ECOLOGY, BIOTECHNOLOGY, AGRICULTURE AND FORESTRY

IN THE 21ST CENTURY

PROBLEMS AND SOLUTIONS




EDITED BY
S.STANKEVYCH, O.MANDYCH

ECOLOGY, BIOTECHNOLOGY, AGRICULTURE AND FORESTRY IN THE 21ST CENTURY: PROBLEMS AND SOLUTIONS

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Reviewers:

Mykola DOLYA, Ph.D., Prof., Head Department of Integrated Plant Protection and Quarantine of National University of Bioresources and Nature Management;

Oleksandr KUTS, Ph.D., leading of science collaboration, Director of the Institute of Vegetable Growing and melon growing of NAAS of Ukraine.

The monograph is a collection of the results of scientists' achievements obtained directly in real conditions. The authors are recognized specialists in their fields, as well as young scientists and graduate students of Ukraine. The studies are conceptually grouped in sections: biotechnology, ecology, agriculture, forestry, sustainable development of the economy and the principles of effective agribusiness. The monograph will be of interest to specialists in biotechnology, ecology, breeding, plant protection, agrochemistry, soil science, forestry, agribusiness, etc., researchers, teachers, graduate students and students of specialized specialties of higher educational institutions, as well as everyone who is interested in sustainable development in the agricultural sphere and Green Deal Implementation strategies.

Keywords: sustainable development, modern technologies, agricultural production, biotechnology, ecology, plant protection, forestry, agribusiness.

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OPTIMIZATION OF THE TECHNOLOGY OF GROWING ROOT VEGETABLE PLANTS

S. VDOVENKO
Doctor of Agricultural Sciences, Professor,
Vinnytsia National Agrarian University
I. PALAMARCHUK
Candidate of Agricultural Sciences, Associate Professor,
Vinnytsia National Agrarian University

The work is dedicated to the study of the possibility of implementing organic technology for growing vegetable plants with the aim of reducing environmental pollution with pesticides, obtaining ecologically clean vegetable products with high yield indicators. Optimizing the water supply of vegetable plants of the root group due to the use of water-retaining granules. The positive influence of biological preparations and water-retaining granules on the growth, development, yield and quality of vegetable plant products has been established. **Goal.** Study of the influence of biological preparations and water-retaining granules on the growth, development, yield and quality of vegetable plant products. It has been established that the systemic use of biological preparations during the growing season of plants ensures rapid growth and development, increases immunity to diseases, reduces the activity of pathogenic microorganisms in the soil, and ensures an increase in overall yield. The general application of biological preparations contributed to the formation of the highest yield of table beet root crops in the Pablo F1 hybrid – 72.5 t/ha with the use of organic balance + Azotophyt + Liposam biological preparations, where the increase compared to the control was 10.5 t/ha. The highest yield was recorded in the Bordo Harkivskiy variety – 85.6 t/ha. The increase in the yield of table beet on the variants with the use of water-retaining granules was 23.0 - 17.5 t/ha compared to the controls. Also, the weight of the root crop was influenced by water-retaining granules, which ensured an increase in the weight of Bordo Harkivskiy and Opolskyi varieties by 83.0 and 63.0 g. The highest yield of table carrots was obtained from the variant using the growth regulator Phytocid-r, which ensured an increase in the yield at the level: in the Shantane KL variety – 6.6 t/ha, in the Brilliance F_1 hybrid – 7.1 t/ha. The highest percentage of marketable yield was obtained by using the growth regulator Phytocid-r both in the variety and in the hybrid – 79.9 and 80.1 %, which is more than the control by 6.4 and 8.0 %. It was established

that the use of biological preparations provides a higher yield of table beet plants by 10.5 t/ha. The use of water-retaining granules provides an increase in yield at the level of 23.0 – 17.5 t/ha compared to the control. The positive effect of water-retaining granules on the biometric indicators of the crop was revealed, so the mass of the root crop increased by 83.0 and 63.0 g.
Key words: biological preparations, water-retaining granules, biometric parameters, technology, vegetable plants, productivity, quality, yield.

Introduction

Carrot (*Daucus carota Sativus*) is one of the most important seasonal root crops of the *Apiaceae* (Zontychni) family and is widely grown. Carrot is a widespread vegetable crop, which is primarily of nutritional importance, as well as fodder and technical [6-8]. The greatest value of table carrots is that they have a rich chemical composition. It contains vitamins of groups B, C, K, E, PP, A, as well as minerals and useful essential oils. According to the norms approved by the Institute of Nutrition of the Academy of Sciences, 15.5 kg of carrots should be consumed per year per capita. Root crops are rich in nutrients, vitamins and mineral salts. Carrots are the main source of carotene, which plays an important role in maintaining the body's resistance to various infectious diseases. According to the State Committee of Statistics, there is an insufficient production of carrots and their active import in Ukraine. It is possible to increase the production of carrots, in particular, by creating new varieties and F_1 hybrids with high productivity and a level of adaptation to the soil and climatic conditions of growing zones [11, 26, 38].

More and more interest is also focused on the nutraceutical compounds of this root because of their importance for good health. Indeed, carrots are interesting because of the content of antioxidant compounds, mainly anthocyanins or chlorogenic acid and carotenoids. β-carotene or provitamin A is a carotenoid that is converted into vitamin A by human metabolism [13-14, 21]. Carrots are one of the important root vegetables rich in biologically active compounds such as carotenoids and dietary fibers with notable levels of several other functional components that have significant health benefits. The consumption of carrots and its products is steadily increasing due to its recognition as an important source of natural antioxidants with anti-cancer activity [2-5,16-17, 23].

Increasing the production of quality products was and remains a key task for the entire agro-industrial complex of Ukraine. One of the means to increase productivity and increase the volume of production of vegetable crops is the use of bioactivators and plant growth regulators [1, 15, 19]. Today, a promising direction is the introduction into the production of re-regulating substances, which, when used in low doses, are able to increase the potential of biological productivity of plants. As a result of significant climate changes throughout Ukraine and the optimization of sunflower cultivation technology, the use of growth regulators is gaining importance. These drugs make it possible to adapt the physiological and biological properties of the plant organism to specific growing conditions [10, 12, 18, 20, 24, 25].

Analysis of recent research and publications

Table beet is a plant with a high level of potential productivity. However, in order to obtain high yields with excellent quality indicators, it is necessary to improve the growing technology, in particular, to apply new agricultural measures that could create optimal conditions for obtaining a harvest at the appropriate level. An alternative to this is the use of superabsorbents, which are able to absorb moisture when it is in excess and give it to the plants when they need it [43, 44].

A significant limiting factor in obtaining high yields of agricultural crops is the insufficient and rather uneven supply of water to plants during the growing season. Phenomena of deviations from the average long-term temperature norms in the direction of increase, with a simultaneous decrease in the amount of precipitation, occur more often in recent years. At the modern stage of agriculture, a number of effective agricultural measures aimed at increasing the reserves of productive moisture in the soil and their rational use have been studied and tested. Such measures include the use of superabsorbents [19, 33-37].

Water-retaining granules also provide a positive effect when growing seedlings of vegetable crops with minimal consumption of moisture and nutrients [31].

