Dynamics of formation of yield of seed potatoes applying humic drugs

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Abstract. The use of the Hypergrin allows to reduce the harvesting time when growing potatoes for seed purposes, to increase the yield and production of marketable tubers when cultivated for food purposes. In the arid conditions of the period 2017 - 2018 the use of the Hypergrin in combination with chemical preparations contributed to a yield increase of 4.6 t/ha.

1. Introduction
Humic substances are of great importance for the development of plants. They increase the labile part of humus [1], improve soil structure and water-air regime, activate microbiological processes, react with chemical elements, making them more accessible for absorption by plants, contain nitrogen, potassium, phosphorus and other nutrients. Due to the limited use of organic and mineral fertilizers, a sharp decrease in the intake of plant residues in the soils of agrocenoses, an increase in the processes of mineralization of organic matter, and increasing degradation of arable soils, a decrease in the level of fertility of agricultural lands occurs.

The introduction of organic fertilizers into the soil helps to increase the ecological cleanliness of the products, and the effectiveness of the applied mineral fertilizers [2]. Organic fertilizers and modern biological preparations, which, in combination with other chemical means, have a multilateral positive effect on all the most important agrochemical indicators and soil functions, and also have a stimulating effect on plant growth and development, contributing to the formation high crop yields. Against the background of an increase in the use of mineral fertilizers and a reduction in the introduction of organic fertilizers when growing crops, the use of humic preparations allows not only to increase productivity, but also to reduce the threat of environmental pollution. The aim of our research was to study the effect of the drug Hypergrin on the formation of potato productivity in the Krasnoyarsk forest-steppe.

2. Objects and methods of research
The study was conducted in 2017-2018 based on the Borsky gas processing plant of the Krasnoyarsk GA, which is located in the Sukhobuzim district, 57 km north of the regional center. A characteristic feature of the Krasnoyarsk forest-steppe relief is the wide distribution of the lowland-hilly mesoscale
and microrelief. It is most pronounced on river terraces and deluvial loops in the area of loesslike rocks and to a lesser extent on slopes and peaks of ridges [3]. The soil of the experimental fields is leached chernozem medium-heavy heavy loamy on yellow-brown clay. Spring supply of soil with available nutrients is good. According to the nitrogen content, the soil belongs to the fifth class (high), phosphorus - to the fourth (high), potassium - to the seventh (high availability).

A study of the influence of the pesticides system and Hypergrin on potato productivity was carried out on the Aramis super elite variety. Hypergrin is a biological product that combines the properties of a plant growth activator, immunostimulant, antistress and antidote. Mass fraction of water-soluble biologically active substances is 3.5 - 5.0 g/l. Aramis variety is included into the State Register for the East Siberian region. It is mid-season, table appointment. In the year of planting potatoes, at the first opportunity to leave the field, early spring harrowing was carried out, then the soil loosened to a depth of 18–20 cm before planting. The planting was carried out by the AVR potato planter, the consumption of planting material per hectare was 2.8 tons. The planting density was 48 thousand tubers/ha with row spacing 90 cm. Processing of crops with pesticides was carried out using a mounted sprayer OP-600. The consumption of drugs - in accordance with the recommendations of the manufacturers, the working solution when processing tubers is 25 l/t, vegetative plants - 200 l/ha. To determine the structure and yield value, three dynamic digging was carried out, digging 20 bushes in triplicate. The harvest of all digs dealt with the allocation of marketable (weight more than 40 g) and non-marketable tubers (up to 40 g).

As a control, a variant without Hypergrin was used. The system of protection against diseases and pests was applied on all variants of the experiment in order to ensure the production of high-quality potato planting stock.

