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GROWTH REGULATORS FOR SUGAR BEETS

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Abstract

Plant growth regulators stilites were synthesized in the Department of Organic Chemistry, Kaunas University of Technology. The researches of the physiological activity of growth regulators stilites were performed by screening in the Laboratory of Agrobiotechnology, Lithuanian University of Agriculture (LUA). Field studies were performed at the Research Station of LUA. The growth regulators and microelement fertilizers "ARVI mikro" as well as the effect of the fertilizer mixtures with the growth regulators on the productivity of sugar beets were researched.

The results of the physiological-activity researches showed that the stilite – 123 was the most active compound among the growth regulators tested. The productivity of the roots of the sugar-beet plants that were sprayed with the solution of the mentioned growth regulator increased by 6.5 t ha^{-1} (10%), whereas the sugar content increased by 0.45 % and the production of white sugar increased by 1.14 t ha^{-1} (14 %) compared to the control plants.

An even better result was achieved by additional fertilization of sugar-beet leaves by using growth regulator stilite-123 mixture with micro-fertilizer "ARVI mikro". As a result of the mentioned additional fertilization the productivity of the beetroots increased by 7 t ha^{-1} (11 %), the sugar content by 0.5 %, and the production of white sugar by 1.25 t ha^{-1} (15.6 %) compared to that of the control plants.

Key words: growth regulators, physiological activity, micro-fertilizers, beetroots, productivity, sugar-content.

Introduction

Sugar beets are one of the most profitable crops in agriculture, the income from which constitutes about 25–34 % of the total income from agricultural products. During recent years the total area of 29–30 thousand ha has been used for cultivation of sugar beets. The productivity and sugar-content indices of sugar beets are increasing. In the long term, the increased productivity of sugar beets and improved indices of the quality of roots shall result in the decrease of cultivation areas of sugar beets as well as the major concentration of sugar beets in those areas that are most suitable for cultivation. Thanks to these developments it will be possible to fulfil the objective of the topmost importance, i.e. to optimise the growth factors of sugar beets. The cultivation practise of sugar beets showed, that the main factors such as pH level and composition of soil, sowing time, and amount of nutrients had a significant effect on the yield of sugar beets /Lithuanian Institute of Agricultural Economy, 2005 /.

To improve the assimilation of nutrients by plants as well as to intensify the growth and development of plants, the materials for growth stimulation were started to be used in the cultivation technologies of sugar beets. Since the growth of sugar beets is slow in the early stage of vegetation, the vegetation period is the most optimal period for stimulation of growth by using growth regulators. The synthetic growth regulators absorbed by a plant stimulate the activity of natural phytohormones, which in turn intensify the natural physiological processes of the plant. Physiological activity of synthetic growth regulators refers to an ability of growth regulators to affect a particular component of phytohormone system, i.e. to the ability to increase the amount of the particular endogenic phytohormone, to intensify or inhibit the biosynthesis of natural phytohormones in the plant /Jakienė et al., 2004/.

The usage of growth regulators is limited in agriculture due to several reasons: the growth regulators change the status and ratios of individual hormones produced in the plant tissues during ontogenesis whereas the plants tend to maintain a particular status of hormones in the tissues. In the case of an additionally supplied phytohormone, the phytohormone is destructed, conjugated with other compounds or neutralised /Darginavičienė et al., 2002/.

During the recent decades there has been quite an increase of synthetic compounds, however only one tenth of them have found their usage in horticulture. The main feature of such synthetic compounds is that they affect the whole plant by inhibiting or stimulating its growth. However the same effect can be obtained by using modern agrotechnical and agrochemical means. Therefore major attention should be paid to search and synthesis of physiological analogues of phytohormones of narrow specialisation as well as to their synthesis, researches and application in horticulture /Merkys et al., 1993/.

Application of phytohormones, their physiological analogues and other types of growth regulators is a new field of chemization in horticulture. Synthetic analogues of phytohormones must have the following features: the transportation of the synthetic phytohormones must be the same as transportation of endogenic phytohormones; the synthetic phytohormones must be recognised by the receptors of the relevant phytohormones; the synthetic phytohormones must modify the synthesis of proteins, which are associated with the activity of tissues or entire organism. Considering all the mentioned features, it is necessary to solve the problem of organogenesis, metabolism, generative development and regulation of productivity in the most effective way: to study the physiological activity of synthetic analogues of phytohormones and to use the most active compounds in the practice of horticulture /Merkys et al., 1993, 2000/.

The aim of these researches: to establish the physiological activity of synthetic analogues of phytohormones (i.e. stilites) as well as the optimal concentrations of the solutions for growth stimulation and the effect of the researched growth regulators on the growth and productivity of sugar beets.

