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REGULATION OF GROWTH, DEVELOPMENT AND PRODUCTIVITY OF PEPPERS BY VITAZYME

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The article is devoted to the study of the influence of the growth stimulator Vitazyme on growth, development and productivity of pepper cv. Antey. The treatment of the drug caused an increase in the linear size of peppers, led to an increase in the number of leaves per plant and leaf mass. The leaf surface area increased under the action of Vitazyme. The use of the drug caused an increase in the concentration of chlorophyll.

The accumulation of fruit dry matter accelerated and the number of fruits on the plant increased under the influence of the drug. Yield increased and the indicators of economic efficiency of their cultivation improved under the action of Vitazyme.

Key words: sweet pepper, morphogenesis, foliar preparation, Vitazyme, coenotic indicators of plantings, yield

Introduction. One of the important tasks of modern plant physiology and biochemistry is to find new ways and means to increase the productivity of cultivated plants and to improve the quality of their products [11, 34]. The condition for obtaining significant achievements in this direction is to optimize the level of realization of the genetic potential of plants while minimizing the impact of negative environmental factors in the process of their ontogenesis [22, 26, 27].

Growth and development regulators make it possible to control plant productivity more effectively and purposefully. among which one of the first and most used in agricultural production is a group of stimulators [12, 35]. By their nature, these drugs are native phytohormones, or their synthetic analogues. They have a wide range of effects on plants, and their use allows to regulate the individual stages of growth and development of plants in order to mobilize the potential of the plant organism, and above all more fully use light energy for enhanced synthesis of plastic substances [3, 19].

It is known that the action of physiologically active substances is associated with hormonal changes [30], which causes a restructuring of the assimilation apparatus of the plant, changes in habitus, the ratio of the masses of its organs, the emergence of additional attractive centers and strengthening or weakening of existing ones that is indicating changes in the nature of donor-acceptor relations in the plant [15, 25].

The effect of growth-promoting drugs is associated with the acceleration of separation processes, stretching and differentiation with a simultaneous increase in the linear size of plants [3, 19, 20, 27], the assimilation surface area [12, 25, 28, 34], increasing the concentration of chlorophyll [18, 28, 39] and as a consequence, the activation of photosynthetic processes [21, 27, 28] and the growth of crop productivity [2, 7, 10].

There is enough information in the scientific literature about the use of native and

synthetic growth stimulants to activate the production process through morphometric changes in cereals [9, 18, 22, 42], legumes [40], oil [5, 6, 11, 34], vegetables [2, 13, 32, 37, 39], technical [11, 21, 27], fruit [1, 4, 17], medicinal and decorative [3, 8, 19] crops. Growth stimulators increase also the resistance of crops to adverse abiotic and biotic environmental factors due to changes in hormonal status and activation of antioxidant systems of the plant organism [9, 22, 23, 37, 40].

There is sufficient information in the scientific literature on the use of gibberellins to regulate the growth, development and productivity of cultivated plants. The action of gibberellins is associated primarily with the activation of meristematic tissues and, as a consequence, the formation of larger plants with a powerful assimilation apparatus and better potential for the formation of biological productivity [1, 2, 4]. In addition, gibberellins delay the aging of the leaves and induce the laying of more flowers on the plant.

In particular, gibberellic acid accelerated growth processes, increased leaf biomass, intensified photosynthetic processes in *Polygonum cuspidatum* plants, but reduced the specific surface density of leaves [36]. Gibberellic acid contributed to the accumulation of dry matter by flax plants, increasing the rate of net productivity of photosynthesis, increasing seed yield, increasing its oil content and fiber yield [21]. The same drug increased the resistance of wheat seedlings to salinization and increased crop yields [22], otherwise it accelerated the growth and stretching of stems and leaves and increased the weight of raw and dry matter of the plant and leaf area [42]. An increase in the dry weight of the fruit and a decrease in the raw weight were recorded after application of the drug on tangerines [10]. Gibberellic acid at a concentration of 35 mg per liter significantly reduced the falling mango fruit and increased their size, which led to increased yields [1]. The use of gibberellic acid on the sugar-cane plantations led to an increase in the linear size of plants, number of stems and internodes on the stem, raw matter weight and stem diameter, leaf area, index of leaf surface, net photosynthesis productivity and duration of photosynthesis compared to control. Such morphometric changes of plants led to an increase in the biological productivity of the culture [27]. Treatment of potato plants with gibberellic acid at a dose of 0.05% increased the number of leaves on the plant, the weight of raw and dry matter of the leaves, their area and chlorophyll content [31, 33]. Similar morphometric effects on the leaf apparatus were obtained in the eggplant culture [29].

Auxin growth stimulants are quite diverse in chemical structure, but with similar anatomical-morphological and physiological-biochemical effects on plants. Literature data indicate that synthetic auxin from the group of indolines indole-3-butyric acid enhanced the rooting of seedlings of *Eriocephalus africanus* [19], and indole-3-acetic acid increased the yield of rice under salinity [9].