Water-retaining granules ensure rational use of moisture during the entire growing season of agricultural plants, including vegetables. Water-retaining granules are environmentally safe, they can be used for planting vegetable plants in a permanent place and for growing seedlings [26-30].

Aquad consists of polyacrylamide anions, which are cross-linked polymers of acrylamide and potassium acrylate that are insoluble in water, which absorbs the amount of distilled water 500 times more than its weight, turning into a gel. Polymers contain a set of polymer chains parallel to each other, forming a network. The more cross-linked polymer, the more cross-linked mesh. This helps to reduce the capacity, but increase the stability of the polymer over time, that is, its longevity of operation.

Lack of precipitation and lack of soil moisture cause plant growth to slow down. Irrigation during the growing season can prevent the death of plants, but part of the water that reaches the root system of plants is in an inaccessible form. A significant part of it evaporates and seeps into the soil layer, inaccessible to the root system of plants. Therefore, introduction of absorbents – hydrogel into the soil prevents water loss [32, 39-42, 56-59].

Hydrogel is polyacrylamide polymer granules that are able to absorb water and fertilizers dissolved in it, which are hundreds of times greater than the granules' own weight, and then give them to plants depending on the needs of the corresponding phases of development. Granules have the ability to absorb and retain moisture when swollen, when their roots grow into swollen granules. Plants can be grown directly on the hydrogel, or it can be added to the soil mixture or applied to the soil in pre-sowing cultivation. By sprouting into the gel, plant roots are able to use the moisture and nutrients accumulated in the granules. Plant roots germinate into swollen hydrogel granules usually in 1.5-2 weeks [22, 45-55].

Research conditions and methods

In the experiment, table beets were grown without seedlings. The research was conducted at the experimental field of the Vinnytsia National Agrarian University, which is located on the territory of the "Podillia" botanical garden.

Table beet cultivation was carried out according to the recommendations of the Institute of Vegetable and Melon Growing of the National Academy of Sciences. Table beet was sown in the second decade of March. Varieties were sown with a row spacing of 45 cm. Later, plants were left in a row at a distance of 8 cm. The density of plants per hectare was 278,000 plants.

The research was conducted with the table beet variety Chervona kylia and the hybrid Pablo F_1. During cultivation, the plants were treated with solutions of biological preparations Organic balance (0.5 l/ha), Gumifrend (0.5 l/ha), Azotophyt (0.3 l/ha), Liposam (0.3 l/ha) was used as an adhesive. Processing was carried out in phase 3 of true leaves. The control was the variant without processing.

During the research, phenological observations were made of the onset of the phases of growth and development of beetroot plants, namely: the beginning and mass appearance of seedlings, the appearance of pairs of real leaves, the molting phase and the phase of intensive root growth; as well as biometric observations, where plant height, diameter, length and mass of the food organ were determined depending on the effect of biological preparations. The beginning of the phenological phases of plant growth and development was monitored by the observation method, and the laboratory method was used to establish biometric indicators.

Field and laboratory-field methods were used to observe the processes of growth, development and formation of products, synthesis method – for the purpose of forming conclusions, statistical and economic-mathematical analysis to determine the effectiveness of the technology of growing the object of research. The average weight of the fruit was determined by weighing the total number of root crops on laboratory scales and dividing the obtained value by the number of root crops. The total yield was calculated from the yield of individual variants. Beets were harvested at technical maturity, according to the requirements of the current standard [9].

The study of the formation of the table beet crop depending on the variety and the use of water-retaining granules was conducted in the conditions of the "Podillia" botanical garden of VNAU. The purpose of the research is to study the influence of the variety and the use of water-retaining granules on the yield of table beet plants.

To fulfill this goal, the following tasks were set: the influence of the table beet varietal factor and the water-retaining granule factor on: the onset and passage of phenological phases; biometric parameters of plants; productivity and biometric indicators of products. The experimental field where the research was conducted was leveled by soil type and fertility level. In field experiments, the predecessor of beetroot plants was zucchini. Agrotechnical measures were carried out in accordance with the requirements of the culture (table beet) and the tasks set for the research.

Experiment: The formation of the table beet crop depending on the variety and the use of water-retaining granules in the conditions of the "Podillia" botanical garden of VNAU. The experiment included 4 variants with four times repetition. The area of the accounting plot is 10 m^2. In the experiment, water-retaining granules "Aquod" were used as a superabsorbent in order to improve the supply of moisture to plants. Granules were introduced into the pre-sowing cultivation with the subsequent work into the soil at the rate of 20 kg/ha. The research was conducted with Bordo Harkivskiy and Opolsky varieties.

For each variant, the accounting area was determined. At each accounting site, 10 experimental plants were marked, on which the phenological phases of growth and development were noted, biometric measurements were carried out. Table beet harvest was calculated from the entire plot. The area of plant nutrition was 45x8 cm (277 thousand plants/ha).

During the experimental work, field and statistical research methods were used. Phenological observations included: the beginning and mass emergence of seedlings, the emergence of the first, second, third and fifth pairs of true leaves, the beginning and mass phase of root molting, the beginning of intensive root growth and the end of the growing season of beetroot plants. The beginning of each phenological phase was considered the time when 15 % of the plants entered it, and the time of the mass phase – when it occurred in 75 % of the plants. The vast majority of observations were made visually [9].

Biometric measurements were carried out during the growing season: plant height, root diameter, number of leaves per plant, leaf area was determined [9]. Harvest accounting was carried out at the technical maturity of table beet plants in accordance with the requirements of the current standard. Mathematical data processing was carried out using computer programs, using the method of dispersion analysis. Calculation of the economic efficiency of cultivation was carried out in accordance with methods and recommendations and according to technological maps [9].

Experiments to study the influence of growth regulators on the yield of table carrots were conducted in 2020 at the experimental site of the Department of Forestry, Horticulture, Horticulture and Viticulture of the Vinnytsia National Agrarian University. During the research, observations, records, calculations were carried out, and experimental schemes were pre-developed according to methodical instructions [9]. The predecessor of the table carrot was the onion.

Experiment: The effect of growth regulators on the yield of table carrots in the conditions of the "Podillia" botanical garden of VNAU. The experiment includes 8 variants with three repetitions. The area of the accounting plot was 5 m^2, and the number of accounting plants in one option was 10. The options in the experiment were placed by the method of randomized blocks in three repetitions. Sowing was carried out in the first decade of April. Treatment of plants with growth regulators was carried out in the phase of 3-4 true leaves and in the phase of root formation.

Growth regulators were used in recommended concentrations. The consumption of the working solution was 300 l/ha. The seeds were sown by hand with a row spacing of 45 cm. The depth of its wrapping was 2-3 cm. The research was carried out with the Shantane CL variety and the Brilliance F_1 hybrid. In the experiment, growth regulators were studied: Emistym C, Ivin, Fitotsid-r. The control was the variant without processing.

During the growing season, phenological observations and biometric measurements were carried out according to the methodology of the research case. The following phases were noted: individual and mass shoots, the phase of root crop formation, the phase of technical maturity. Biometric measurements were carried out in the corresponding phases of growth and development of table carrot plants. The number of leaves and the height of the largest leaf were noted [9]. Harvest accounting was carried out at the technical maturity of plants in accordance with the requirements of the current standard. The mass of root crops from each plot was determined separately by weighing, the diameter of the fruits – with the help of a caliper, the length – with the help of a measuring ruler.

