red beets.

The experiment was performed according to the scheme:

1. Control - beet seeds were soaked in water,
2. Growth regulator Mars EL (0,2 ml/kg) was treated with beet seeds,

3. Seeds (0,2 ml/kg) were treated with Mars EL growth regulator and red beet plants were sprayed once after emergence of beet seedlings (5 ml / 100 m²),

4. Seeds (0,2 ml/kg) were treated with Mars EL growth regulator and red beet plants were sprayed three times with an interval of 10 days during the growing season (3 ml/100 m²).

Modern vegetable growing uses substances that stimulate the growth of cultivated plants in order to optimize the conditions of their cultivation to increase yields. According to the literature, growth regulators increase the field germination of seeds, ensure intensive development of the root system, activate the process of chlorophyll formation and increase plant resistance to disease and stress. They also actively affect the enzyme systems responsible for root growth, stimulating the outflow of nutrients to them.

It is very important to accelerate the germination of seeds and get a friendly seed germination. In this

way, cultivated plants compete better with weeds and are provided with moisture for further dominance in the territory.

Beetroot plants are very sensitive to spring frosts. A sharp drop in temperature adversely affects the growth processes, and in some cases can even cause the death of seedlings. Beets are also very sensitive to lack of water during seed germination. Therefore, in order to increase seed germination and ensure better initial growth of cultivated plants in the field, it was decided to treat red beets with growth regulator Mars EL.

As a result of the experiment it was found, that pre-sowing treatment with the growth regulator Mars EL the seeds of hybrids of red beet Vodan and Pablo contributed to the growth of field germination on average over two years of research by 9,0-9,5%, and ultimately it was 92,6-93,9% (Table 1). Synchrony in the emergence of seedlings of cultivated plants was also noted.

Table 1

Germination of red beet seeds depending on the use of growth regulator Mars EL, 2019-2020

Variant	Laboratory germination,%	Field germination,%
Hybrid Vodan		
1- Seeds were soaked in water (control)	86,3	83,6
2- Seeds were treated with Mars EL (0,2 ml/kg)	89,2	92,6
Hybrid Pablo		
1- Seeds were soaked in water (control)	87,4	84,4
2- Seeds were treated with Mars EL (0,2 ml/kg)	89,7	93,9

Red beets are characterized by high heat and drought resistance, but to obtain its high yield the sufficient plant moisture is required. The experimental years were characterized by uneven rainfall, which created certain problems.

Red beets are very valuable nutritional vegetables, that is part of the borsch set. In summer from June, the sale of its beam products begins. Therefore, it is very important for cultivated plants to have favorable conditions for the formation of roots. Red beets are very light-loving crops [7, 8]. Plants need light throughout the growing season, for its lack, the yield can be reduced by 30%. Lack of light, reduction of its intensity lead to deterioration of the chemical composition of roots, which negatively affects the taste.

Both experimental hybrids have a small leaf apparatus with vertically arranged leaf blades. This feature

protects plants from unproductive moisture loss in dry weather and from the retention of excess moisture, in which pathogens can develop, as well as facilitates the harvesting process. But for effective photosynthesis, horizontal placement of the leaf blade in plants is considered the best.

After analyzing the data on the size and number of leaves in experimental hybrids, it was found, that the treatment with Mars EL provides the formation of a better developed leaf surface, compared with the control variant. As a result of analysis of data on the parameters and number of leaves in the studied hybrids, it was found that treatment with Mars EL provided the formation of a better developed leaf surface in comparison with the control variant (Table 2).

Table 2

Leaf parameters in hybrids of red beets in the phase of technical maturity depending on the application of the growth regulator Mars EL, 2019-2020

Variants	Morphometric parameters		
	Number of leaves, number of plants.	Leaf length, cm	Leaf width, cm
Hybrid Vodan			
1. Control (water)	9	10,9	7,7
2. Mars EL (seed treatment)	10	12,7	8,2
3. Mars EL (seed treatment + 1-time spraying of plants during the growing season)	11	13,4	8,9
4. Mars EL (seed treatment + 3-time spraying of plants during the growing season)	12	13,8	9,7
Hybrid Pablo			
1. Control (water)	8	9,4	6,4
2. Mars EL (seed treatment)	10	9,8	6,7
3. Mars EL (seed treatment +1-time spraying of plants during the growing season)	11	10,3	7,3
4. Mars EL (seed treatment +3-time spraying of plants during the growing season)	12	10,9	8,1

Therefore, the use of growth regulator had a positive effect on the growth of the assimilation surface in beets.