Materials and Methods

The physiological activity of growth regulators stilites was researched in the Laboratory of Agrobiotechnology, LUA. Screening method was used for the researches /Stašauskaitė, 1995, 1999/. Malt barley of 'Alsa' variety was chosen as the model plant for the researches. The barley seeds were spread on a filter paper moistened with the solutions of the researched concentrations of growth regulators stilites in the *Petri* plates and germinated for eight days and nights. The control plants were germinated from barley seeds sprayed with purified water. The germination was repeated three times with the duration of illumination of 16 hours and with the temperature of 18–20 ^{o}C. Upon the expiry of the exposure time the viability of barley seeds, growth intensity of a seed and its root system as well as average biomass of ten seeds were established.

Precision field tests were performed in the *Balhihylogleyi - Calc(ar)ic Luvisol at the* Research Station of LUA during the period 2005–2006. The specifications of the soil: humus 2.5 %, phosphorus content P_2O_5 180–240 mg kg^{-1} soil, potassium content K_2O 120–150 mg 1 kg^{-1} soil, and soil pH_{KCh} 7.1.

Winter wheat was used as a preceding crop for sugar beets.

In spring the dry soil was fertilized with complex fertilizers (NPK 11:13:30 400 kg ha^{-1}) by using fertilizer spreader. The next day the soil cultivation followed and the surface of the cultivated soil was sprayed with the soil herbicide Pyramin Turbo. The seeds were sowed every 16 cm in beds (width of a bed: 45 cm) by using a pneumatic sowing machine PTO MAX-540.

Upon renewal of massive growth of weeds, the field was sprayed with herbicide Betanal Expert (1.3 l ha^{-1}). Ammonium nitrate (200 kg ha^{-1}) was used for additional fertilization of sugar beets. The sample plants at a growth stage of 6 pairs of leaves were sprayed with the solutions of growth regulators stilites, solution of micro-fertilizer and mixtures of the micro-fertilizer and growth regulators. Two days later the herbicide mixture comprising Betanal Expert (1.1 l ha^{-1}) and Lontrel (0.3 l ha^{-1}) was used to control the weeds.

The yield of sugar beets was harvested manually by using root-crop lifter. During harvesting all beetroots of every test field were counted and weighed and the samples were taken to establish the content of sugar. The sugar content of the beetroots was determined in the Sugar Factory of Marijampolė.

Table 1. Agrotechnical means and their schedule
1 lentelė. *Agrotechnikos priemonės ir jų atlikimo laikas*

Research Station of LUA
LŽŪU Bandymų stotis

Agrotechnical means *Agrotechnikos priemonė*	Schedule of operations *Darbų atlikimo laikas*	
	2005	2006
Fertilization by using complex fertilizer (NPK 11:13:30 400 kg ha^{-1}) *Tręšta kompleksinėmis trąšomis (NPK 11:13:30 400 kg ha^{-1})*	25th of April *Balandžio 25 d.*	20th of April *Balandžio 20 d.*
Spraying of soil herbicide Pyramin Turbo (4.0 l ha^{-1}) *Purkšta dirviniu herbicidu piraminu turbo (4,0 l ha^{-1})*	26th of April *Balandžio 26 d.*	21st of April *Balandžio 21 d.*
Cultivation of soil before sowing *Priešsėjinis dirvos dirbimas*	26th of April *Balandžio 26 d.*	21st of April *Balandžio 21 d.*
Sowing / *Sėja*	27th of April *Balandžio 27 d.*	22nd of April *Balandžio 22 d.*
Spaying of herbicide Betanal Expert (1.3 l ha^{-1}) *Purkšta herbicidu betanalu expertu (1,3 l ha^{-1})*	25th of May *Gegužės 25 d.*	18th of May *Gegužės 18 d.*
Additional fertilization by using ammonium saltpetre (N_{68}, 200 kg ha^{-1}) *Tręšta papildomai amonio salietra (N_{68} 200 kg ha^{-1})*	27th of June *Birželio 27 d.*	24th of June *Birželio 24 d.*
Spraying of sugar beets by using solutions of growth regulators (concentration: 90 mg l^{-1}) and micro-fertilizers (concentration: 1g l^{-1}) / *Cukriniai runkeliai purkšti augimo reguliatorių (koncentracija 90 mg l^{-1}) ir mikroelementinių trąšų (koncentracija 1g l^{-1}) tirpalais*	28th of June *Birželio 28 d.*	27th of June *Birželio 27 d.*
Spraying with a mix of herbicides (Betanal Expert 1.1 l ha^{-1} + + Lontrel 0.3 l ha^{-1}) / *Purkšta herbicidų (betanalo experto 1,1 l ha^{-1} + lontrelo 0.3 l ha^{-1}) mišiniu*	30th of June *Birželio 30 d.*	2nd of July *Liepos 2 d.*
Harvesting *Derliaus nuėmimas*	27th of September *Rugsėjo 27 d.*	26th of September *Rugsėjo 26 d.*