There is sufficient information in scientific sources on the use of halogen-containing derivatives of phenoxyacetic acid. In particular, the treatment with 3,5,6-trichloro-2-pyridyloxyacetic acid in mandarin plants inhibited growth and photosynthetic processes during the first decade after the treatment and intensified them in subsequent stages of

ontogenesis, which led to increased productivity compared to control [20]. According to other researchers, this drug increased the yield of mandarin by increasing the size and weight of the fruit without increasing their number [7]. A similar effect was observed under the action of 2,4-dichlorophenoxyacetic acid used on mango plants [1]. This drug increased the yield of orange plants by reducing the fall of unripe fruits and increasing their size and weight [41]. A representative of the same group of auxins - phenylacetic acid increased the concentration of photosynthetic pigments in the green microalgae *Chlorella vulgaris* [23].

Extremely active group of auxins are derivatives of naphthyl-carboxylic acids and their salts. A number of researchers state the positive effect of 1-naphthylacetic acid on the growth, development and productivity of cultivated plants. Thus, the drug increased the concentration of chlorophyll in the cells of green algae [23], under its influence increased the size of the plant and the length of wheat leaves, while increasing the mass of raw and dry matter of the whole plant [42]. An increase in the linear size of plants, the number of leaves on the plant, the mass of their raw and dry matter were recorded in potato and eggplant plants under the action of 1-naphthylacetic acid [29, 31, 33]. However, the drug had virtually no effect on the morphometric parameters of *Lachenalia montana* according to other data [1].

The literature contains information about the use of cytokinin drugs in agricultural practice [13]. Thus, phenylurea derivatives - thidiazuron and N-(2-chloro-4-pyridyl)-N-phenylurea increased the number of buds in onions [37]. 2,6-dimethylpyridine-1-oxide is the most common representative of another group of cytokinins - N-oxide substituted pyridine. The drug is used widely as a growth stimulant in the cultivation of vegetable and industrial crops. In particular, treatment with treptolem (a.s. 2,6-dimethylpyridine-1-oxide) of sunflower plants [34], oil poppy [24] and flax [11] caused an increase in crop yields and improved oil quality.

The most widely used group of synthetic cytokines are analogues of natural cytokines of the purine series [13]. The scientific literature contains information on the use of 6-benzylaminopurine in many crops. Drug treatment of *Polygonum cuspidatum* seedlings increased the raw weight of the leaves [36]. The stimulant increased the number of female flowers in *Plukenetia volubilis*, that had a positive effect on crop yields [6], as in *Jatropha curcas* [5]. 6-benzylaminopurine inhibited the growth of young shoots in apple trees, but enhanced the flowering of the plant [17]. The use of the same drug in maize crops had a positive effect on the mesostructure of leaves, increased the number of chloroplasts and the content of chlorophyll in them, as well as increased the leaf surface index and net productivity of photosynthesis. Such changes in the leaf apparatus had a positive effect on grain yield [28]. The increase of the content of chlorophyll in the wheat leaves [18] and cucumber leaves [39] was noted under the action of 6-benzylaminopurine in the works of other authors. At the same time, grain yields increased in these crops [18] and product quality indicators improved [39]. Treatment of potato and eggplant plants with 6-benzylaminopurine increased the content of chlorophyll in the leaves and increased the quantitative indicators of the leaf apparatus, which ultimately had a positive effect on the

biological productivity of crops [18]. The use of various drugs in this group of synthetic analogues of cytokinin (6-benzylaminopurine, isopentenyladenine, meta-topolin, meta-topolinriboside and 6-(3-hydroxybenzylamino)-9-(tetrahydropyran-2-yl) purine) on the medicinal plant *Eriocephalus africanus* affected the morphogenesis of the culture differently. The largest number of stems was recorded under the influence of meta-topolin, the maximum linear size of the stems was observed after treatment by isopentenyladenine, and 6-benzylaminopurine and 6-(3-hydroxybenzylamino)-9-(tetrahydropyran-2-yl) purine promoted to the growth of plant raw matter [19]. Similar results under the influence of the same drugs are shown in experiments of other scientists [3]. In the ornamental culture of *Lachenalia montana*, meta-topolinriboside increased the number of stems, 6-benzylaminopurine increased the number of bulbs, and isopentenyladenine had almost no effect on anatomical and morphological characteristics. The increase of productivity of *Jatropha curcas* occurred after the use of 6-benzylaminopurine and forchlorfenuron [5]. Forchlorfenuron increased the weight of kiwi fruit [4], and furfuryladenine (kinetin) increased rice grain yield [9].

Thus, numerous data from the literature indicate that exogenously applied gibberellins, auxins and cytokinins lead to the optimization of the production process of crops and increase their yield and quality of product. However, in the literature there are almost no comparative systematic studies of the regulation of growth rate, morphogenesis, the formation of the photosynthetic apparatus under the action of the latest synthetic growth stimulants on pepper plants.