Mathematical data processing was carried out with the help of computer programs, by the method of dispersion analysis. Calculation of the economic efficiency of cultivation was carried out in accordance with the methods and recommendations and according to technological maps [9].

Research results

Research on the study of the formation of the table beet crop depending on the variety and the influence of biological preparations was carried out in the conditions of the botanical garden "Podillia" of the Vinnytsia National Agrarian University. During the research, control over the onset of the phases of growth and development of beetroot was carried out, as well as studies were carried out on the effect of biological preparations and their comparison with the control variant, where treatment with biological preparations was not carried out. The research was conducted with the Chervona kylia variety and the Pablo F_1 hybrid. According to the calendar dates, single seedlings appeared earlier in the Pablo F_1 hybrid – on 26.04, and in the variety Chervona kylia, single seedlings appeared on 28.04 (Table 1).

Mass seedlings of table beet plants appeared earlier in the Pablo F_1 hybrid – 11.05 in all studied variants, which is two days earlier than in the Chervona kylia variety – 13.05. The same regularity was observed at the appearance of the first and third pairs of real beetroot leaves. The appearance of the first pair of true leaves was first observed in the hybrid Pablo F_1 – 14.05, and a little later in the variety Chervona kylia – 16.05.

Table 1

Dates of the onset of the phenological phases of table beet depending on the variety and biological preparation, 2019-2021.

Variety, hybrid	Biological preparation	Emergence of stairs		The appearance of pairs of true leaves		
		individual	mass	first	third	fifth
Chervona kylia	No treatment (control)	28.04	13.05	16.05	24.05	04.06
	Organic balance + Azotophyte + Liposam	28.04	13.05	16.05	24.05	02.06
	Gumifrend + Aztofit + Liposam	28.04	13.05	16.05	24.05	02.06
Pablo F_1	No treatment (control)	26.04	11.05	14.05	22.05	02.06
	Organic balance + Azotophyte + Liposam	26.04	11.05	14.05	22.05	01.06
	Gumifrend + Aztofit + Liposam	26.04	11.05	14.05	22.05	01.06

The appearance of the third and fifth pair of true leaves was previously noted in the Pablo F_1 hybrid on 22.05, and the appearance of the third pair of leaves in the Chervona kylia variety was noted on 24.05. The appearance of the fifth pair of true leaves after the introduction of biological preparations in the Pablo F_1 hybrid was observed on 01.06, which is one day earlier than in the control variant, in the Chervona kylia variety – on 02.06, which is two days earlier than in the control variant. The passage of subsequent phases of beetroot plant development also depended on the variety and biological preparations used (Table 2).

In the experiment, the growth and development of the table beet plant was uneven, as it depended on the varietal characteristics of the plants and the biological preparation used. Seedlings of table beet plants were typical, massive, which testified to the high energy of seed germination.

Table 2

Dates of the onset of the phenological phases of table beet depending on the variety and biological preparation, 2019-2021.

Variety, hybrid	Biological preparation	The molting phase of the beet root	Phase of intensive root crop growth	The phase of technical maturity	Harvesting
Chervona kylia	No treatment (control)	08.06	12.06	21.07	17.09
	Organic balance + Azotophyte + Liposam	06.06	11.06	18.07	17.09
	Gumifrend + Aztofit + Liposam	07.06	11.06	20.07	17.09
Pablo F_1	No treatment (control)	06.06	11.06	19.07	17.09
	Organic balance + Azotophyte + Liposam	04.06	09.06	16.07	17.09
	Gumifrend + Aztofit + Liposam	05.06	10.06	18.07	17.09

Depending on the varietal characteristics of table beet and applied biological preparations, the investigated variety and hybrid had different durations of interphase periods. The duration of the interphase period "sowing – seedling" was 11 days for the Pablo F_1 hybrid and 13 days for the Chervona kylia variety. During the specified periods, the steps were aligned. Varietal characteristics and the action of biological preparations influenced the duration of interphase periods (Table 3).

As a result of the cultivation of table beet in open ground, the molting phase and the formation of the root crop testified to the adaptation of the plants to the environmental conditions and determined the effectiveness of the studied biological preparations. On the basis of the obtained data, it was established that the period from mass emergence to the molting phase was the shortest under the action of biological preparations Organic Balance + Azotophyt + Liposam and amounted to 24 days in the Chervona kylia variety and the Pablo F_1 hybrid, which is 2 days less compared to the control variants. Under the action of the biological preparations Gumifrend + Aztofit + Liposam, the interphase period from mass emergence to the molting phase was 25 days, which is one day less than in the control version.

Table 3

The duration of the interphase periods of table beet depending on the variety and biological preparation, 2019-2021.

Variety, hybrid	Biological preparation	Mass sprouting of plants is the molting phase of the root crop	Mass emergence is the beginning of intensive formation of the root crop	Mass sprouting of plants is the end of the growing season
Chervona kylia	No treatment (control)	26	30	70
	Organic balance + Azotophyte + Liposam	24	29	67
	Gumifrend + Aztofit + Liposam	25	29	69
Пабло F_1	No treatment (control)	26	31	70
	Organic balance + Azotophyte + Liposam	24	29	67
	Gumifrend + Aztofit + Liposam	25	30	69

The interphase period of mass emergence – the beginning of intensive formation of the root crop in both variants was 29 days under the action of biological preparations Organic Balance + Azotofit + Liposam. Compared to the control variant, it is 2 days less in the Pablo F_1 hybrid and one day less in the Chervona kylia variety. The duration of the interphase period from mass emergence to the beginning of intensive root formation under the action of the biological preparation Gumifrend + Aztophyt + Liposam was

29 days in the Chervona kylia variety and 30 days in the Pablo F_1 hybrid, which is one day less than the control variant.

The duration of the interphase period mass germination – the end of the growing season under the action of the biological preparation Organic Balance + Azotophyt + Liposam in both variants was 67 days, which is three days less than in the control variant. With the action of the biological preparation Gumifrend + Aztofit + Liposam, the duration of the period of mass germination – the end of the growing season was 69 days, compared to the control option – one day less.

In the experiment, biometric measurements of table beet plants were carried out, such as: plant height, the number of leaves on the plant, the length of leaf veins to determine the leaf area, depending on the development phases of the Chervona kylia variety and the Pablo F_1 hybrid, as well as the effects of the biological preparations used. Measurements were carried out in the molting phase, the phase of intensive growth of the root crop and the phase of technical ripeness (Table 4). On the basis of the obtained data, the studies established the dependence of the formation of biometric indicators on the varietal characteristics of the plant and the applied biological preparation.

Table 4

Biometric indicators of beetroot plants in the molting phase depending on the variety and biological preparation, 2019-2021.

