

The effect of biostimulants on *Solanum tuberosum* L. variety "Zakhar" in arid conditions of Orenburg Cis-Urals

Alexander Mushinskiy¹, Aliya Saudabaeva^{1*}, and Tatyana Vasilyeva¹

¹Federal Research Centre of Biological Systems and Agrotechnologies of the Russian Academy of Sciences Orenburg, 460000 Orenburg, Russia

Abstract. The article presents the results of a study of biostimulants Fitosporin-M, Zh (AS) + amino acids and Bionex-Kemi, Zh, (NPK 21:4:4) + ME on potato productivity indicators. As a result of the research, a positive effect of biostimulants on the growth and accumulation of underground biomass of *Solanum tuberosum* L. variety "Zakhar" was established. The analysis showed that when *Solanum tuberosum* L. plants of Zakhar variety are treated with Bionex-Kemi, Zh, NPK 21:4:4 + ME, the content of starch in tubers increases by 1.3 %, and when plants are treated with Fitosporin-(M, F (AS) + amino acids) - by 0.9 % in comparison with the control variant. The accumulation of underground potato biomass was more intense when using Bionex-Kemi, G, (NPK 21:4:4) + ME. For the cultivation of potatoes in the conditions of the Orenburg Cis-Urals, it is recommended to use the biostimulator Bionex-Kemi, Zh, (NPK 21:4:4) + ME (bioactivated nitrogen-phosphorus-potassium fertilizer), which stimulates plant growth and the accumulation of underground biomass.

1 Introduction

Recently, the use of biostimulants has been of particular interest. According to the FAO, the term "biostimulant" is defined as "a product that activates the processes of photosynthesis, growth, metabolism in order to stimulate one or more factors: efficiency the efficiency of nutrient uptake by plants; plant resistance to abiotic stresses; the predominance of qualitative characteristics of crops " [1-10].

The use of fertilizers and pesticides in crop production worsens the ecological situation in the region, and therefore, at present, special attention should be paid to the use of new generation biostimulants based on microelements and phytostimulants in the cultivation of agricultural plants in order to stimulate the growing season, production processes [2]. It should be noted that the use of biological products could help to reduce the use of fertilizers in agriculture by up to 50 %. The use of humic acids contained in biostimulants has a positive effect on the physicochemical properties of the soil, improves its structure and provides a more suitable environment for plant growth and development, and reduces the

* Corresponding author: aleka_87@bk.ru

use of chemical fertilizers and pesticides in soils [3]. A group of young scientists investigated the effects of growth regulators on potatoes. The results of the experiment showed that when using the growth regulators zircon, epin-extra, immunocytophyte in the recommended doses during the pre-planting treatment of potato tubers, as well as in the budding and mass flowering phase, the Udacha variety surpasses the Nevsky variety in terms of yield and marketability in almost all variants. [4] Biostimulants based on microorganisms often have fungicidal properties, that is, they suppress the development of pathogenic microflora [5]. The positive effect of biostimulants can be seen in an increase in the content of photosynthetic pigments and an increase in resistance to stress factors, in particular, to drought [6].

Aim is to study of the effect of biostimulants on *Solanum tuberosum L.* variety "Zakhar".

2 Research objectives

- to study the morphometric parameters of *Solanum tuberosum L.* variety "Zakhar";
- analyze the chemical composition of potato tubers for starch content;
- to study the effect of biostimulants on the amount and weight of underground potato phytomass.

3 Materials and research methods.

3.1 Object of study.

Solanum tuberosum L., variety "Zakhar".

3.2 Experimental design.

The studies were carried out for 3 years on the irrigated plot of the KFH "Khomutsky V.I." in the vicinity of Kubanka, Perevolotsky district, Orenburg region, using the methodology of field experience [6]. The predecessor is pure black fallow. Biological preparations used in the studies: Bionex-Kemi, Zh, NPK 21:4:4 + ME, s Fitosporin-M, Zh (AS) + amino acids.

Bionex-Kemi, F, (NPK 21:4:4) + ME contains 21 % nitrogen, 4 % phosphorus and 4 % potassium, humates bioactivated in terms of molecular weight and composition, which have growth-accelerating, anti-stress and immunostimulating properties, especially on "potassium-loving" crops (sunflower, sugar beet, potatoes, fruit and berries during the budding period). Certificate of state registration of the drug No. 2568-13-204-006-0-0-0-1.