In connection with the above, the aim of the study was to establish the role of anatomical and morphological component in the regulation of donor-acceptor relations of pepper plants under the influence of Vitazyme.

Research methods. Vitazyme - a complex growth stimulator that is consisting of triacontanol, brassinosteroids, kinetin, gibberellic acid, indole-acetic acid, biotin, folic acid, niacin, pantothenic acid, vitamins B_1, B_2, B_6, B_{12}, porphyrins (chlorophyll derivatives), glycosides, salicylic acid and salicylates, amino acid methionine, nucleotides (adenine, etc.), gallic acid, glucuronic acid, enzymes, K_2O - 0.8, Cu - 0.007%, Zn - 0.006%, Fe - 0.2% and others. These chemical elements in the drug are in the form of chelate [43].

Field small-plot experiments were established on the lands of the peasant farm "Berzhan P.G." Gorbanivka Village, Vinnytsia District, Vinnytsia Region during the growing seasons 2015 & 2016.

The plants were treated in the morning with a backpack sprayer OP-2 until complete wetting of the leaves with Vitazyme in the budding phase on July 17, 2015 and July 10, 2016. Control plants were sprayed with tap water only at the same time.

Pepper seeds for seedlings were sown in greenhouses on March 15, 2015 and March 5, 2016. Seedlings were planted on May 29, 2015 and May 21, 2016 in a tape method according to the formula $80 + 50 + 50 \times 25$. Application of mineral fertilizers $N_{50}P_{40}K_{30}$. The area of the plots is 33 m^2, the recurrence is five times [16].

Morphological parameters were studied every 10 days. The mass of individual

organs was weighed on laboratory scales. Yield was determined by counting and weighing. The area of the leaves was determined by weight [16]. Determination of the total chlorophyll content was performed in fresh material by photoelectrocolometric method. The data of the device were entered into the formula and calibration graph [16].

The results were statistically processed using the computer program Statistica 6.0. One-way analysis of variance was used (differences between mean values were calculated by Student, they were considered probable by $P \leq 0.05$) [38].

Results and discussion. The functioning of the plant as a donor-acceptor self-regulatory system depends on a significant number of exogenous and endogenous factors, among which the regulation of native hormones and their synthetic analogues or modifiers is quite significant, because changes in growth, physiological and biochemical processes in this way cause the restructuring of the entire plant organism [17, 25, 26].

The results of our research show that a single application of liquid organic-mineral fertilizer with growth regulating properties - Vitazyme for treatment of pepper plantations of cv. Antey, at a dose of 1 l/ha, in the phase of budding caused the strengthening of growth processes in the plant. In particular, at the beginning of the phase of active fruit formation, the height of the experimental plants increased significantly and exceeded the control variant by 34% and 20% over the years of the study (Table 1). The increase of the linear size of plants under the influence of growth stimulants has been recorded in other studies [11-14, 24].

Tab. 1

Influence of Vitazyme on the linear dimensions of pepper plants cv. Antey (cm)

Sampling dates	2015		2016	
	Control	Vitazim	Control	Vitazim
Budding phase	18,81±0,92	18,81± 0,92	21,22± 0,94	21,22± 0,94
Flowering phase	24,72 ± 1,23	*35,01 ±1,76	26,53 ± 1,28	*36,75 ±1,69
The beginning of catapogenesis	31,14 ± 1,48	*43,16 ±2,12	30,14 ± 1,44	*39,85 ±1,84
The beginning of maturation	38,26 ± 1,92	*49,98 ± 2,37	32,56 ± 1,47	*43,41 ±2,09
Mass ripening of fruits	44,17 ± 2,16	*55,15 ± 2,66	38,11 ± 1,76	*45,57 ±2,12

Note. * - the difference is significant at $P \leq 0.05$

We found that Vitazyme affects the leaf apparatus of pepper plants significantly. It was investigated that during the growing season the number of leaves on the plant increased by an average of 44% and 37% over the years of the study (Table 2). An increase in the number of leaves under the action of growth stimulants is characteristic also for other plants [29-34].

Tab. 2

Influence of Vitazyme on the number of leaves of pepper plants cv. Antey (pcs.)

A variant of the experiment	2015				
	09.07.2015	19.07.2015	29.07.2015	09.08.2015	19.08.2015
Control	55,09±2,22	59,75±2,93	69,25±3,46	79,97±3,89	93,75±4,47
Vitazyme	55,09±2,22	*89,13±4,47	*101,01±4,87	*117,16±5,74	*128,06±6,36
	2016				
	25.07.2016	05.08.2016	15.07.2016	25.08.2016	05.09.2016

Control	57,63±2,74	91,03±4,32	93,97±4,56	104,52±4,93	128,74±5,62
Vitazyme	57,63±2,74	*118,75±4,89	*130,78±6,44	*144,58±6,86	*176,75±6,98

Note. * - the difference is significant at P≤0.05

The results of our studies indicate that under the influence of Vitazyme the leaf surface area increased by an average of 32% and 24% compared to the control during the study period in 2015 and 2016 (Table 3). The area of the photosynthetic surface increased in oilseed flax plants, oil poppy and sunflower under the influence of the cytokinin growth stimulator - treptolem [12, 24, 29, 32, 33].