Growth stimulator Mars EL is characterized as a drug, that has in addition to regulatory, and protective effect against pathogens: fungal and bacterial. Hybrid Vodan is characterized by susceptibility to infection, which automatically means the need for enhanced protection against disease. The Pablo hybrid is resistant to cercosporosis. But during the growing season of beet plants there were periods rather favorable for the development of pathogens of this disease.

The leaves of red beet plants in both experimental hybrids, sprayed during the growing season with the drug Mars EL, had no signs of cercosporosis. Plants in the control variant had 5-7% of the leaf surface area, affected by cercosporosis. It is well known that the affected leaves use sunlight less effectively, and this inhibits the process of photosynthesis. At the end, all this is reflected in the declining of crop yields. Local necrotic spots eventually turn into yellowing of the entire leaf blade. A characteristic feature of the pathogen cercosporosis is that it can withstand high temperatures: 35⁰ C and even higher. Over the last decade, due to global warming, such summer temperatures have been observed in Ukraine for a long time. The economic threshold of cercosporosis is 5% of the affected leaves.

Growth regulators include biologically active substances or their complexes. They increase the resistance of cultivated plants to low temperatures and arid conditions, intensive resistance to pathogens, fuller realization of potential opportunities.

Mars EL also has an anti-stress effect, which is especially relevant during our two years of research. In addition, it is resistant to precipitation. It is well known, that the efficiency of crop spraying is influenced by weather conditions during the treatment of plants and in the first hours after treatment. Certain difficulties of weather conditions during the growing seasons of the study made it possible to confirm the positive effect of Mars EL, which provided an increase in plant resistance to changes in air temperature and arid conditions.

In order to obtain stable yields of red beets with high quality and excellent taste, it is necessary to provide cultural plants during the growing season with all the important factors for their normal growth and development.

The yield of red beet roots in the experimental plots for two years of research ranged from 51,4 to 58,0 t/ha. In the control variant, the plants lagged behind in growth and development compared to the experimental ones. It was found that the use of growth regulator Mars EL provides an increase in yield from 4,9 to 6,3 t/ha for early-ripening hybrid Vodan and from 4,8 to 6,6 t/ha for medium-ripe hybrid Pablo.

Table 3

Yield and marketable indicators of red beet hybrids depending on the use of growth regulator Mars EL, 2019-2020.

Variant	Yield, t/ha			Addition		Marketability, %
	2019	2020	average	t/ha	%	
Hybrid Vodan						
1. Control (water)	53,2	50,2	51,7	-	-	93
2. Mars EL (seed treatment)	58,4	54,8	56,6	4,9	9,5	94
3. Mars EL (seed treatment and 1-time spraying of plants during the growing season)	58,8	55,6	57,2	5,5	10,6	95
4. Mars EL (seed treatment and 3-time spraying of plants during the growing season)	59,6	56,4	58,0	6,3	12,2	96
Hybrid Pablo						
1. Control (water)	52,1	50,7	51,4	-	-	93
2. Mars EL (seed treatment)	56,6	55,8	56,2	4,8	9,3	95
3. Mars EL (seed treatment and 1-time spraying of plants during the growing season)	57,2	57,0	57,1	5,7	11,1	96
4. Mars EL (seed treatment and 3-time spraying of plants during the growing season)	58,5	57,5	58,0	6,6	12,8	97

SSD₀₅, t/ha 3,5 3,3

Statistical analysis was performed by B. Dospekhov [1]. The increase in yield on the experimental variants exceeds the smallest significant difference over the years of research. The highest yield of both red beet hybrids was formed on the variant where Mars EL was used for seed treatment and three times during the growing season of foliar treatment of cultivated plants. In the areas where red beets were grown from seeds treated with Mars EL, the marketability of root crops increased by 1-2% relatively to the control options. Where beet plants were treated with Mars EL, the marketability of root crops increased by 2-3% in the Vodan hybrid and 3-4% in the Pablo hybrid. Only a small part of the roots in the experimental plots were classified as small or damaged.

Conclusions. Based on statistical analysis of the results of field studies, it was found that the use of growth regulator Mars EL in the cultivation of hybrids of red beets Vodan and Pablo provides a significant increase in yield and marketability of roots. The highest results were obtained in areas using the drug Mars EL for seed treatment and three times during the growing season foliar application: the yield of beet roots increased on average over two years of research by 12,2-12,8%, and their marketability, respectively, by 3 and 4 %, compared to the control version.

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