Fitosporin-M, Zh (AS) + Amino acids are classified as biofungicides, the composition includes living symbiotic bacterial cultures of *Bacillus subtilis* strain 26D (1×10^9 living cells and spores per 1 ml); live symbiotic bacterial cultures of *Bacillus subtilis* 1K, 3K, 3H, 8K, 7K, 3/18 (1×10^6 cells per 1 ml); three species of *Trichoderma* antagonist fungus with a total titer of at least 1×10^6 cells per 1 ml; lysates of rhizospheric bacteria; 20 L-amino acids of natural origin – 5 %. Amino acids have powerful anti-stress, growth-accelerating, immunostimulating properties, which is important in case of climatic, chemical, pesticide and other stresses and to increase the productivity of crops, as well as to reduce re-infections (certificate of state registration No. 677-09-307-006-0-0 -3-1 1677-09-307-006-0-0-3-1/01 1677-09).

The use of biological preparations was carried out on experimental plots using knapsack sprayers. The area of the plot was 140 m², the accounting area was 70 square m (length - 50

m, width - 1.4 m). 9 plots were planted. Each experiment was carried out in triplicate. The arrangement of variants in repetition is systematic. In the control variants, the treatment was carried out with water (Table 1).

All agrotechnical practices corresponded to the cultivation zone.

Table 1. Experimental scheme

Variant	Drug flow rate
Control	Water
Phytopsporin M, F (AS) + Amino acid	Presowing treatment of tubers (dose 1 l/t), Spraying in the budding phase, 1 l/ha
Bionex-Kemi, F, (NPK 21:4:4)+ME	Foliar top dressing at a dose of 3 l/ha in the phase of budding

Plant height was determined by measuring 10 plants in two non-adjacent repetitions. Accounting for tubers was carried out on sites of 0.25 m² in 4 replicates. Determination of the structure and marketability of the crop was carried out in the pre-harvest digging of tubers, distributed them into fractions (GOST 26545-85). Equipment and technical means. Potatoes were planted in semi-ridges with a potato planter (GRIMME, Germany) with simultaneous dressing of tubers. Irrigation was carried out with a sprinkling machine DM-100 "Fregat" (Fregat, Ukraine) from 6 to 9 times, depending on weather conditions. Laboratory studies to determine the quantitative content of starch in potato tubers were carried out in the laboratory of the Orenburg branch of the Federal State Budget Research Institution of the Federal Research Centre for Horticulture in accordance with GOST 7194-81 "Fresh potatoes. Acceptance rules and methods for determining quality (with Amendments No. 1, 2, 3)".

3.3 Statistical processing

Statistical analysis of the results was carried out using the Statistica 10.0 statistical software package (StatSoftInc., USA)

4 Research results

New generation drugs revealed a positive effect on plants after treatment of the aerial parts of potatoes in various phases of growing season with biostimulants.

The effect of biological products on morphometric parameters in the phase of budding and flowering differed insignificantly (Table 2, Fig. 1).

Table 2. Indicators of plants in various phenological phases

Experimental variants	Plant height in phenological phases, cm	
	budding	flowering
Control	42,1±0,43	43,2±0,76
Phytopsporin-M, F (AS)+Amino acids	43,3±0,51	45,8±0,32
Bionex-Kemi, F, (NPK 21:4:4)+ME	43,1±0,45	45,5±0,43