Tab. 3

Influence of Vitazyme on leaf area in Antey pepper plants (cm^2)

A variant of the experiment	**2015**				
	09.07.2015	**19.07.2015**	**29.07.2015**	**09.08.2015**	**19.08.2015**
Control	413,53±19,95	553,26±26,37	803,33±39,91	993,79±48,87	1404,76±69,54
Vitazyme	413,53±19,95	629,81±28,83	*999,77±49,18	*1375,94±67,43	*2138,68±104,32
	2016				
Control	1133,40±56,65	1498,82±69,96	2000,87±97,34	2404,57±111,07	2866,86±128,84
Vitazyme	1133,40±56,65	*2100,23±99,32	*2823,59±132,88	*3247,41±143,76	*3539,47±155,93

Note. * - the difference is significant at P≤0.05

It was found that the use of growth stimulant Vitazyme caused an increase of the content of chlorophyll in the leaves of peppers on average during the growing season by 6 and 14% (Table 4). The increase of the content of the main photosynthetic pigment under the influence of treptolem has been found in other crops [29-34].

Tab. 4

Effect of Vitazyme on chlorophyll content in leaves of Antey pepper plants (% / dry matter)

A variant of the experiment	**2015**				
	09.07.2015	**19.07.2015**	**29.07.2015**	**09.08.2015**	**19.08.2015**
Control	0,64±0,01	0,66±0,01	0,71±0,02	0,73±0,02	0,84±0,02
Vitazyme	0,64±0,03	0,69 ±0,01	0,77±0,02	0,79±0,02	0,89±0,02
	2016				
	25.07.2016	**05.08.2016**	**15.07.2016**	**25.08.2016**	**05.09.2016**
Control	0,61±0,01	0,63±0,01	0,69±0,02	0,75±0,02	0,77±0,02
Vitazyme	0,61±0,03	0,65 ±0,01	0,71±0,02	0,78±0,02	0,88±0,02

Note. * - the difference is significant at P≤0.05

It was studied that the drug Vitazyme significantly affected the accumulation and redistribution of raw and dry matter by pepper plants. In particular, it was found that under the action of the drug increased the mass of raw material of the root at the beginning of the phase of active fruit formation in 2015 and 2016 by 32 and 10%, the raw matter of the stem by 21 and 17%, the raw matter of leaves by 49 and 16% and the mass raw matter of fruits by 41 and 19% (Table 5). The growth of the mass of raw matter of vegetative organs under the influence of growth stimulants is indicated in other sources [11-14, 24].

Tab. 5

Influence of Vitazim on the mass of raw matter of plant organs of peppers of Antey variety

A variant of the experiment	**Root**		**Stem**		**Leaves**		**Fruit**	
	Control	**Vitazyme**	**Control**	**Vitazyme**	**Control**	**Vitazyme**	**Control**	**Vitazyme**
2015								
09.07.15	8,02±0,36		18,04±0,87		18,11±0,83		-	

19.07.15	9,13 ±0,38	9,98 ±0,47	21,19 ±1,07	*25,21 ±1,19	25,07 ±1,14	*32,12 ±1,47	27,31 ±1,34	*55,28 ±2,68
29.07.15	9,51 ±0,44	*12,05 ±0,57	32,06 ±1,38	35,14 ±1,47	27,21 ±1,33	*47,11 ±1,21	121,02 ±5,85	*156,12 ±7,67
09.08.15	9,97 ±0,48	*15,18 ±0,74	34,01 ±1,63	*47,21 ±2,25	38,09 ±1,77	*61,18 ±2,96	211,08 ±9,63	*249,95 ±11,05
19.08.15	13,03 ±0,59	*18,05 ±0,88	46,96 ±2,31	*54,89 ±2,57	56,32 ±2,78	74,26 ±3,59	264,01 ±9,11	*296,44 ±11,12
2016								
25.07.16	2,12±0,09		19,98±0,94		29,87±0,96		-	
05.08.16	2,37 ±0,11	*3,25 ±0,14	41,91 ±1,74	49,97 ±1,89	40,13 ±1,94	*61,17 ±2,78	114,16 ±5,68	118,97 ±5,79
15.08.16	3,54 ±0,16	*7,13 ±0,33	54,04 ±2,32	*73,99 ±3,54	44,42 ±2,14	*63,39 ±2,84	129,73 ±6,17	*159,26 ±7,71
25.08.16	9,17 ±0,41	*12,18 ±0,57	89,53 ±3,91	*111,97 ±5,04	110,38 ±1,77	*143,12 ±6,16	518,41 ±21,84	561,36 ±23,78
05.09.16	18,12 ±0,88	19,97 ±0,93	109,93 ±4,81	*128,55 ±6,09	194,23 ±8,97	*226,15 ±9,93	582,24 ±25,69	*693,23 ±27,83

Note. * - the difference is significant at P≤0.05

Accordingly, there was an increase in the dry matter of vegetative organs and fruits of peppers cv. Antey. Thus, it was found that under the action of the drug increased the dry matter of the root during the growing season on average over the years by 30%, the dry matter of the stem by 28%, the dry matter of the leaves by 25% and the dry matter of the fruit by 29% during the study period (Table 6). Similar results were observed under the influence of growth stimulants in other cultivated plants [12, 14, 24, 29, 33].