Experimental design:

1. Control plants (plants sprayed with water)
2. Plants sprayed with a solution of ARVI micro-fertilizers (concentration: 1g l^{-1})
3. Plants sprayed with a solution of stilite-123 (concentration: 90 mg l^{-1})
4. Plants sprayed with a solution of stilite-124 (concentration: 90 mg l^{-1})
5. Plants sprayed with a solution of stilite-125 (concentration: 90 mg l^{-1})
6. Plants spayed with the mixture of ARVI micro-fertilizers and stilite-123
7. Plants spayed with the mixture of ARVI micro-fertilizers and stilite-124
8. Plants spayed with the mixture of ARVI micro-fertilizers and stilite-125

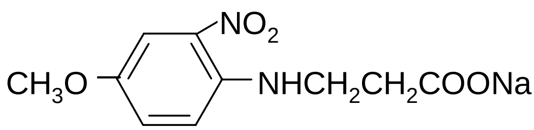
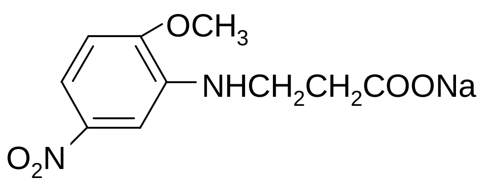
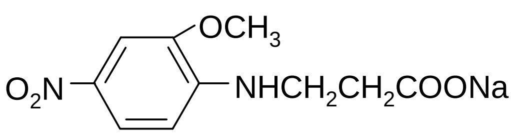
Composition of ARVI micro-fertilizers:

Total Nitrogen (N)	14 %
Ammonium Nitrogen (NH_4-N)	14 %
Magnesium (MgO)	5.3 %
Sulphur (S)	19.5 %
Manganese (Mn)	0.117 %
Copper (Cu)	0.1 %
Zinc (Zn)	0.067 %
Boron (B)	0.017 %
Molybdenum (Mo)	0.003 %

The recommended amount of micro-fertilizer “ARVI mikro“ for fertilization of sugar beets is 3–4 kg ha^{-1} diluted with 300 l ha^{-1} of water.

The growth regulators stilites produced in the Department of Organic Chemistry, Kaunas University of Technology were tested.

Table 2. Structural formula of the growth regulators stilites tested
2 lentelė. *Augimo reguliatorių stilitų struktūrinės formulės*

Structural formula / *Struktūrinė formulė*	Name / *Pavadinimas*
	Stilite - 123
	Stilite -124
	Stilite -125

Stilites are eco-friendly non-toxic compounds that are easily assimilated by plants. If the seeds of field plants, vegetables or perennial grass are soaked in a water-based solution of stilites, the seeds shall grow faster, their growth energy and viability shall increase, the sprouts of the seeds shall grow and develop more intensively, and the plants shall develop a better system of roots. The field plants shall grow faster and require less time to develop a maximal assimilation surface of leaves as well as the processes of photosynthesis shall become more intense if the field plants are sprayed with stilite solutions during vegetation period. The productivity and its quality increase /Jakienė et al., 2003; Jakienė i dr., 2003/. However, it is noteworthy that the major effect of growth regulators on the productivity of sugar beets may be achieved only if agrotechnical means of high standard are applied. It is not reasonable to expect a large yield and high quality of agricultural plants if poor agrotechnical means are used.

Results

Based on the results of the physiological-activity researches of the stilites performed at the Laboratory of Agrobiotechnology, LUA, the growth regulators stilites stimulated the germination and growth of plants. The viability of plants increased as a result of spraying the plants with the solutions of growth regulators stilites. The major increase (11 %) of the viability of seeds was reported for the growth regulator stilite-123 (see Fig.1). The viability of the barley seeds sprayed with the solutions (concentration: 90 mg l^{-1}) of other researched growth regulators was 5-7 % higher compared to the control plants sprayed with purified water.

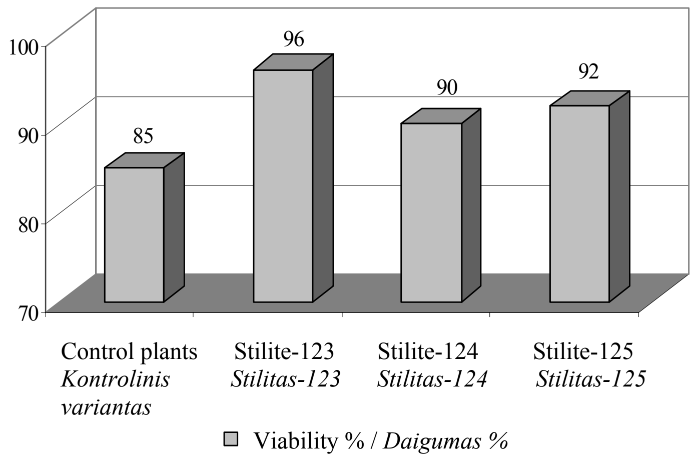


Figure 1. Effect of growth regulators on the viability of seeds
1 paveikslas. *Augimo reguliatorių įtaka sėklų daigumui*