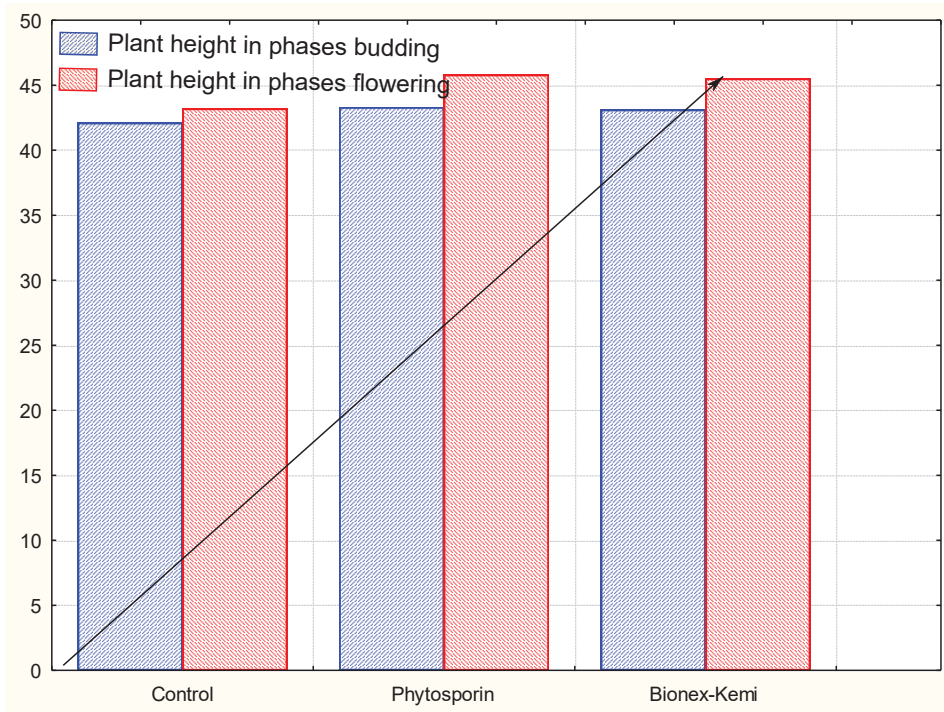


Fig. 1. shows the plant height in centimeters (“...80, 100, 120”). Fitosporin-M, Zh (AS) + Amino acids in the phase of budding and flowering of *Solanum tuberosum L.* had a fungicidal effect, thanks to which the plants had good morphometric parameters.

The data of a laboratory study of the starch content in *Solanum tuberosum L.* tubers of the Zakhar variety showed that foliar treatment of the aerial parts of potatoes with biological preparations of various compositions increased the starch content of tubers in comparison with the control (Table 3). The best effect and higher starch content in potato tubers was after treatment of plants with biostimulant Bionex-Kemi, Zh, (NPK 21:4:4) + ME (Table 3).

An analysis of the structure of the plant yield showed that treatment of plants with a solution of Bionex-Kemi, G, (NPK 21:4:4) + ME resulted in the best quality indicators and commercial characteristics of potato tubers (Table 3).

Table 3. Yield structure and starch content in tubers of *Solanum tuberosum L.* variety "Zakhar" (mean values)

Treatment options	Weight, kg and quantity, pcs. of all tubers per experimental site	Starch content, %	Fraction					
			commercial		seed		small	
			quantity, pcs	weight, kg	quantity, pcs	weight, kg	quantity, pcs	weight, kg
Control	1,50/20	11,8	13	1,25	3	0,20	4	0,05

Phytosporin -M, F (AS)+ Amino acids Bionex Kemi, F, (NPK 21:4:4)+M E	1,85/24	12,7	20	1,73	2	0,10	2	0,02
	1,97/27	13,1	23	1,82	3	0,14	1	0,01

5 Discussion

Biostimulants affect the development of *Solanum tuberosum L.*: photosynthesis, growth of above-ground phytomass and yield. The positive effect of the biological product Fitosporin-M, Zh during presowing treatment of seeds is described in the works of researchers [8-9]. Goryanin O.I. reports on the effectiveness of the use of the Bionex-Kemi preparation during the tillering period of spring wheat. (2019). The height of the aboveground phytomass of *Solanum tuberosum L.* is one of the morphological indicators. As a result of the treatment of plants with various biostimulants, differences in the morphometric parameters of the vegetative parts of plants were revealed. So, when using Fitosporin-M, Zh (AS) + Amino acids and Bionex-Kemi Zh, (NPK 21:4:4) + ME in the budding phase, an increase in plant height by 3 % and 2.5 %, respectively, was noted compared with control. When Fitosporin-M, Zh (AS) + Amino acids and Bionex-Kemi Zh, (NPK 21:4:4) + ME were introduced into the next phenological phase (flowering) of *Solanum tuberosum L.*, the growth of aerial parts increased by 2.5 and 2.3 % compared to the control variant. Plant height is a genetically determined trait, but under the influence of cultivation technology, plant height can vary (Table 2).

Laboratory studies of the chemical composition of *Solanum tuberosum L.* tubers of the Zakhar variety showed that when plants are treated with Bionex-Kemi, Zh, (NPK 21:4:4) + ME, their starch content increases by 1.3 %, and when treated with plants with Fitosporin-M, Zh (AS) + Amino acids by 0.9 % compared with the control (Table 3, figure 2).