Tab. 6

Influence of Vitazyme on the mass of dry matter of plant organs of Antey peppers.

A variant of the experiment	**Root**		**Stem**		**Leaves**		**Fruit**	
	Control	**Vitazyme**	**Control**	**Vitazyme**	**Control**	**Vitazyme**	**Control**	**Vitazyme**
2015								
09.07.15	0,98±0,05		2,01±0,08		2,02±0,07		-	
19.07.15	1,31 ±0,06	1,39 ±0,06	3,03 ±0,10	3,63 ±0,17	1,31 ±0,06	1,39 ±0,06	3,03 ±0,10	3,63 ±0,17
29.07.15	2,29 ±0,11	*3,01 ±0,13	5,09 ±0,23	*6,53 ±0,32	2,29 ±0,11	*3,01 ±0,13	5,09 ±0,23	*6,53 ±0,32
09.08.15	3,09 ±0,14	*3,98 ±0,18	6,16 ±0,29	*9,11 ±0,38	3,09 ±0,14	*3,98 ±0,18	6,16 ±0,29	*9,11 ±0,38
19.08.15	4,15 ±0,19	*5,55 ±0,25	7,93 ±0,39	*11,01 ±0,53	4,15 ±0,19	*5,55 ±0,25	7,93 ±0,39	*11,01 ±0,53
2016								
25.07.16	0,35±0,01		2,99±0,14		3,11±0,15		-	
05.08.16	0,51 ±0,02	*0,73 ±0,03	6,53 ±0,32	*7,71 ±0,34	0,51 ±0,02	*0,73 ±0,03	6,53 ±0,32	*7,71 ±0,34
15.08.16	1,05 ±0,04	*2,02 ±0,09	8,73 ±0,38	*11,77 ±0,53	1,05 ±0,04	*2,02 ±0,09	8,73 ±0,38	*11,77 ±0,53
25.08.16	2,59 ±0,12	*3,32 ±0,24	14,52 ±0,67	*18,21 ±0,89	2,59 ±0,12	*3,32 ±0,24	14,52 ±0,67	*18,21 ±0,89
05.09.16	4,55 ±0,21	4,74 ±0,23	19,12 ±0,93	*23,63 ±0,97	4,55 ±0,21	4,74 ±0,23	19,12 ±0,93	*23,63 ±0,97

Note. * - the difference is significant at P≤0.05

We found that the drug Vitazyme optimized the productivity of pepper cultivar cv. Antey. Under the action of drug, the yield of fruits from one bush and the total yield per plot per hectare increased by 34% in 2015 and by 35% in 2016 (Table 7). Optimization of the production process under the action of a synthetic analogue of cytokinins - treptolem has been established in sunflower plants [34], oil flax [12] and oil poppy [24], eggplant [29], potatoes [33].

Tab. 7.

Influence of Vitazyme on yield of Antey pepper plants

Option / Indicator	2015		2016	
	Control	**Vitazyme**	**Control**	**Vitazyme**
The average weight of one fruit, kg	0,086±0,004	0,085±0,004	0,063±0,003	0,067±0,003
The number of fruits from the bush, pcs.	5,13±0,24	*6,96±0,32	4,12±0,18	*5,25±0,21
Weight of fruit from one bush, kg	0,44±0,02	*0,59±0,03	0,26±0,01	*0,35±0,02
Plant density per 1 ha	66000	66000	66000	66000
Yield, t / ha	29,11±1,44	*39,07±1,92	17,16±0,81	*23,11±1,12

Note. * - the difference is significant at $P \leq 0.05$

Calculations of the economic efficiency of Vitazyme indicate that additional net profit and profitability increased, and the cost of growing 1 ton of products decreased under the influence of the drug (Table 8).

Tab. 8

Economic efficiency of Vitazyme application on Antey pepper plants

№	Indicator	2015		2016	
		Control	**Vitazyme**	**Control**	**Vitazyme**
1	Total production costs, UAH	55913,50	62649,77	56818,15	63955,78
2	Gross collection, t	29,11	39,07	17,16	23,11
3	Yield, t / ha	29,11	39,07	17,16	23,11
4	Yield supplement, t / ha	-	9,96	-	5,95
5	Yield growth,%	-	34,22	-	34,67
6	Product price, UAH / t	7500,00	7500,00	3500,00	3500,00
7	The cost of gross output, UAH	218325,00	293025,00	60060,00	80885,00
8	The cost of additional products, UAH	-	74700,00	-	20825,00
9	Net profit, UAH	162411,51	230375,23	3241,85	16929,22
10	Additional net profit due to the use of the drug, UAH / ha	-	67963,72	-	13687,37
11	Cost, UAH / t	1920,77	1603,53	3311,08	2767,45
12	Cost difference, UAH	-	317,24	-	543,63
13	Profitability,%	290,47	367,72	5,71	26,47
14	Profitability difference,%	-	77,25	-	20,76

Conclusions.

