

Growth Regulators as A Factor of Optimizing the Biometric Parameters and Productivity of Improved Potatoes in Nursery Conditions

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Abstract: *The paper is focused on the influence of synthetic growth regulators on the biological productivity of potato plants and on some biometric indicators in nursery conditions on sod-podzolic soils. The field method was used for this research; after measuring the metric and weight properties, the data obtained were further subjected to statistical analysis of variance. A positive effect of growth regulators (Amulet, El-1) on the productivity and quality of improved potato varieties of the early variety Udacha in the system of original seed breeding has been discovered. The use of growth regulators on potato in nursery conditions contributed to increasing the vegetative mass of plants, the yield, the reproduction rate, and the qualitative indicators, to reducing the content of nitrates in the tubers, and to improving plants' resistance to late blight and viral diseases.*

Index Terms: *growth regulators, Amulet, El-1, the yield, leaves' assimilation surface, productivity, dry matter, starch, nitrates, late blight, viruses.*

I. INTRODUCTION

Obtaining yields of high-quality improved potatoes in nursery conditions is one of the main goals of the original seed breeding [1]. One of the innovative biotechnological methods of increasing productivity of potato plants is the use of growth regulators. Growth regulators make a large group of natural or synthesized organic compounds with high biological activity at low concentrations [2-6]. They have the ability to actively influence the hormonal balance of plants, stimulate their growth and development, increase their resistance to disease as well as increase yield and quality of mini tubers, and influence their adaptive properties (drought resistance, cold resistance) [2, 4, 7-9]. Thus, growth regulators are currently increasingly used in original potato

seed breeding.

A. The purpose of the study

In view of the above, the research was aimed at studying the effect of growth regulators on the productivity and the quality of improved potato in nursery conditions.

II. MATERIALS AND METHODS

The experimental work was performed in the greenhouse of OOO Elitkhoz in the Bor district of the Nizhny Novgorod region. The analytical studies were performed in the laboratory of the Department of Biology, Chemistry, and Biology at the Nizhny Novgorod State Pedagogical University n.a. K. Minin. Improved material of the early potato species Udacha (of domestic breeding) was used in the experiment. Micro plants were planted into greenhouse soil in the second half of May. Agricultural activities included irrigation, soil loosening, weeding, hilling, and preventive spraying against aphids. Two weeks before harvesting, the tops were mowed. Growth regulators Amulet and El-1 were used in the experiments. The scheme of the experiment included two variants: 1 (reference) – without treatment, 2 – Amulet (2.5 l/ha), and 3 – El-1 (0.2 l/ha). During the vegetation season, the above-ground parts of the plants were sprayed twice: when plant height was 15 – 20 cm, and in the phase of budding – beginning of flowering. The plants were treated with the use of a hand-driven backpack sprayer.

Field experiments were laid and statistically processed in accordance with the established methods [10-14]. The total plot area was 28 m², the accounting plot area was 14 m², the experiment was repeated four times, the plots were arranged in a periodical order. The planting scheme was 70×24 cm. During the vegetation period in nursery conditions, the biometric parameters of plants, the occurrence rate of viral and fungal diseases on the foliage of potato plants, the potato yield, starch content, dry matter and nitrates' content in the tubers were determined by the method of the All-Russia Potato Breeding Research Institute [15].

III. RESULTS

The studies revealed positive influence of the growth regulators on the biometric indicators of



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potato plants (Table 1).

Table 1. The influence of growth regulators on the biometric indicators of potato plants in nursery conditions

Variant	Plant height, cm	The number of stems per plant	The assimilatory surface of the leaves	
			m ² per plant	thousand m ² /ha
Reference	43.7	4.4	0.63	37.2
Amulet	59.1	5.6	0.74	43.7
El-1	51.6	5.1	0.68	41.9
<i>LSD</i> ₀₅	3.3	0.4	0.09	-

According to researchers [16, 17], the most important indicator of potato productivity and quality is the process of the vegetative mass formation.

Biometric indicators in the flowering phase in the experimental variants were higher, compared to the reference. For instance, in both cases, plant height increased by 35.2 – 18.1 %, the number of stems – by 27.2 – 15.9 %, and the assimilation leaf surface – by 17.5 – 7.9 %. The best result was obtained when potatoes were processed with growth regulator Amulet.

The use of growth regulators in the cultivation of mini-tubers in nursery conditions not only contributed to increasing the height of potato plants and the number of stems per plant but also had positive impact on the yield and the quantity of obtained mini-tubers (Table 2).

For instance, the greatest growth of the yield and the number of mini-tubers was obtained with the use of the Amulet preparation. In this case, the average significant increase per plant over the three years, compared to the reference, amounted to 91.2 g in terms of the weight and 1.4 pcs. in terms of the number of tubers. Smaller but also significant increases in the yield and the number of mini-tubers were obtained by treatment with preparation El-1. On average over the three years, the yield increase was 53.4 g per plant, while the number of mini-tubers increased by only 1.4 tubers per plant. However, the net reproduction in case of using growth regulator Amulet in terms of the numerical value was slightly higher than in case of using El-1, while the weight of tubers on a single plant was much lower, and therefore the potatoes' yield was lower.