The most intensive growth of barley plants was reported for those plants, which had been sprayed with the solution of growth regulator stilite-123 (concentration: 90 mg l-1). After eight days from the start of germination the length of the roots and the height of the barley plants treated with the above-mentioned solution were respectively larger by 1.55 cm and 1.15 cm compared with the control plants (Figures 2 and 3). The barley plants treated with the mentioned stilite were thicker and stronger compared to the control plants. The biomass of ten plants treated with the stilite was larger by 0.28 g compared to the biomass of ten control plants (Figure 4).

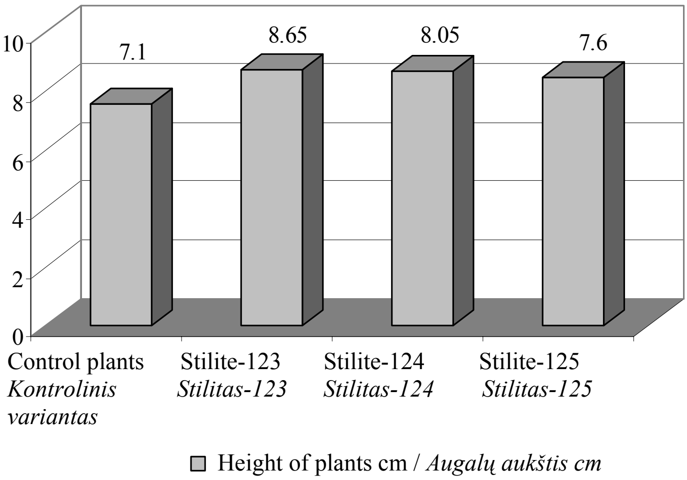


Figure 2. Effect of growth regulators on the formation of roots
2 paveikslas. *Augimo reguliatorių įtaka šaknų formavimuisi*

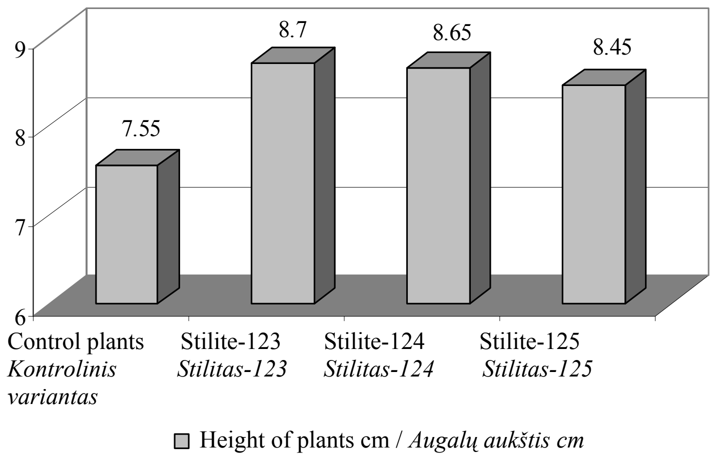


Figure 3. Effect of growth regulators on the growth of plants
3 paveikslas. *Augimo reguliatorių įtaka augalų augimui*

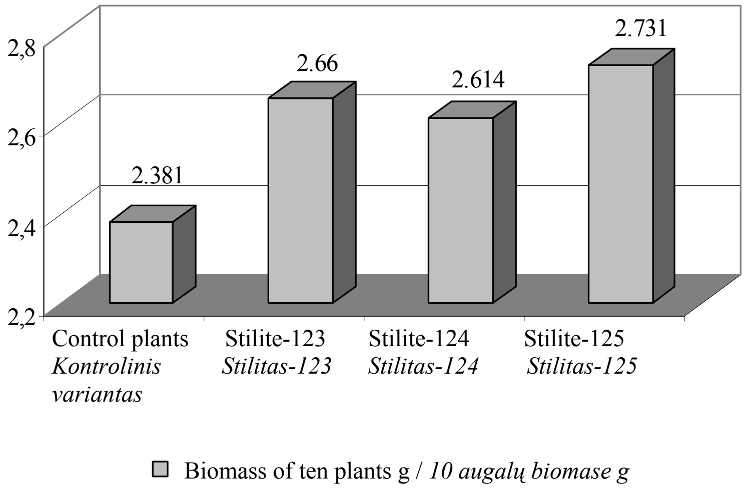


Figure 4. Effect of growth regulators on the biomass of plants
4 paveikslas. *Augimo reguliatorių įtaka augalų biomasei*

A slightly smaller physiological activity was reported for the growth regulators stilite-124 and stilite-125. After eight days of the exposure of the barley seeds to the solutions of the mentioned growth regulators (concentration: 90 mg l^{-1}), the length of the barley roots and the height of the barley plants were respectively larger by 0.95–0.50 cm and 1.10–0.90 cm compared to the control plants. The biomass of ten plants of these two study groups was larger by 0.23–0.35 compared to the biomass of ten plants of the control group.