1. The use of Vitazyme on the pepper plants cv. Antey led to an increase the height of plant, increased the number and the area of leaves.
2. Vitazyme increased the mass of raw and dry matter of plants.
3. The drug caused an increase of the chlorophyll content in the leaves.
4. Vitazyme treatment of the pepper plantations provided an increase of the fruit yield.
5. An additional net profit of 67,963.72 UAH / ha in 2015 and 13,687.37 UAH / ha in 2016 was obtained after using Vitazyme on the pepper plantations.

Literature

1. Ahmed, W., Tahir, F. M., Rajwana, I. A., Raza, S. A., & Asad, H. U. (2012). Comparative Evaluation of Plant Growth Regulators for Preventing Premature Fruit Drop and Improving Fruit Quality Parameters in Dusehri Mango. International Journal of Fruit Science, 12, 372-389.
2. Alexopoulos, A. A., Karapanos, I. C., Akoumianakis, K. A., & Passam, H. C. (2017). Effect of Gibberellic Acid on the Growth Rate and Physiological Age of Tubers Cultivated from True Potato Seed, Journal of Plant Growth Regulation, 36 (1) 1–10.
3. Aremu, A. O., Plackova, L., Masondo, N. A., Amoo, S. O., Moyo, M., Novak, O., Dolezal, K., & Staden J. V. (2017). Regulating the regulators: responses of four plant growth regulators during clonal propagation of *Lachenalia montana.* Plant Growth Regulation, 82 (2),305–315.
4. Cruz-Castilloa, J. G., Baldicchib, A., Frionib, T., Marocchic, F., Moscatellod, S., Proiettid, S., Battistellid, A., & Famianib F. (2014). Pre-anthesis CPPU low dosage application increases Hayward kiwifruit weight without affecting the other qualitative and nutritional characteristics. Food Chemistry, 158 (1), 224-228.
5. Froschle, M., Horn, H., & Spring, O. (2017). Effects of the cytokinins 6-benzyladenine and forchlorfenuron on fruit-, seed- and yield parameters according to developmental stages of flowers of the biofuel plant *Jatropha curcas* (*Euphorbiaceae*). Plant Growth Regulation, 81 (2), 293–303.
6. Fu, Q., Niu, L., Zhang, Q., Pan, B-Z., He, H., & Xu, Z-F. (2014). Benzyladenine treatment promotes floral feminization and fruiting in a promising oilseed crop Plukenetia volubilis. Industrial Crops and Products, 59, 295-298.
7. Gonzatto, M. P., Boettcher, G. N., Schneider, L. A., Lopes, A. A., Junior, J. C. S., Petry, H. B., Oliveira, R. P., & Schwarz, S. F. (2016) 3,5,6-trichloro-2-pyridinyloxyacetic acid as effective thinning agent for fruit of Montenegrina mandarin. Ciencia Rural, 46 (12).
8. Gouveia, E. J., Rocha, R. B., Galveas, B., Ramalho, L. A. R., Ferreira, M. G. R., & Dias, L. A. S., (2012). Grain yield increase of physic nut by field-application of benzyladenine. Pesquisa Agropecuária Brasileira, 47 (10), 1541-1545.
9. Javid, M. G., Sorooshzadeh, A., Sanavy, S. A. M. M., Allahdadi, I., & Moradi., F. (2011). Effects of the exogenous application of auxin and cytokinin on carbohydrate accumulation in grains of rice under salt stress. Plant Growth Regulation, 65, (2), 305–313.
10. Khalid, S., Malik, A. U., Khan, A. S., Razzaq, K., & Naseer, M. (2016). Plant growth regulators application time influences fruit quality and storage potential of young kinnow mandarin trees. International Journal of Agriculture & Biology, 18, 623–629.
11. Khodanitska, O. O., & Kuryata, V. G. (2011) Dija treptolemu na nasinnjevu produktyvnist' i jakisni harakterystyky olii' l'onu [The effect of treptolem on seed yield and quality characteristics of flaxseed oil]. Kormy i kormovyrobnyctvo, 70, 54-59 (in Ukrainian).
12. Khodanitska O. O., Kuryata V.G., Shevchuk O.A., Tkachuk O.O. & Poprotska I.V. (2019) Effect of treptolem on morphogenesis and productivity of linseed plants. Ukrainian Journal of Ecology, 9 (2), 119-126.
13. Kuryata, V.G., Kushnir, O.V. & Kravets, O.O. (2020). Effect of 6-Benzylaminopurine on Morphogenesis and Production Process of Sweet Pepper (*Capsicum annuum* L.). Ukrainian Journal of Ecology, 10 (2), 106-111.
14. Kuryata V. G., Polyvanyi S. V., Shevchuk O. A. & Tkachuk O. O. (2019) Morphogenesis and the effectiveness of the production process of oil poppy under the complex action of retardant chlormequat chloride and growth stimulant treptolem. Ukrainian Journal of Ecology, 9 (1), 127-134.
15. Kuryata, V. G., Poprotska, I. V., & Rogach, T. I. (2017). Vplyv stymuljatoriv rostu ta retardantiv na utylizaciju rezervnoi' olii' prorostkamy sonjashnyku [The impact of growth stimulators and retardants on the utilization of reserve lipids by sunflower seedlings]. Regulatory mechanisms in biosystems, 8(3), 317–322 (in Ukrainian).
16. Latimer, G. W. (2010) Official Meethods of Analysis of Association of Analytical Chemist International. Association of Official Analytical Chemists. 18 (3). 1-771.
17. Li, Y., Zhang, D., Xing, L., Zhang, S., Zhao, C., & Han, M. (2016). Effect of exogenous 6-benzylaminopurine (6-BA) on branch type, floral induction and initiation, and related gene expression in Fuji apple (*Malus domestica*). Plant Growth Regulation, 79 (1), 65–70.
18. Luo, Y., Yang, D., Yin, Y., Cui, Z., Li, Y., Chen, J., Zheng, M., Wang, Y., Pang, D., Li, Y., & Wang, Z. (2016). Effects of Exogenous 6-BA and Nitrogen Fertilizers with Varied Rates on Function and