Table 2. The influence of growth regulators on potato productivity in nursery conditions

Variant	Tubers' yield rate			The number of tubers per plant
	g/plant	t/ha	± to reference, %	
Reference	367.9	21.7	100.0	7.2
Amulet	459.1	27.1	124.8	8.6
El-1	421.3	24.9	114.7	8.1
<i>LSD</i> ₀₅	13.2	-	-	0.4

A number of scientists [18-20] believe that the quality of tubers is a consolidated figure, which is formed in the process of potato cultivation, and to a greater extent depends on the

variety, the soil-climatic conditions, the agronomic practices, and the yield. Among the main indicators of tubers' quality, the most important are the contents of starch, dry matter, and nitrates [2, 21].

The results of potato biochemical research are shown in Table 3.

Table 3. The effect of growth regulators on the biochemical parameters of tubers in nursery conditions

Variant	Dry matter, %	Starch, %	Nitrates, mg/kg
Reference	20.1	11.4	43.1
Amulet	21.8	12.1	37.5
El-1	20.6	11.8	40.3
<i>LSD</i> ₀₅	0.6	0.4	4.3

No clear patterns have been found in the content of dry matter and starch in potato tubers, however, the best results were obtained with the use of growth regulator Amulet. Treatment with preparation El-1 had no significant effect on the biochemical composition of tubers, compared to the reference.

The content of nitrates in the tubers was not high in all variants of the experiment. The minimum accumulation of nitrates was observed in the tubers of the plants treated with growth regulator Amulet, which apparently contributed to a more uniform delivery of nitrogen to the plants, as evidenced by the data from the previous experiments performed both in the nursery and in the open soil [8].

The results of phytopathological records have shown that potato affection in the variants was insignificant, and depended to a greater extent on treatment with growth regulators since the humidity conditions in the greenhouse did not depend on the meteorological conditions outside (Table 4).

Compared to the reference, the use of growth regulator Amulet contributed to the most significant reduction of the occurrence rate (52.8 %) and development (47.5 %) of late blight on the tops. Preparation El-1 contributed to a lesser extent to the reduction of the occurrence rate and development of the disease by 28.4 % and 20.4 %, respectively.

Table 4. Effect of growth regulators on the occurrence rate and development of late blight on potato tops in nursery conditions

Variant	Occurrence rate, %	Development, %
Reference	5.3	5.9
Amulet	2.5	3.1
El-1	3.8	4.7
<i>LSD</i> ₀₅	0.9	1.1

It should also be noted that during all years of the research, the immunoenzymometric analysis of the plants for hidden infestation with viruses showed no infection in the leaf samples in all variants.



IV. ANALYSIS

A positive consequence of plant stimulation with growth regulators is the fact that increasing the above-ground biomass of the plants in the experiment resulted in increasing the tuberous parts of the plants, i.e., in improving potato productivity.

There is an opinion [18, 19, 21] that with the advent of the new generation regulators, an opportunity appeared to more efficiently manage the production process, to improve the resistance of plants to stress conditions, particularly to the nursery conditions dominated by high temperatures, and to influence the resistance to various pathogens and thereby ensure high quality of the tubers in the system of original seed breeding.

V. CONCLUSION

Thus, the use of growth regulators on potato in nursery conditions contributed to increasing the vegetative mass of the plants, the yield and the reproduction rate, to reducing the occurrence rate and development of late blight on the tops, to improving resistance of healthy plants to viruses and increasing the content of starch and dry matter in the tubers, as well as to decreasing the nitrates' accumulation in the tubers. The obtained data may be explained by the fact that growth regulators have a multifunctional action that can simultaneously stimulate both growth and development, and to increase the yield rate. In addition to increasing productivity, growth regulators indirectly contribute to fighting pathogens by increasing plants' immunity. This allows saying for sure that these growth regulators may compete with chemical pesticides, as they feature high biological activity, which ultimately leads to increased potato productivity at low cost without damage to the environment.

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REFERENCES

1. S. A. Buldakov, N. A. Shackleina, L. P. Plekhanova, O. N. Loginov, "Ozdorovlenniy kartofel v plenochnykh teplitsakh" [Improved potatoes in plastic film greenhouses], *Potatoes and vegetables*, 6, 2013, pp. 28.
2. K. D. Dyatlova, I. A. Koplakov, "Kompleksnoe soprovozhdenie individualnoi samostoyatelnoi raboty studentov mladshikh kursov Biologicheskogo fakulteta klassicheskogo universiteta" [Comprehensive support for individual independent work of junior students of the Biological Faculty of the Classic University], *Vestnik of Minin University*, 1(18), 2017, pp. 11.
3. V. M. Dyakov, Y. S. Korzannikov, V. V. Matychenkov, "Regulatory rosta rastenii" [Plant growth regulators], Moscow: Agropromizdat, 1990, pp. 43 – 44.
4. E. V. Zazorina, L. K. Rodionov, K. S. Katunin, "Reaktsiya sortov kartofelya na primeneniye regulyatorov rosta v Tsentralnom Chernozeme" [Reaction of potato varieties to the use of growth regulators in the Central Black-Soil Region], *Bulletin of the Kursk State Agricultural Academy*, 5(5), 2010, pp. 51.
5. Y.M. Avdeev, S.M. Hamitova, A.E. Kostin, V.M. Lukashevich, M.V. Lukashevich, A.V. Kozlov, I.P. Uromova, M.A. Trushkova, Y.Y. Davydova, V.A. Kuzletsov, "Assessing the Properties of Tree Trunks in Forest Phytocenoses Depending on the Soil and the Climatic Conditions on