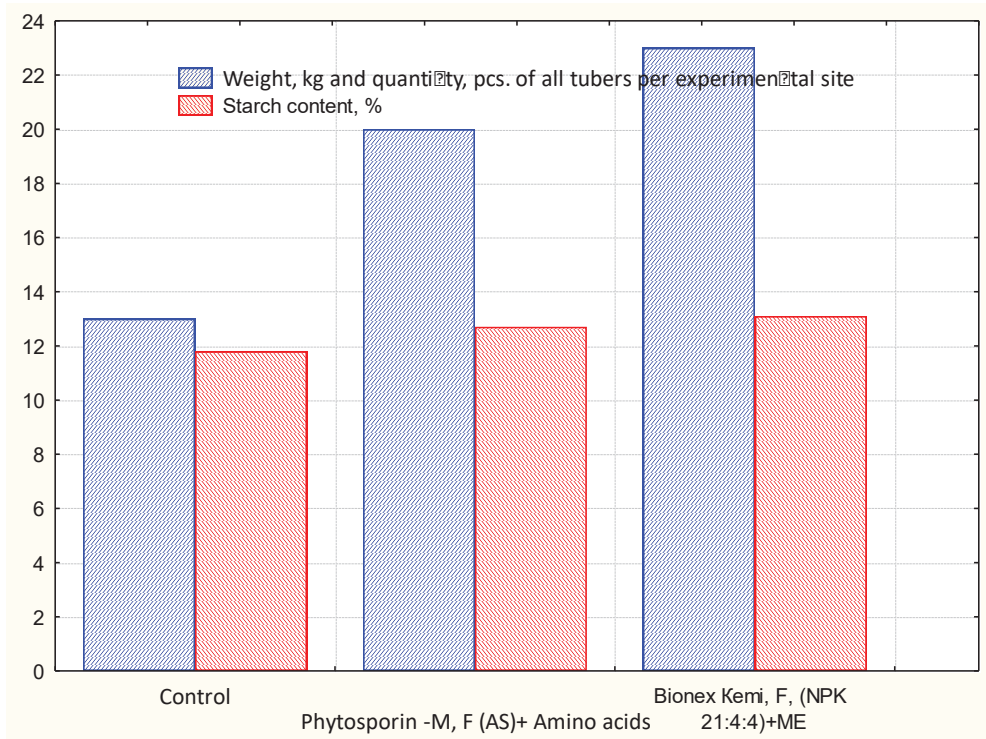


Fig. 2. Yield and starch content in tubers of *Solanum tuberosum* L. variety "Zakhar" (mean values)

According to the distribution of tubers by fractions, the highest yield of marketable tubers

(41.3 %) was treated with Bionex-Kemi, F, (NPK 21:4:4) + ME (Table 3). The treatment of plants with Bionex-Kemi, Zh, (NPK 21:4:4) + ME showed that the share of marketable tubers was 35.71 %, while in the control variant this share was only 23 % of the total number of potato tubers.

Thus, foliar treatment of potatoes with new generation biostimulants had a positive effect on the morphometric parameters of potato plants, on the accumulation of starch in its tubers, on the number and weight of tubers in all variants of the experiment compared to the control.

6 Conclusion

As a result of the action of biostimulants on the aerial parts of plants *Solanum tuberosum* L. cultivar "Zakhar" observed a positive effect. In terms of the effectiveness of the influence of various biological products on morphometric indicators (plant height), the differences were insignificant.

The data of a laboratory study of the starch content in *Solanum tuberosum* L. tubers of the Zakhar variety showed that foliar treatment of the aerial parts of potatoes with biological preparations of various compositions increased the starch content of tubers in comparison with the control. The analysis showed that when *Solanum tuberosum* L. plants of the Zakhar variety are treated with Bionex-Kemi, Zh, (NPK21:4:4) + ME, the content of starch in tubers increases by 1.3 %, and when plants are treated with Fitosporin-M, F (AC) + Amino acids by 0.9 % in comparison with the control variant.

When plants are treated with Bionex-Kemi, F, (NPK 21:4:4) + ME, the share of marketable tubers was 41.3 %, when treated with the stimulant Fitosporin-M, Zh (AS) + Amino acids - 35.71 %, in the control variant, the share of marketable tubers was 23 % of their total number.

Foliar treatment of potatoes with new generation biostimulants had a positive effect on morphometric parameters, on the accumulation of starch in potato tubers, on the number and weight of tubers in all variants of the experiment compared to the control.

For the cultivation of potatoes in the conditions of the Orenburg Cis-Urals, it is recommended to use the biostimulator Bionex-Kemi, Zh, (NPK 21:4:4) + ME (bioactivated nitrogen-phosphorus-potassium fertilizer), which stimulates plant growth and the accumulation of underground biomass.

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