Variety, hybrid	Biological preparation	Plant height, cm	Number of leaves, pcs/plant	Leaf area, dm^2/plant
Chervona kylia	No treatment (control)	27,5	6,2	0,85
	Organic balance + Azotophyte + Liposam	28,5	8,5	0,94
	Gumifrend + Aztofit + Liposam	28,1	7,6	0,91
Pablo F_1	No treatment (control)	28,5	7,7	0,93
	Organic balance + Azotophyte + Liposam	29,4	9,0	1,06
	Gumifrend + Aztofit + Liposam	29,2	8,4	0,98

The analysis of the number of leaves established a positive effect of the biological preparation Organic Balance + Azotophyt + Liposam on the studied indicator during the cultivation of the Chervona kylia variety and the Pablo F_1 hybrid. In this variant, the number of leaves exceeded the number of leaves of the control variant by 2.3 and 1.3 leaves, respectively. In another version of the experiment, biological preparations did not significantly affect the process of increasing leaf mass of plants.

The calculation of the area of the leaves on the investigated variants established a positive effect of Organic Balance + Azotophyte + Liposam. Under the action of these biological preparations, the area of leaves in the Chervona kylia variety was 0.94 dm^2/plant, which is 0.9 dm^2/plant more than the control variant. In the Pablo F_1 hybrid, under the action of these biological preparations, the difference between the control variant was 0.13 dm^2/plant.

Biometric indicators of beetroot plants in the phase of intensive root growth are shown in table. 5.

Table 5

Biometric indicators of table beet plants in the phase of intensive root growth depending on the variety and biological preparation, 2019-2021.

Variety, hybrid	Biological preparation	Plant height, cm	Number of leaves, pcs/plant	Leaf area, dm^2/plant
Chervona kylia	No treatment (control)	32,5\	12,1	2,8
	Organic balance + Azotophyte + Liposam	34,6	14,6	3,1
	Gumifrend + Aztofit + Liposam	33,3	13,7	3,0
Pablo F_1	No treatment (control)	34,5	14,6	3,7
	Organic balance + Azotophyte + Liposam	36,6	17,3	3,8
	Gumifrend + Aztofit + Liposam	34,5	15,8	3,7

Plants of the Pablo F_1 hybrid had the highest plant height in the phase of intensive root growth among the studied variants under the action of biological preparations Organic Balance + Azotophyt + Liposam – 36.6 cm, where the difference with the control was 2.1 cm, in the variety Chervona kylia the plant height was 34 .6 cm with a difference of 2.1 cm from the control. At the same time, under the action of Gumifrend + Aztophyt + Liposam, the height of the plants in the Pablo F_1 hybrid did not exceed the control variant and was 34.5 cm, and in the Chervona kylia variety, the plant height was 33.3 cm, which is 0.8 cm more than the control.

The analysis of the number of leaves in the phase of intensive growth of the root crop established a positive effect of Organic Balance + Azotophyte + Liposam on the investigated indicator during the experiment. In this variant, the number of leaves exceeded the number of leaves in the Chervona kylia variety to the control variant by 2.5 pcs/plant, the difference between the Pablo F_1 hybrid and the control variant was 2.7 pcs/plant. In another version of the experiment, biological preparations had almost no effect on the process of increasing leaves on the plant: the difference with the control was 1.6 and 1.2 units/plant, respectively. Biometric indicators of table beet plants in the phase of technical ripeness are shown in *Table 6.*

Table 6

Biometric indicators of table beet plants in the phase of technical ripeness depending on the variety and biological preparation, 2019-2021

Variety, hybrid	Biological preparation	Plant height, cm	Number of leaves, pcs/plant	Leaf area, thousand m^2/ha
Chervona kylia	No treatment (control)	34,8	11,8	2,6
	Organic balance + Azotophyte + Liposam	35,5	12,4	3,0
	Gumifrend + Aztofit + Liposam	35,2	12,0	2,9
Pablo F_1	No treatment (control)	37,2	13,7	3,5
	Organic balance + Azotophyte + Liposam	38,3	14,2	3,7
	Gumifrend + Aztofit + Liposam	37,7	13,9	3,6

According to the data in table 3.6. it can be seen that the action of biological preparations was positive in the formation of biometric parameters of table beet plants in the phase of technical ripeness. As can be seen from the data in the table, the height of table beet plants increased in the phase of technical ripeness under the action of biological preparations in all variants. Under the action of the biological preparation Organic Balance + Azotophyt + Liposam, the table beet plants were the tallest in the Pablo F_1 hybrid and had a height of 38.3 cm, which was 1.1 cm more than the control variant. In the Chervona kylia variety, plant height was the highest under the action of Organic balance + Azotophyte + Liposam and was 35.5 cm, which is 0.7 cm more than the control variant. beetroot plants. Biological preparations also had a positive effect on the growth of leaves on beetroot plants. The effect of the drugs Organic balance + Azotofit + Liposam showed a significant effect. In the Chervona kylia variety under the influence of these drugs, the number of leaves, compared to the control one, was 0.6 more per plant and was 12.4 per plant. In the hybrid under the action of Organic balance + Azotophyte + Liposam, the number of leaves was at the level of 14.2 pcs/plant, which is 0.5 pcs/plant more than in the control variant. The action of Gumifrend + Aztofit + Liposam was lower in the formation of the number of leaves on beetroot plants. The difference with the control variants in the Chervona kylia variety and the Pablo F_1 hybrid was at the level of 0.2 units/plant.

The effects of biological preparations in the phase of technical ripeness of table beet plants were not noted when the leaf area increased. In the phase of technical ripeness, the area of leaves in all studied variants began to decrease. In the option using Organic Balance + Azotophyt + Liposam in the Chervona kylia variety, the leaf area was 3.0 thousand m^2/ha, which is 0.4 thousand m^2/ha more than the control option and 0.1 thousand less. m^2/ha in comparison with the area of leaves in the phase of intensive root crop growth. In the Pablo F_1 hybrid, under the action of Organic balance + Azotophyte + Liposam, the leaf area was 3.7 thousand m^2/ha, which is 0.2 thousand m^2/ha more than the control variant and smaller than the phase of intensive root growth by 0. 1 thousand m^2/ha. In the variant using Gumifrend + Aztophyt + Liposam, the area of leaves on beetroot plants also decreased in both studied variants.

Therefore, the action of biological preparations during the cultivation of table beet plants had a significant impact on crops. Under the action of biological drugs in both studied options, we observed an effect on the passage of interphase periods, the terms of which were somewhat shorter compared to the options without withdrawal. Also, biological preparations showed a significant impact on the formation of biometric parameters of table beet plants in all studied options. In comparison with the options without treatment, the biometric parameters of the plants were slightly higher when biological preparations were used. Only in the phase of technical ripeness, the effect of biological preparations was not observed in the formation of the area of leaves of beetroot plants – compared to the previous phases, the area of leaves on beetroot plants began to decrease.

In general, the obtained yield can be assessed as high, which determines the adaptability of the varieties to their cultivation in open soil conditions of the Vinnytsia region. The obtained products fully met the requirements of the standard and were not damaged by pests and pathogens. Based on the obtained yield data, the positive influence of biological preparations on yield indicators and biometric parameters of table beet production was established (Table 7.).

As a result of the research, the Pablo F_1 hybrid was characterized by the highest yield, where the average yield of the root crop is higher than the control by 10.5 t/ha and is 72.5 t/ha under the action of biological preparations Organic Balance + Azotophyt + Liposam. The Chervona kylia variety also showed the highest yield due to the action of biological preparations Organic Balance + Azotophyt + Liposam, it was 65.4 t/ha, which is higher than the control variant by 6.8 t/ha.