- the Territory of the Taiga Zone of the European North of Russia", *Journal of Pharmaceutical Sciences and Research*, 10(5), 2018, pp. 1288-1291.
6. S.M. Hamitova, Y.M. Avdeev, N.A. Babich, A.S. Pestovskiy, V.S. Snetilova, A.V. Kozlov, I.P. Uromova, N.N. Koposova, N.A. Pimanova, I.R. Novik, "Toxicity assessment of urban soil of Vologda oblast", *International Journal of Pharmaceutical Research*, 10(4), 2018, pp. 651-654.
7. A. N. Orlov, "Urozhainost i kachestvo klubnei kartofelya v zavisimosti ot primeneniya regulyatorov rosta" [The yield rate and quality of potato tubers depending on the use of growth regulators], *Actual problems of agriculture at the present stage of agriculture development*, Penza, 2004, pp. 82.
8. I. P. Uromova, "Urozhai i kachestvo kartofelya pri ispolzovanii biopreparatov" [Potato yield and quality with the use of bio-preparations], *Crop-producing power*, 1, 2009, pp. 33.
9. I. Pivovarova, M. Tregubova, "The application of geo-information technologies to the efficiency improvement of the managing system for gas supply facilities and processing the results of gas pipelines network monitoring", *ARPN Journal of Engineering and Applied Sciences*, 13(2), 2018, pp. 725-732.
10. B. A. Dospikhov, "Metodika polevogo opyta (s osnovami statisticheskoi obrabotki rezultatov issledovaniya)" [The methodology of field experiment (with basics of statistical processing research results)], Moscow: Agropromizdat, 1985, pp. 351.
11. I. Pivovarova, V. Kuzmin, "Role of hydrological monitoring in the description of the runoff formation processes", *Journal of Engineering and Applied Sciences*, 12(17), 2017, pp. 4495-4499. doi:10.3923/jeasci.2017.4495.4499
12. V. Kuzmin, I. Pivovarova, "Monitoring and long-term probabilistic assessment of hydrological risks in the conditions of climate change and variable anthropogenic burden on river basins", *International Journal of Mechanical Engineering and Technology*, 9(11), 2018, pp. 1652-1661.
13. I. Pivovarova, "Optimization methods for hydroecological monitoring systems", *Journal of Ecological Engineering*, 17(4), 2016, pp. 30-34. doi:10.12911/22998993/64503
14. Y.P. Popov, Y.M. Avdeev, S.M. Hamitova, A.A. Tesalovsky, A.E. Kostin, V.M. Lukashevich, M.V. Lukashevich, A.V. Kozlov, N.N. Koposova, I.P. Uromova, "Monitoring of green spaces' condition using GIS-technologies", *International Journal of Pharmaceutical Research*, 10(4), 2018, pp. 730-733.
15. N. A. Andryushina, N. S. Batsanova, "Metodika issledovaniya po kulture kartofelya" [Potato research method], Moscow: Potato Breeding Research Institute of the Russian Federation, 1967, pp. 263.
16. A. A. Nichiporovich. Photosynthetic activity of plant crops / A. A. Nichiporovich. – M.: USSR AS, 1961. – pp. 34 – 43.
17. Kozlov A.V. Optimization of the productivity of agricultural crops at application of natural minerals as ameliorants and mineral fertilizers on sod-podzolic soils / A.V. Kozlov, I.P. Uromova, N.N. Koposova, I.R. Novik, I.V. Vershinina, Y.M. Avdeev, S.M. Hamitova, A.N. Naliukhin, A.E. Kostin, Y.V. Mokretsov // *Journal of Pharmaceutical Sciences and Research*. – 2018. – vol. 10. – № 3. – P. 677-680.
18. V. V. Vakulenko, "Regulatory rosta" [Growth regulators], *Plants protection and quarantine*, 1, 2004, pp. 24.
19. E. V. Zakharina, I. Y. Pigarev, "Growth regulators for potatoes in the Central Black-Soil Region", *Agricultural science*, 7, 2005, pp. 20 – 22.
20. A. V. Kozlov, I. P. Uromova, "Nauchno-issledovatel'skaya deyatelnost obuchayushchikhsya kak osnova realizatsii professionalnykh kompetentsii" [Research activities of students as a basis for implementation of professional competences], *Vestnik of Minin University*, 1(18), 2017, pp. 4.
21. I. F. Ustimenko, A. N. Postnikov, "Effektivnost preparata tsirkon pri vozdeleyvaniy kartofelya" [Efficiency of preparation Zircon in potato cultivation], *Achievements of agricultural science and technology*, 4, 2009, pp. 38 – 39.