Fluorescence Characteristics of Wheat Leaves Post Anthesis. Scientia Agriculturalura Sinica, 49 (6), 1060-1083.
19. Madzikane-Mlungwana, O., Moyo, M., Aremu, A. O., Plíhalova, L., Doleal, K., Staden, J. V., & Finnie, J. F. (2017). Differential responses to isoprenoid, N^6-substituted aromatic cytokines and indole-3-butyric acid in direct plant regeneration of *Eriocephalus africanus*. Plant Growth Regulation, 82 (1), 103–110.
20. Mesejo, C., Rosito, S., Reig, C., Martínez-Fuentes, A., & Agustí, M. (2012). Synthetic Auxin 3,5,6-TPA Provokes Citrus clementina (Hort. ex Tan) Fruitlet Abscission by Reducing Photosynthate Availability. Journal of Plant Growth Regulation, 31 (2), 186–194.
21. Mohammad, N. K., & Mohammad, F. (2013). Effect of GA_3, N and P ameliorate growth, seed and fibre yield by enhancing photosynthetic capacity and carbonic anhydrase activity of linseed. Integrative Agriculture, 12 (7), 1183-1194.
22. Muhammad, I., & Muhammad, A. (2013). Gibberellic acid mediated induction of salt tolerance in wheat plants: Growth, ionic partitioning, photosynthesis, yield and hormonal homeostasis. Environmental and experimental botany, 86, 76–85.
23. Piotrowska-Niczyporuk, A., & Bajguz, A. (2014). The effect of natural and synthetic auxins on the growth, metabolite content and antioxidant response of green alga *Chlorella vulgaris* (*Trebouxiophyceae*). Plant Growth Regulation, 73 (1), 57–66.
24. Polyvanyj, S. V., & Kuryata, V. G. (2015) Dija treptolemu na morfogenez, produktyvnist' ta jakisni harakterystyky maku olijnogo [Effects of treptolem on morphogenesis, productivity and qualitative characteristics of poppy oil]. Agrobiologija: Zbirnyk naukovyh prac', 117 (1), 65-72 (in Ukrainian).
25. Poprotska, I. V., & Kuryata, V. G. (2017). Features of gas exchange and use of reserve substances in pumpkin seedlings in conditions of skoto- and photomorphogenesis under the influence of gibberellin and chlormequat-chloride. Regulatory Mechanisms in Biosystems, 8 (1), 317-322.
26. Poprotska I., Kuryata V., Khodanitska O., Polyvanyi S., Golunova L. & Prysedsky Y. (2019) Effect of gibberellin and retardants on the germination of seeds with different types of reserve substances under the conditions of skoto-and photomorphogenesis. Biologija, 65, (4), 296–307.
27. Rai, R. K., Tripathi, N., Gautam, D., & Singh, P. (2017). Exogenous Application of Ethrel and Gibberellic Acid Stimulates Physiological Growth of Late Planted Sugarcane with Short Growth Period in Sub-tropical India. Journal of Plant Growth Regulation, 36 (2), 472–486.
28. Ren, B., Zhang, J., Dong, S., Liu, P., & Zhao, B. (2017). Regulations of 6-Benzyladenine (6-BA) on Leaf Ultrastructure and Photosynthetic Characteristics of Waterlogged Summer Maize. Journal of Plant Growth Regulation, 36 (3) 743–754.
29. Rohach, V. V. (2017). Vplyv stymuljatoriv rostu na fotosyntetychnyj aparat, morfogenez i produkcijnyj proces baklazhana *(Solanum melongena)* [Influence of growth stimulants on photosynthetic apparatus, morphogenesis and production process of eggplant (*Solanum melongena*)]. Biosystems Diversity, 25(4), 297–304 (in Ukrainian).
30. Rogach V. V., Voitenko L. V., Shcherbatiuk M. M., Kosakivska I. V. & Rogach T. I. (2020) Morphogenesis, pigment content, phytohormones and productivity of eggplants under the action of gibberellin and tebuconazole. Regulatory Mechanisms in Biosystems, 11, (1), 129-135.
31. Rogach, V.V. & Rogach, T.I. (2015) Vplyv syntetychnyh stymuljatoriv rostu na morfofiziologichni harakterystyky ta biologichnu produktyvnist' kul'tury kartopli [Influence of synthetic growth stimulators on morphological and physiological characteristics and biological productivity of potato culture]. Visnyk Dnipropetrovs'kogo universytetu. Biologija, ekologija 23(2), 221–224 (in Ukrainian).
32. Rohach V.V., Kiriziy D.A., Stasik O.O., Mickevicius S. & Rohach T.I. (2020) The effect of growth promotors and retardants on the morphogenesis, photosynthesis and productivity of tomatoes (*Lycopersicon esculentum* Mill.). Fiziol. rast. genet., 52, 4, 279-294.
33. Rohach V.V., Rohach T.I., Kylivnyk A.M., Polyvanyi S.V., Bayurko N.V., Nikitchenko L.O., Tkachuk O.O., Shevchuk O.A., Hudzevych L.S. & Levchuk N.V. The influence of synthetic growth promoters on morphophysiological characteristics and biological productivity of potato culture. Modern Phytomorphology, 14, 111-114.
34. Rogach, T. I. (2009). Osoblyvosti morfogenezu i produktyvnist' sonjashnyku za dii' treptolemu [Particularity of morphogenesis and productivity of sunflower plants under the influence of treptolem]. Fiziologija roslyn: problemy ta perspektyvy rozvytku, 2, 680-686 (in Ukrainian).
35. Shevchuk O. A., Kravets O. O., Shevchuk V. V., Khodanitska O. O., Tkachuk O. O., Golunova L. A.,