The field studies of the sugar beets of the variety 'Latine' were performed at the Research Station of LUA. At a growth stage of six pairs of leaves the sugar beets were sprayed by using the solutions of the researched growth regulators stilites (concentration 90 mg l^{-1}), solution of micro-fertilizer "ARVI mikro", and mixtures of the mentioned micro-fertilizer with the growth regulators according to the indicated schedule. The test field of control plants was sprayed with water.

According to the experimental results, the highest yield of the sugar beets was reported for those plants, which had been sprayed with the solution made from the growth regulator stilite-123 and micro-fertilizer "ARVI mikro".

As a result of the treatment of sugar beets with the mixture of the mentioned solutions, the productivity of the beetroots increased by 7.12 t ha^{-1} (11.2 %) compared with the control plants sprayed with water.

The most intensive growth of sugar beets and the highest yield of beetroots were reported for the plants sprayed with the solution of stilite-123 (concentration: 90 mg l^{-1}). As a result of the treatment of sugar beets with the above-mentioned growth regulator, the productivity of beetroots increased by 6.48 t ha^{-1} (10.2 %) compared to the control plants. Other researched growth regulators increased the productivity of the beetroots by 1.35–2.81 t ha^{-1} (2–4 %) compared to the control plants; however the increase was not essential.

Table 3. Effect of additional spraying of sugar beets with the solutions of micro-fertilizers and growth regulators on the productivity of sugar beets
3 lentelė. *Cukrinių runkelių papildomo tręšimo per lapus mikroelementinėmis trąšomis ir augimo reguliatorių tirpalais įtaka šakniavaisių derlingumui*

Average data of the period 2005–2006; Research Station of LUA
LŽŪU Bandymų stotis, vidutiniai 2005–2006 m. duomenys

Test groups *Bandymo variantas*	Productivity *Derlingumas* t ha^{-1}	Difference compared with the control group *Skirtumas palyginus su kontroliniu var.*		Number of plants, thous. ha^{-1} *Augalų skaičius tūkst.ha^{-1}*	Average weight per beet-root *Vidutinio vieno šakniavaisio masė*	
		t ha^{-1}	%		kg	difference compared with the control group *skirtumas palyginus su kontroliniu var. kg*
Control Group (H_2O) *Kontrolinis (H_2O)*	63.54	-	100	90.3	0.703	-
Group "ARVI mikro" *„ARVI mikro" trąšos*	68.63	5.09	108.0	84.5	0.812	0.109
Stilite -123 *Stilitas-123*	70.02	6.48	110.2	94.2	0.743	0.040
Stilite– 124 *Stilitas-124*	64.89	1.35	102.1	93.8	0.692	- 0.011
Stilite– 125 *Stilitas-125*	66.35	2.81	104.4	87.3	0.760	0.057
Group "ARVI mikro" and Stilite -123 *„ARVI mikro" trąšos ir Stilitas-123*	70.66	7.12	111.2	92.7	0.762	0.059
Group "ARVI mikro" and Stilite -124 *„ARVI mikro" trąšos ir Stilitas-124*	66.04	2.50	103.9	89.5	0.738	0.035
Group "ARVI mikro" and Stilite -125 *„ARVI mikro" trąšos ir Stilitas-125*	68.43	4.89	107.7	93.1	0.735	0.032
LSD_{05} / R_{05}	2.357				0.028	

Additional fertilization of sugar beets with the micro-fertilizer "ARVI mikro" increased the productivity of beetroots by 5 t ha^{-1} (8 %) compared to the control plants.

The mixtures of micro-fertilizers "ARVI mikro" with the growth regulators stilite-124 and stilite-125 were reported as ineffective, because these mixtures reduced the productivity of beetroots (the productivity obtained by the mentioned mixtures was 2.50–4.89 t ha^{-1} (3–7 %) higher compared with the control group) compared to productivity of the sugar beets sprayed only with the micro-fertilizer.