The effectiveness of the use of Gumifrend + Aztophyt + Liposam showed a slightly lower effect on the formation of the yield of the studied variants.

Thus, under their influence, the average yield was higher in the Pablo F_1 hybrid and amounted to 70.4 t/ha, compared to the control, this indicator is higher by 8.4 t/ha, in the Chervona kylia variety, the average yield is 63.2 t/ha, which is higher than the control variant by 4.6 t/ha.

Biometric measurements of root crops were also carried out during beet harvest. Among the investigated variants, the greatest biometric data of root crops were found in the Pablo F_1 hybrid.

Biological preparations Organic balance + Azotofit + Liposam had the best effect on the formation of biometric indicators: the average weight of root crops was 326 g, which is 31 g more than the control variant, the diameter and length of the studied root crops were 8.7 and 8.5 cm, respectively, while in of the control version, these indicators are lower by 0.5 cm (Table 8).

Table 7

The yield of table beet depending on the variety and biological preparation, 2019-2021

<table>
<tr><th rowspan="2">Variety, hybrid</th><th rowspan="2" colspan="2">Biological preparation</th><th colspan="4">Productivity, t/ha</th><th rowspan="2">Increase ± to control, %</th><th colspan="3">Biometric parameters of products</th></tr>
<tr><th>2019</th><th>2020</th><th>2021</th><th>Average</th><th>mass of the root crop, g</th><th>root crop diameter, cm</th><th>root length, cm</th></tr>
<tr><td rowspan="3">Chervona kylia</td><td colspan="2">No treatment (control)</td><td>55,8</td><td>55,2</td><td>64,8</td><td>58,6</td><td>–</td><td>270</td><td>8,0</td><td>7,8</td></tr>
<tr><td colspan="2">Organic balance + Azotophyte + Liposam</td><td>63,6</td><td>62,8</td><td>69,8</td><td>65,4</td><td>+6,8</td><td>315</td><td>8,5</td><td>8,3</td></tr>
<tr><td colspan="2">Gumifrend + Aztofit + Liposam</td><td>60,7</td><td>60,2</td><td>68,7</td><td>63,2</td><td>+4,6</td><td>298</td><td>8,2</td><td>8,0</td></tr>
<tr><td rowspan="3">Pablo F_1</td><td colspan="2">No treatment (control)</td><td>59,5</td><td>58,5</td><td>68</td><td>62</td><td>-</td><td>295</td><td>8,2</td><td>8,0</td></tr>
<tr><td colspan="2">Organic balance + Azotophyte + Liposam</td><td>68,8</td><td>67,3</td><td>81,4</td><td>72,5</td><td>+10,5</td><td>326</td><td>8,7</td><td>8,5</td></tr>
<tr><td colspan="2">Gumifrend + Aztofit + Liposam</td><td>68,2</td><td>67,6</td><td>75,4</td><td>70,4</td><td>+8,4</td><td>318</td><td>8,4</td><td>8,2</td></tr>
<tr><td colspan="2" rowspan="3">least significant difference 05 t/ha</td><td>A</td><td>0,6</td><td>0,6</td><td>0,7</td><td colspan="5" rowspan="3">–</td></tr>
<tr><td>B</td><td>0,8</td><td>0,8</td><td>0,9</td></tr>
<tr><td>AB</td><td>1,2</td><td>1,2</td><td>1,3</td></tr>
</table>

In the Chervona kylia variety, organic balance + Azotophyt + Liposam biological preparations also had the most effective effect on the formation of biometric parameters of root crops. Under the influence of these preparations, the average weight of the root crop was 315 g, which compared to the control is 45 g more than in the variant without treatment with biological preparations. The diameter and length compared to the control version were 0.5 cm smaller and amounted to 8.5 and 8.3 cm.

Table 8

Biometric parameters of table beet production depending on the variety and biological preparation, 2019-2021

Variety, hybrid	Biological preparation	Weight of the root crop, g	Root diameter, cm	Root length, cm
Chervona kylia	No treatment (control)	270	8,0	7,8
	Organic balance + Azotophyte + Liposam	315	8,5	8,3
	Gumifrend + Aztofit + Liposam	298	8,2	8,0
Pablo F_1	No treatment (control)	295	8,2	8,0
	Organic balance + Azotophyte + Liposam	326	8,7	8,5
	Gumifrend + Aztofit + Liposam	318	8,4	8,2

The use of biological preparations Gumifrend + Aztophyt + Liposam had a slightly smaller effect on the formation of yield and biometric indicators of the variety and hybrid.

In general, the studied biological preparations showed a rather effective effect on the formation of the crop of the studied variety Chervona kylia and hybrid Pablo F_1. However, according to the results of the harvest accounting, it was established that the biological preparations Organic Balance + Azotophyt + Liposam are more effective for processing table beets, which had the most effective effect on the formation of the yield of table beets.

Plant growth regulators are an important element of modern industrial and intensive agricultural production technologies. These include natural and synthetic physiologically active substances, which in very small amounts exert a significant influence on all processes occurring in the plant organism. This leads to noticeable changes in growth and development, causing an improvement in their quality, an increase in productivity and ensuring the mechanized cultivation of vegetables without a phytotoxic effect on the plant.

Observations of the growth and development of beetroot plants using water-retaining granules showed the dependence of the onset of growth and development phases in time on varietal characteristics and the use of superabsorbents (Table 9).

Table 9

Dates of the onset of the phenological phases of table beet depending on the variety and the use of water-retaining granules, 2019–2021

Version		Plant seedlings		The appearance of pairs of true leaves			
Variety (A)	application of granules (B)	individual	mass	1	2	3	5
Bordo Harkivskiy	without granules (control)	5.05	9.05	12.05	15.05	18.05	26.05
	with granules	5.05	8.05	11.05	14.05	17.05	25.05
Opolsky	without granules (control)	5.05	10.05	13.05	16.05	18.05	27.05
	with granules	5.05	9.05	12.05	15.05	17.05	26.05

In the initial phases of growth and development of beetroot plants, a small effect of varieties and water-retaining granules on the onset of phases was noted. However, on the versions with the introduction of granules, a somewhat friendlier appearance of the stairs was noted, which subsequently affected the passage of subsequent phases.

Previously, the appearance of mass seedlings of table beet was noted on variants with the use of water-retaining granules: in the Bordo Harkivskiy variety – on the 13th day after germination, in the Opolsky variety – on the 14th day, which is 1 day earlier compared to the variants where granules were not used (Table 10).

The appearance of the first pair of true leaves was noted on the 3rd day after the appearance of mass shoots. However, in the Opolsky variety without the use of granules – for 4 days. The same regularity was noted when the second pair of true leaves appeared. The appearance of the third pair of true leaves was influenced by the cultivar factor. Thus, in the Bordo Harkivskiy variety, this phase was observed on the 9th day after the appearance of mass shoots, in the Opolskyi variety – on the 8th day, which is, respectively, 1 day earlier than the previous variety. The appearance of the fifth pair of leaves was noted in all studied variants on the 17th day.