Polyvanyi S. V., Knyazyuk O. V. & Zavalnyuk O. L. (2020). Features of leaf mesostructure organization under plant growth regulators treatment on broad bean plants. Modern Phytomorphology. 14, 104-106.
36. Sugiura, D., Sawakami, K., Kojim, M., Sakakibara, H., Terashima, I., & Tateno, M. (2015). Roles of gibberellins and cytokinins in regulation of morphological and physiological traits in Polygonum cuspidatum responding to light and nitrogen availabilities. Functional Plant Biology, 42(4).
37. Tubic, L., Savic, J., Mitic, N., Milojevic, J., Janosevi, D., Budimir, S., & Zdravkovic-Korac, S. (2016). Cytokinins differentially affect regeneration, plant growth and antioxidative enzymes activity in chive (*Allium schoenoprasum*). Plant Cell, Tissue and Organ Culture January, 124 (1), 1–14.
38. Van Emden, H.F. (2008). Statistics for terrified biologists. Blackwell, Oxford.
39. Xiaotao, D., Yuping, J., Hong, W., Haijun, J., Hongmei, Z., Chunhong, C., & Jizhu, Y. (2013). Effects of cytokinin on photosynthetic gas exchange, chlorophyll fluorescence parameters, antioxidative system and carbohydrate accumulation in cucumber (*Cucumis sativus*) under low light. Acta Physiologiae Plantarum, 35 (5) 1427–1438.
40. Xing, X., Jiang, H., Zhou, Q., Xing, H., Jiang, H., & Wang, S. (2016). Improved drought tolerance by early IAA- and ABA-dependent H_2O_2 accumulation induced by α-naphthaleneacetic acid in soybean plants. Plant Growth Regulation, 80 (3), 303–314.
41. Yildirım, B., Yesiloglu, T., Incesu, M., Kamiloglu, M. U., Cimen, B., & Tamer, S. (2012). Effects of 2,4-DP (2,4-dichlorophenoxypropionic acid) plant growth regulator on fruit size and yield of Valencia oranges (*Citrus sinensis*). New Zealand Journal of Crop and Horticultural Science, 40 (1), 55-64.
42. Zhao, H., Cao, H., Ming-Zhen, P., Sun, Y., & Liu, T. (2017). The Role of Plant Growth Regulators in a Plant Aphid Parasitoid Tritrophic System. Journal of Plant Growth Regulation, 36 (4), 868–876.
43. Access mode https://vitazyme.com.ua/sposib-zastosuvannia.