Table 4. Effect of additional fertilization of sugar beets with the solutions of micro-fertilizers and growth regulators on the sugar-content of beetroots
4 lentelė. *Cukrinių runkelių papildomo tręšimo per lapus mikroelementinėmis trąšomis ir augimo reguliatorių tirpalų įtaka šakniavaisių cukringumui*

Average data of the period 2005 – 2006; Research Station of LUA
LŽŪU Bandymų stotis, vidutiniai 2005-2006 m. duomenys

Test groups *Bandymo variantas*	Sugar Content *Cukringumas*		Amount of biological sugar *Biologinio cukraus kiekis* *t ha* $^{-1}$	Amount of white sugar *Baltojo cukraus kiekis* *t ha* $^{-1}$	Difference compared with the control group *Skirtumas palyginus su kontroliniu var.*	
	%	difference compared with the control group *skirtumas palyginus su kontroliniu var. %*			t ha^{-1}	%
Control Group (H_2O) *Kontrolinis(H_2O)*	16.85	-	10.70	7.98	-	100
Group "ARVI mikro" *„ARVI mikro" trąšos*	16.95	0.10	11.63	8.69	0.71	108.9
Stilite -123 *Stilitas-123*	17.30	0.45	12.11	9.12	1.14	114.3
Stilite– 124 *Stilitas-124*	16.88	0.03	10.95	8.17	0.19	102.4
Stilite– 125 *Stilitas-125*	17.02	0.17	11.29	8.45	0.47	105.9
Group "ARVI mikro" and Stilite -123 *„ARVI mikro" trąšos ir Stilitas-123*	17.35	0.50	12.26	9.23	1.25	115.6
Group "ARVI mikro" and Stilite -124 *„ARVI mikro" trąšos ir Stilitas-124*	16.94	0.09	11.19	8.36	0.36	104.8
Group "ARVI mikro" and Stilite -125 *„ARVI mikro" trąšos ir Stilitas-125*	17.07	0.22	11.68	8.75	0.77	109.6
LSD_{05} / R_{05}	0.093			0.292		

The thickest sugar beets were reported for the test group, which was additionally fertilized with the micro-fertilizer "ARVI mikro". The average weight of the sugar beets of the mentioned test group was 109 g larger than the weight of the control plants. As a result of treatment of the sugar beets with the solutions of the growth regulators stilites, the average weight of beetroots increased by 0.32–0.59 g compared to the control plants.

Additional spraying of sugar beets with micro-fertilizers did not have any significant influence on the sugar-content of beetroots. The sugar-content of the mentioned test group of sugar beets increased only by 0.10 % compared to the control plants.

The major effect on the sugar-content of beetroots was reported for the stilite-123. As a result of the treatment of sugar beets with the solution of the mentioned growth regulator (concentration: 90 mg l^{-1}), the sugar-content of the beetroots increased by 0.45 %. A slight increase of sugar-content was reported for the growth regulator stilite-125 as well. The sugar content of the mentioned test group of sugar beets increased by 0.17 % compared to the control plants. The growth regulator stilite-124 had no effect on the sugar-content of beetroots. The sugar-content of the test group increased only by 0.03 % and this increase was not essential.

Among the test groups sprayed with the mixtures of the micro-fertilizer and the researched growth regulators the highest sugar-content was received for the test group sprayed with a mixture of micro-fertilizer "ARVI mikro" and stilite-123. The sugar beets of the mentioned test group had the highest sugar-content. The sugar-content of the beetroots increased by 0.5 % compared with the control plants.

Additional fertilization of sugar beets by using a mixture of the micro-fertilizer "ARVI mikro" and the stilite-124 had no effect on the sugar-content of beetroots. The sugar-content of the plants of the test group sprayed with a mixture of the micro-fertilizer "ARVI mikro" and growth regulator stilite-125 increased by 0.22 % compared to the sugar-content of control plants.

The highest content of white sugar was received for those test groups, which had been sprayed with the growth regulator stilite-123. In the case of treatment of sugar beets with a solution of stilite-123 (concentration: 90 mg $l^{-1)}$, the amount of white sugar increased by 1.14 t ha^{-1} (14 %) compared to the control plants. In the case of treatment of plants with the mixture of the growth regulator stilite-123 and micro-fertilizer, the amount of the white sugar increased by 1.25 t ha^{-1} (15.6 %) compared to the control plants.

The amount of white sugar produced from the plants sprayed with the solutions of growth regulators stilite-124 and stilite-125 was smaller than the amount of white sugar produced from plants sprayed with the researched micro-fertilizer. A slightly larger amount of white sugar was produced from the plants that had been additionally fertilized with a mixture of growth regulator stilite-125 and micro-fertilizer "ARVI mikro". However, the increase is insignificant compared to the amount of white sugar produced from the sugar beets that had been additionally fertilized only with micro-fertilizers.

Discussion

Exogenic growth regulators are becoming more and more significant for the productivity of field plants. The growth regulators are synthetic compounds representing physiological analogues of natural phytohormones and are used to control the processes of growth and development as well as to fortify the immune system of plants. Depending on the conditions of application of growth regulators as well as on their concentration and the physiological state of a plant, it is possible to stimulate the formation of roots, growth of a stem, time of blooming and ripeness of a plant. Thus the growth regulators can change the speed of ontogenesis, however the direction of ontogenesis remains the same, because it is determined by genetic information /Merkys et al., 2003/.