Table 10

Duration of interphase periods of table beet depending on the variety and application of water-retaining granules, days, 2019-2021

Version		Plant seedlings		The appearance of pairs of true leaves			
Variety (A)	application of granules (B)	individual	mass	1	2	3	5
Bordo Harkivskiy	without granules (control)	10	14	3	6	9	17
	with granules	10	13	3	6	9	17
Opolsky	without granules (control)	10	15	4	7	8	17
	with granules	10	14	3	6	8	17

A more noticeable effect of water-retaining granules was noted at the appearance of subsequent phases of growth and development of table beet plants (Table 11.). This is due to the fact that the summer of 2020 was quite hot and there was less precipitation compared to the long-term average. The granules provided the plants with a certain amount of moisture, which had a positive effect on the arrival of beetroot plant phases.

The molting phase of the root crop was marked 1 day earlier on varitas with the use of water-retaining granules. However, the beginning of the phase of intensive formation of the root crop was recorded: in the Bordo Harkivskiy variety 4 days earlier, in the Opolsky variety 3 days earlier compared to variants without granules. The end of this phase was also noted earlier on variants where granules were applied: in the Bordo Harkivskiy variety for 5 days, in the Opolsky variety also for 5 days.

However, the duration of the interphase periods of table beet indicates that they were influenced by the investigated varieties and the use of water-retaining granules (Table 12.).

Table 11

Dates of the onset of the phenological phases of table beet depending on the variety and the use of water-retaining granules, 2019-2021

Variety (A)	Application of granules (B)	Plant seedlings		The molting phase of the root crop		Intensive root formation	
		beginning	mass	beginning	mass	beginning	end
Bordo Harkivskiy	without granules (control)	5.05	9.05	16.05	19.05	9.06	25.09
	with granules	5.05	8.05	15.05	18.05	5.06	20.09
Opolsky	without granules (control)	5.05	10.05	17.05	20.05	11.06	28.09
	with granules	5.05	9.05	16.05	19.05	8.06	23.09

Table 12

Duration of interphase periods of table beet depending on the variety and application of water-retaining granules, 2019-2021.

Variety (A)	Application of granules (B)	Mass ladder – molting phase	Mass emergence is the beginning of intensive formation of the root crop	Mass shoots - the end of the growing season
Bordo Harkivskiy	without granules (control)	10	31	142
	with granules	10	27	138
Opolsky	without granules (control)	10	32	141
	with granules	10	29	137

The interphase period of mass emergence – molting phase did not differ between the studied variants and was 10 days. However, the influence of the studied factors was noted in subsequent phases. The period of mass germination – the beginning of intensive formation of root crops was shorter on the variants with the use of water-retaining granules: in the Bordo Harkivskiy variety – 27 days, in the Opolsky variety – 29 days, which are 4 and 3 days shorter, respectively, compared to the variants without granules.

The period from mass germination to the end of the growing season was less long in the variants with the use of water-retaining granules: in the Bordo Harkivskiy variety – 138 days, in the Opolsky variety – 137 days, which is 4 days shorter compared to the variants without granules.

Therefore, water-retaining granules accelerated the onset of phases of beetroot plant development and contributed to the reduction of interphase periods. Biometric measurements of table beet plants (Table 13.) are no less important in conducting research. The highest plant height was recorded in the Bordo Harkivskiy variety when water-retaining granules were used – 32.3 cm, which is 4.9 cm more compared to the version without granules. The positive effect of the use of water-retaining granules was also noted in the Opolsky variety, where the increase was 3.7 cm compared to the version without granules.

Table 13

Biometric indicators of beetroot plants in phase 5 of a pair of true leaves depending on the variety and application of water-retaining granules, 2019-2021.

Variety (A)	Application of granules (B)	Plant height, cm	Mass root crop, g	The mass of the above-ground part, g	The ratio of the mass of the root crop to the plant %
Bordo Harkivskiy	without granules (control)	27,4	29,3	28,2	50,9
	with granules	32,3	35,8	33,6	51,6
Opolsky	without granules (control)	21,0	27,1	19,6	57,6
	with granules	24,7	34,7	24,5	58,6

An important indicator in the assessment of biometric parameters of plants is the mass of the root crop. The highest given indicator was recorded on the variants with the use of water-retaining granules: in the Bordo Harkivskiy variety compared to the control, the increase was 6.5 g, in the Opolsky variety – 7.6 g. Biometric measurements also showed an increase in the mass of the above-ground part under the influence of water-retaining granules by 5 .4 and 4.9 g, respectively. A higher percentage of the mass of the root crop in relation to the entire mass of the table beet plant in the phase of 5 pairs of true leaves was obtained in the Opolsky variety – 57.6 - 58.6 %. However, an increase in this indicator was noted for both studied varieties depending on the use of water-retaining granules.

In order to better study the patterns of growth and development of beetroot plants, depending on the variety and the use of water-retaining granules, biometric measurements were also carried out in the phase of intensive root formation (Table 14). The indicators indicated in the table indicate that beetroot plants were influenced by both varietal characteristics and water-retaining granules.

Table 14

Biometric indicators of beetroot plants in the phase of intensive root formation depending on the variety and the use of water-retaining granules, 2019-2021

Variety (A)	Application of granules (B)	Plant height, cm	Number of leaves, pcs./plant	Mass root crop, g	Mass above-ground part, g	The ratio of the mass of the root crop to the plant, %
Bordo Harkivskiy	without granules (control)	34,4	11,0	70,1	90,2	42,6
	with granules	37,6	14,5	73,4	97,5	57,1
Opolsky	without granules (control)	26,0	10,8	41,2	31,4	55,3
	with granules	29,2	14,0	45,2	35,7	56,0

The highest plant height was recorded in Bordo Harkivskiy and Opolsky varieties with the use of water-retaining granules, where the increase was 3.2 cm compared to the control. The same regularity was noted with the determined number of leaves on the plant, where the increase was 3.5-3.2 leaves/plant.

The mass of the root crop in the phase of intensive formation was in the range of 41.2 - 73.4 g. An increase in the mass of the root crop was observed with the introduction of water-retaining granules by 3.3 and 4.0 g, respectively.

In the Bordo Harkivskiy variety, the mass of the aerial part was greater compared to the mass of the root crop, while in the Opolsky variety, on the contrary, a higher mass of the root crop was noted, the indicator of which was 55.3 - 56.0 % of the total plant mass.

Measurements of the area of table beet leaves showed that this indicator depended on the variety and the use of water-retaining granules (Table 15).

Table 15

Leaf surface area of table beet plants depending on the variety and application of water-retaining granules, 2019-2021 (thousand m^2/ha)

Variety(A)	Application of granules (B)	The molting phase of the root crop	Intensive root formation	Technical maturity
Bordo Harkivskiy	without granules (control)	1,0	3,8	3,4
	with granules	1,4	4,3	3,7
Opolsky	without granules (control)	0,8	2,0	2,1
	with granules	1,1	2,3	2,2

In the molting phase of the root crop, it was greater with the use of water-retaining granules of 1.1 - 1.3 thousand m^2/ha, which is more than the control variants by 0.3 - 0.4 thousand m^2/ha. The largest area of leaves was recorded in the phase of intensive root formation in all studied variants. On the variants where water-retaining granules were used, the increase was 0.5 thousand m^2/ha in the Bordo Harkivskiy variety, 0.3 thousand m^2/ha in the Opolsky variety. In the phase of technical ripeness of table beet plants, a decrease in the area of leaves relative to the phase of intensive formation of the root crop was noted. However, this indicator was the highest on the variants with the introduction of water-retaining granules.