The researched growth regulators stilites were produced at the Department of Organic Chemistry, Kaunas University of Technology. However, not all synthetic materials that are produced in the laboratories of the mentioned Department are able to stimulate growth. Physiological activity of the new synthetic compounds and their optimal concentrations for stimulation of growth are determined in the Laboratory of Genetics and Biotechnology, LUA. The materials researched in this study also had a different physiological activity.

The growth regulator stilite-123 was the most active one. In the case of barley seeds that had been treated with the solution of the mentioned growth regulator (concentration: 90 mg $l^{-1)}$, the length of the barley roots and the height of the barley plants were respectively larger by 1.5 cm and 1.15 cm compared to the control plants as determined after the expiry of the exposure time (8 days). According to the results of measurements performed after eight days from the start of germination, the viability of the seeds treated with the mentioned growth regulator increased by 11 % and the average biomass of ten plants increased by 0.28 g compared to the control plants.

A slightly smaller physiological activity was reported for the growth regulators stilite-124 and stilite-125. The formation of roots and growth of plants were slower and the viability of seeds increased by 5–7 % compared to the control group. However, the greatest average biomass of ten plants was reported for the plants treated with stilite-125. The barley plants were thicker and stronger compared to the control plants as well as to barley plants treated with the solutions of other growth regulators.

Usually only the most active compounds are selected for field tests, however it was decided to test all the three growth regulators under field conditions.

The growth of sugar beets is slow at the early stage of vegetation. If growth regulators are used in the early stages of growth and development, the plants grow faster and require less time to develop a maximal assimilation surface of leaves, the processes of photosynthesis and metabolism are more intense, the assimilation of nutrients by plants improves and the yield of plants becomes higher and of better quality /Prusakova i dr., 1990/.

Among the test groups that were sprayed with the solutions of growth regulators stilites (concentration: 90 mg l^{-1}) at the period of 6 pairs of leaves, the biggest and statistically reliable yield was received from the test group treated with the most active growth regulator. The productivity of the sugar beets, which were treated by using the growth regulator stilite-123, increased by 6.5 t ha^{-1} (10 %), whereas the sugar-content increased by 0.45 %, and the amount of white sugar increased by 1.14 t ha^{-1} (14 %) compared to the control plants.

Less active compounds had a smaller effect on the productivity and quality of sugar beets. In the case of treatment of sugar beets by using the 90 mg l^{-1} conc. solutions of the growth regulator stilite-124 or stilite-125, the productivity of plants increased by 1.35–2.81 t ha^{-1} (2–4 %), sugar-content increased by 0.03–0.17 %, and the amount of white sugar increased by 0.19–0.47 ha^{-1} (2–6 %) compared to the control plants. However such increases were not essential.

Additional spraying of sugar beets with micro-fertilizers at the early stage of vegetation helps to balance the mineral nutrition of a plant, reduce the time necessary for assimilation of fertilizers by leaves and receive an instant effect /Krištaponytė, 2003/. In the case of additional fertilization of sugar beets by using the micro-fertilizer “ARVI mikro“, the productivity of beetroots increased by 5 t ha^{-1} (8 %) compared to the control plants, however the fertilization did not have any significant effect on the sugar-content of the plants. The sugar-content of the plants increased only by 0.10 % and this increase was not essential. The amount of white sugar produced from the mentioned test groups of plants increased by 0.71 ha^{-1} (9 %) compared to the control plants. Additional fertilization of sugar beets by using the micro-fertilizer helped to increase the productivity of beetroots significantly. The beetroots were thicker compared to the sugar beets of other test groups; however the mentioned fertilization had no effect on the sugar-content.

The most significant effect was reported for the sugar beets that had been additionally sprayed with the micro-fertilizer and the growth regulator stlite-123. The productivity of the mentioned test-group of sugar beets increased by 7 t ha^{-1} (11 %), sugar-content increased by 0.50 %, and the amount of white sugar increased by 1.25 ha^{-1} (15.6 %) compared to the control plants. Such combination of components of additional fertilization intensified the growth of sugar beets and assimilation of nutrients. As a result of faster formation of maximal assimilation surface of leaves, the processes of photosynthesis and metabolism were more intensive, the beetroots managed to acquire a greater content of dry matter, the sugar-content increased and a significantly larger amount of white sugar was produced compared to the control plants.

Additional fertilization of sugar beets by using the micro-fertilizer mixtures with less active growth regulators, such as stilite-124 or stilite-125, did not give the desired effect. The yield and sugar-content of the mentioned test groups of plants were smaller than the yield and sugar-content of the sugar beets fertilized only with the micro-fertilizer. The mixture of the growth regulator stilite-125 and micro-fertilizer “ARVI mikro“ slightly increased the sugar-content of beetroots, however significantly larger effect on productivity of sugar beets was reported for the test groups that were additionally fertilized with the mixture of growth regulator stilite-123 and micro-fertilizer “ARVI mikro“.

Conclusions

1. The laboratory screening results showed that stilite-123 was the most physiologically active compound among the researched growth regulators.

2. The treatment of sugar beets by using the growth regulator stilite-123 effectively increased the yield and sugar-content of sugar beets. In case of sugar beets sprayed with 90 mg l^{-1} conc. solution of the mentioned growth regulator, the productivity of beetroots increased by 6.48 t ha^{-1} (10.2 %), sugar-content increased by 0.45 %, and the amount of white sugar increased by 1.14 ha^{-1} (14.3 %) compared to the control plants.

3. Less active compounds, i.e. stilite-124 and stilite-125, had no significant effect on the productivity of sugar beets.

4. It is worth fertilizing the sugar beets by using the micro-fertilizer. In the case of sugar beets sprayed with the solution of the micro-fertilizer “ARVI mikro“ at a growth stage of six pairs of leaves, the productivity of beetroots increased by 5 t ha^{-1}

(8 %), sugar-content increased by 0.10 %, and the amount of white sugar increased by 0.71 ha^{-1} (8.9 %) compared to the control plants.

5. The most significant effect was reported for the sugar beets that had been additionally fertilized with the mixture of growth regulator stilite-123 and micro-fertilizer “ARVI mikro“. The productivity of the mentioned plants increased by 7.12 t ha^{-1} (11.2 %), sugar-content increased by 0.50 %, and the amount of white sugar increased by 1.25 ha^{-1} (15.6 %) compared to the control plants.

6. Additional fertilization of sugar beets by using the mixtures of micro-fertilizer and growth regulator stilite-124 or stilite-125 was reported to be unreasonable, because the better productivity and quality was achieved for the sugar beets that had been sprayed only with the micro-fertilizer solution.

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AUGIMO REGULIATORIAI CUKRINIAMS RUNKELIAMS

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Santrauka

Augimo reguliatoriai stilitai susintetinti Kauno technologijos universitete, Organinės chemijos katedroje. Augimo reguliatorių fiziologinio aktyvumo tyrimai atlikti skriningo metodu LŽŪU Agrobiotechnologijos laboratorijoje. Lauko bandymai vykdyti LŽŪU Bandymų stotyje. Tirta augimo reguliatorių, mikroelementinių trąšų „ARVI mikro“ bei šių trąšų ir augimo reguliatorių mišinių įtaka cukrinių runkelių produktyvumui.

Cukrinių runkelių daigai šešių porų tikrųjų lapelių augimo tarpsniu nupurkšti bandyme tirtų augimo reguliatorių stilitų 90 mg l^{-1} koncentracijos tirpalais, mikroelementinių trąšų „ARVI mikro“ tirpalu arba šių trąšų ir augimo reguliatorių tirpalų mišiniais. Visos kitos agrotechnikos priemonės taikytos pagal Bandymų stotyje priimtą cukrinių runkelių auginimo technologiją. Cukrinių runkelių derlius nuimtas rankiniu būdu, naudojant traktorinį šakniavaisių keltuvą. Derliaus nuėmimo metu paimti cukrinių runkelių šakniavaisių mėginiai ir jų cukringumas nustatytas Marijampolės cukraus fabrike.

Atlikus fiziologinio aktyvumo tyrimus nustatyta, kad iš tirtų augimo reguliatorių fiziologiškai aktyviausias junginys – stilitas-123. Cukrinių runkelių daigus nupurškus šio augimo reguliatoriaus tirpalu, šakniavaisių derlingumas padidėjo iš esmės 6,5 t ha^{-1}, arba 10 proc., cukringumas 0,45 procentinio vieneto, baltojo cukraus gauta 1,14 t ha^{-1}, arba 14 proc. daugiau, palyginti su kontroliniu variantu.

Dar didesnis efektas pasiektas cukrinius runkelius papildomai patręšus per lapus augimo reguliatoriaus stilito-123 ir mikroelementinių trąšų „ARVI mikro“ mišiniu. Papildomai patręšus, šakniavaisių derlingumas padidėjo 7 t ha^{-1}, arba 11 proc., cukringumas – 0,50 procentinio vieneto, baltojo cukraus gauta 1,25 t ha^{-1}, arba 15,6 procento daugiau, palyginti su kontroliniu variantu.

Reikšminiai žodžiai: augimo reguliatoriai, fiziologinis aktyvumas, mikroelementinės trąšos, cukriniai runkeliai, derlingumas, cukringumas.