So, the conducted phenological observations and biometric measurements showed the influence of varietal characteristics and water-retaining granules on the growth and development of table beet plants.

Table beet harvest was recorded in the phase of technical ripeness according to the current standard. A positive effect of water-retaining granules on the yield index was established (Table 16).

Table 16

Commercial yield of table beet depending on the variety and application of water-retaining granules, 2019-2021.

Variety(A)	Application of granules (B)		Productivity, t/ha			Average	Increase +,– to control
			2019	2020	2021		
Bordo Harkivskiy	without granules (control)		61,7	61,2	64,9	62,6	-
	with granules		84,3	83,8	88,7	85,6	+23,0
Opolsky	without granules (control)		52,6	52	62,2	55,6	-
	with granules		69,9	71,2	78,2	73,1	+17,5
least significant difference $_{05}$ t/ha		A	1,7	1,8	1,8	–	
		B	1,6	1,8	1,8		
		AB	2,4	2,5	2,5		

The yield increase on variants using water-retaining granules was 23.0 - 17.5 t/ha compared to controls. Comparing the studied varieties, it was found that the Bordo Harkivskiy variety was characterized by a higher yield. The conducted variance analysis showed that the yield increase relative to controls is significant. During the research, biometric measurements of table beet production were also carried out (Table 17.).

Table 17

Biometric indicators of table beet production depending on the variety and application of water-retaining granules, 2019-2021.

Variety(A)	Application of granules (B)	The diameter of the beet root, sm	Root length, cm	Mass root crop, g
Bordo Harkivskiy	without granules (control)	7,2	8,8	225
	with granules	8,1	9,4	308
Opolsky	without granules (control)	4,3	13,6	200
	with granules	5,6	15,4	263

The Bordo Harkivskiy variety was characterized by a larger diameter of the root crop – 7.2 - 8.1 cm, which is larger than the Opolsky variety by 2.9 - 2.6 cm, respectively. However, plants of the Opolsky variety have a longer root length compared to the Bordo Harkivskiy variety by 4.8 to 6.0 cm, respectively. The greater weight of the root crop was formed by plants of the Bordo Harkivskiy variety – 225 - 308 g. Also, water-retaining granules had an effect on the weight of the root crop, which ensured an increase in mass of the Bordo Harkivskiy and Opolskyi varieties by 83.0 and 63.0 g.

So, the harvest record and biometric measurements of table beet production showed that both varietal characteristics and the use of water-retaining granules affect the indicated indicators. Studies have shown that the Bordo Harkivskiy variety forms rounded root crops, while the Opolsky variety is elongated.

Plant growth regulators are an important element of modern industrial and intensive agricultural production technologies. These include natural and synthetic physiologically active substances, which in very small amounts exert a significant influence on all processes occurring in the plant organism. This leads to noticeable changes in growth and development, causing an improvement in their quality, an increase in productivity and ensuring the mechanized cultivation of vegetables without a phytotoxic effect on the plant.

Phenological observations of plant development showed that the variety and growth regulators influence the duration of interphase periods of table carrots (Table 18). Prior to the treatment of plants with growth regulators, the studied variants differed depending on the studied variety and hybrid. The period from sowing to mass emergence of plants was long and amounted to 34 days. This is due to the fact that the temperature indicators in the 1st-3rd decades of April were slightly lower compared to the average long-term indicators, and therefore contributed to the extension of the specified interphase period. The increase in temperature contributed to the rapid appearance of the first true leaf, which appeared 2 days after the appearance of mass shoots in all variants of the experiment.

Table 18

Interphase periods of table carrot plants depending on the variety and growth stimulant, days, 2019-2021

Version		Period between individual phases, days					
variety	growth regulator	sowing - mass planting	mass stairs - the first leaf	the first leaf is the formation of a	formation of a rosette - formation of root crops	formation of root crops - technical maturity	duration of the growing season
Shantane KL	no treatment (control)	34	2	17	14	90	123
	Ivin	34	2	17	12	88	119
	Emistym C	34	2	17	12	88	119
	Fitotsyd-r	34	2	17	11	87	117
Brilliance F_1	no treatment (control)	34	2	18	15	89	125
	Ivin	34	2	18	14	86	121
	Emistym C	34	2	18	14	86	121
	Fitotsyd-r	34	2	18	12	85	118

The interphase period "first leaf – rosette formation" was shorter in the Shantane KL variety – 17 days, which is 1 day shorter compared to the

Brilliance F_1 hybrid. The interphase period "formation of the rosette – formation of the root crop" was influenced by varietal characteristics and applied plant growth regulators. Thus, the shortest given period was recorded on the variant using the growth regulator Phytocid-r: in the Shantane KL variety – 11 days, in the Brilliance F_1 hybrid – 12 days, which is 3 days shorter compared to the control. According to the data in the table, it can be seen that all the studied growth regulators contributed to the reduction of the interphase period compared to the variant without treatment.

The greatest influence on the interphase period "formation of root crops – technical maturity" was exerted by the growth regulator Phytocid-r, which contributed to the reduction of the interphase period relative to the control: in the Shantane CL variety by 3 days, in the Brilliance F_1 hybrid by 4 days. In accordance. The growth regulators Ivin and Emystim C had the same effect on the growth of table carrot plants.

The duration of the growing season depends on the characteristics of the variety and hybrid. However, this indicator was influenced by the weather conditions that occurred in the year of the research and researched growth regulators. With the use of the growth regulator Phytocid-r, the duration of the growing season was 117 days in the Shantane CL variety, 118 days in the Brilliance F_1 hybrid, which is 6 and 7 days shorter, respectively, compared to the control. Growth stimulators Ivin and Emistim C also helped shorten the growing season of table carrots by 4 days.

Therefore, observations of the phenological phases of growth and development of table carrot plants showed the influence of growth regulators on the duration of interphase periods, namely, they contributed to their shortening.

For a more detailed study of carrot plants, biometric parameters of carrot plants were measured during the research (Table 19.). Measuring the growth dynamics of root crops of table carrots showed that the mass of the root crop depended on the variety and growth stimulant. The largest mass of the root crop during the vegetation period was noted for the use of the growth regulator Phytocid-r, in the Shantane KL variety, the increase compared to the control was 15.1 - 23.8 g, in the Brilliance F_1 hybrid – 18.5 and 25.6 g. The variants with the use of growth regulators Ivin and Emistym C were also characterized by a greater increase in the mass of root crops, where the increase relative to the control at the end of the growing season was: in the Shantane KL variety – 4.1-8.3 g, in the Brilliance F_1 hybrid – 4.9 and 6.0 g respectively.

Table 19

Growth dynamics of root crops of table carrots depending on the variety and growth stimulator, g, 2019-2021

Version		I dec. 07	I dec. 08	I dec. 09
variety	growth regulator			
Shantane KL	no treatment (control)	25,4	62,5	88,2
	Ivin	32,4	68,7	92,3
	Emistym C	33,0	70,4	96,5
	Fitotsyd-r	40,5	85,6	112
Brilliance F_1	no treatment (control)	26,8	64,3	92,4
	Ivin	34,5	69,8	97,3
	Emistym C	36,7	73,5	98,4
	Fitotsyd-r	45,3	94,4	118

Therefore, the conducted studies established the influence of growth regulators on the formation of the root crop of table carrots.

An important indicator when studying technological techniques, in particular, the use of growth regulators using a variety and hybrid, is yield (Table 20).

In addition to the studied factors, the weather conditions of the year of the research had a significant impact on the yield. Thus, the growing season of table carrots was characterized by somewhat elevated temperature indicators and not a significant amount of precipitation, with a long dry period, and this negatively affected the formation of root crops of table carrots. However, the highest yield was obtained from the variant using the growth regulator Phytocid-r, which provided an increase in yield at the level of: in the Shantane KL variety – 6.6 t/ha, in the Brilliance F_1 hybrid – 7.1 t/ha. Variants with the use of growth regulators Ivin and Emistym C also had a positive effect on the formation of the crop of table carrot plants. In these variants, the increase relative to the control was: in the Shantane KL variety – 1.2 and 2.3 t/ha, in the Brilliance F_1 hybrid – 1.4 and 1.7 t/ha, respectively.

The highest percentage of marketable yield was obtained with the use of the growth regulator Phytocid-r both in the variety and in the hybrid – 94.7 and 95.1 %, which is more than the control by 11.2 and 11.0 %.

Table 20

Commercial yield of root crops of table carrots depending on the variety and growth stimulant, 2019-2021.

Варіант		Commercial productivity, t/ha			Average	Yield increase ± to control	Marketability, %
variety	growth regulator	2019	2020	2021			
Shantane KL	no treatment (control)	33,8	30,5	38,9	34,4	-	83,5
	Ivin	30,8	29,7	46,3	35,6	+1,2	84,0
	Emistym C	32,5	31,4	46,2	36,7	+2,3	85,2
	Fitotsyd-r	39,6	38,7	44,7	41,0	+6,6	94,7
Brilliance F_1	no treatment (control)	32,6	31,5	42,7	35,6	-	84,1
	Ivin	35,1	34,6	41,3	37,0	+1,4	86,2
	Emistym C	35,3	34,2	42,4	37,3	+1,7	88,4
	Fitotsyd-r	39,7	39	49,4	42,7	+7,1	95,1
least significant difference 0,5, t /ha	A	0,6	0,6	0,8	-		
	B	0,9	0,9	1,0			
	AB	1,3	1,3	1,5			

The amount of the harvest was influenced by the biometric indicators of root crops of table carrots (Table 21.). The largest mass of the root crop was formed by plants using the growth regulator Phytocid-r: in the variety Shantane CL – 184 g, in the hybrid Brilliance F_1 – 195 g, which is 29 and 35 g more compared to the control. The indicator of the diameter of the root crop was in the range of 5.8-7.0 cm and varied slightly from the growth regulator.

Table 21

Biometric indicators of root crops of table carrots depending on the variety and growth stimulant, 2019-2021.

Version		Beet root weight, g	The diameter of the beetroot, cm	Root length, cm
variety	growth regulator			
Shantane KL	no treatment (control)	155	5,8	16,4
	Ivin	163	6,2	16,8
	Emistym C	178	6,4	17,1
	Fitotsyd-r	184	6,6	17,6
Brilliance F1	no treatment (control)	160	6,2	17,3
	Ivin	166	6,4	17,6
	Emistym C	183	6,7	17,8
	Fitotsyd-r	195	7,0	18,3

The Brilliance F1 hybrid was characterized by a longer root length. However, taking into account the growth regulator used, it was established that the highest figure was for the use of Phytocid-r: in the variety Shantane KL – 17.6 cm, in the hybrid Brilliance F_1 – 18.3 cm, which is more than the variant without treatment 1.2 and 1.0 cm. A positive effect was also noted when using the growth regulators Ivin and Emistym C.

So, according to the conducted studies, the influence of growth regulators on the yield and biometric parameters of root crops of table carrots was determined.

Conclusions

The studied biological preparations affect the processes of growth and development of table beet plants. When using organic balance + Azotofit + Liposam and Gumifrend + Aztophyt + Liposam biological preparations, it was established that these biological preparations accelerate the growth of plants due to the action of the appropriate bacteria and protect against adverse conditions. Biological preparations Organic balance + Azotophyt + Liposam had the greatest effect on accelerating the growth processes of beetroot plants. Their use will have a better effect on the duration of the interphase periods of beet plants, on the formation of better biometric parameters of plants and, in general, on the formation of the yield of beet plants. The researched Chervona kylia variety and the Pablo F_1 hybrid belong to the early ripening group of table beet. The highest yield of table beet root crops was provided by the Pablo F_1 hybrid – 72.5 t/ha with the use of biological preparations Organic Balance + Azotophyt + Liposam, where the increase compared to the control was 10.5 t/ha.

Water-retaining granules accelerated the onset of phases of beetroot plant development and contributed to the reduction of interphase periods. The period from mass germination to the end of the growing season was less long in the variants with the use of water-retaining granules: in the Bordo Harkivskiy variety – 138 days, in the Opolsky variety – 137 days, which is 4 days shorter compared to the variants without granules. The highest plant height was recorded in Bordo Harkivskiy and Opolsky varieties with the use of water-retaining granules, where the increase was 3.2 cm compared to the control. The largest area of leaves was recorded in the phase of intensive root formation in all studied variants. On the variants where water-retaining granules were used, the increase was 0.5 thousand m^2/ha in the Bordo Harkivskiy variety, 0.3 thousand m^2/ha in the Opolsky variety. The highest yield was recorded in the Bordo Harkivskiy variety – 85.6 t/ha. The yield increase on variants using water-retaining granules was 23.0 - 17.5 t/ha compared to controls. The greater weight of the root crop was formed by plants of the Bordo Harkivskiy variety – 225 - 308 g. Also, water-retaining granules had an effect on the weight of the root crop, which ensured an increase in mass of the Bordo Harkivskiy and Opolskyi varieties by 83.0 and 63.0 g.

Plants treated with the growth regulator Phytocid-r were characterized by a shorter growing season, which was 117 and 118 days depending on the variety and hybrid. The highest yield was obtained from the variant using the growth regulator Phytocid-r, which ensured a yield increase at the level of: Shantane KL variety – 6.6 t/ha, Brilliance F_1 hybrid – 7.1 t/ha.

The highest percentage of marketable yield was obtained with the use of the growth regulator Phytocid-r both in the variety and in the hybrid – 94.7 and 95.1 %, which is more than the control by 11.2 and 11.0 %. The largest mass of the root crop was formed by plants using the growth regulator Phytocid-r: in the variety Shantane CL – 184 g, in the hybrid Brilliance F_1 – 195 g, which is 29 and 35 g more compared to the control. The indicator of the diameter of the root crop was in the range of 5.8-7.0 cm and varied slightly from the growth regulator.

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SCIETIFIC EDITION

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