To study the effect of Hypergrin on seed potato productivity, the following scheme was used:
1. Control (Prestige 1 kg/t; Zenkor Ultra 1.0 l/ha; Bizka 0.3 kg/ha + Consento 2 kg/ha; Bizka 0.3 kg/ha + Infinito 1.6 kg/ha; Bizka 0.3 kg/ha + Consento 2 kg/ha).
2. Prestige 1 kg/t + Hypergrin 0.8 l/t (when planting); Zenkor Ultra 1.0 l/ha (before germination); Biskaya 0.3 kg/ha + Consento 2 kg/ha + Hypergrin 1.0 l/ha (when the tops are closed); Biskaya 0.3 kg/ha + Infinito 1.6 kg/ha + Hypergrin 0.8 l/ha (after 10-14 days); Biskaya 0.3 kg/ha + Consento 2 kg/ha + Hypergrin 1.0 l/ha (after 10-14 days);
3. Hypergrin 10 ml/l; Zenkor Ultra 1.0 l/ha (before germination); Biskaya 0.3 kg/ha + Consento 2 kg/ha + Hypergrin 1.0 l/ha (when the tops are covered); Biskaya 0.3 kg/ha + Infinito 1.6 kg/ha + Hypergrin 0.8 l/ha (after 10-14 days); Biskaya 0.3 kg/ha + Consento 2 kg/ha + Hypergrin 1.0 l/ha (after 10-14 days);
4. Untreated tubers. Zenkor Ultra 0.6 l/ha (before germination); Biskaya 0.3 kg/ha + Consento 2 kg/ha + Hypergrin 1.0 l/ha (when the tops are covered); Biskaya 0.3 kg/ha + Infinito 1.6 kg/ha + Hypergrin 0.8 l/ha (after 10-14 days); Biskaya 0.3 kg/ha + Consento 2 kg/ha + Hypergrin 1.0 l/ha (after 10-14 days).

During the study, weather conditions differed from long-term average data and among themselves. From the second decade of May and June, extremely arid conditions were noted. Most rainfall occurred in the second half of the growing season.

3. Results and discussion

A month after the application of the herbicide, the green mass of weeds in the control was 0.15 t/ha, in the variant with Hypergrin it was 0.09 t/ha. Weed plants were under the cover of culture in a depressed state in the lower tier of agrocnosis. Soil and climatic conditions affect the duration of the protective effect of soil herbicides. Warm, humid weather of the second half of the growing season contributed to an increase in the microbiological activity of soils, which led to faster decomposition of the preparation and accelerated growth of tops. As a result, an increase in the number of weeds was observed already in early August, but they could not compete with the crop. The combined removal of tops led to the complete death of weeds. Adding humic preparations to tank mixtures allows us to solve several problems at once. On the one hand, this is an increase in the action of plant protection products, and on the other, it helps a cultivated plant to overcome chemical stress. Thus, humates help
the plant cope with the “crisis” state faster and continue normal vegetation, acting as growth stimulants. As our studies have shown, the use of Hypergrin in tank mixtures made it possible to mitigate the effects of stress and significantly reduce the time and power of the negative effects of pesticides.

The complex protection scheme implied the use of EmestoKvantum protectant for protection against soil pests and pathogens, common scab and rhizoctonia. Signs of late blight appeared at the end of the growing season of the crop shortly before the removal of the tops, without having any significant effect on yield. The field resistance of the Aramis cultivar in all experiment variants was 7 points. The results of the use of insecticides and fungicides on seed plantings of Aramis potatoes significantly reduced the development and manifestation of the main diseases and common pests, showing high reliability and effectiveness. Processing potato tubers with humic preparations and phytohormones increases the number of sprouts, which in turn affects the number of productive stems and potato productivity [4]. Due to the activation of growth processes at the initial stages of potato development, the following are observed: early emergence of seedlings, good survival and the onset of the main phases of ontogenesis [5].

Potatoes are considered one of the most responsive cultures for the introduction of humic preparations. However, the results of field experiments indicate that the yield increase can vary greatly from insignificant values to 10-20%, in some cases reaching 35-42% depending on the method of cultivation, weather conditions, the degree of cultivation of the soil and the variety of potatoes [6-8]. This is confirmed by the results of our research (figures 1-3).

Figure 1. The number of tubers, pcs/bush.

From figure 1 it is seen that in the first dynamic digging, the indicator shows the number of marketable tubers in the bush, the options using the Hypergrin preparation during planting and three vegetation treatments exceeded the control (variants 1 and 2).
Figure 2. The mass of one tuber, g.

The variant with the use of Hypergrin with soaking tubers for 4 hours followed by three treatments by vegetation exceeded the yield control due to the average weight of marketable tubers.

Figure 3. Productivity, g/m².
When growing seed potatoes, the size of tubers along the largest transverse diameter should be from 28 to 60 mm [9]. Given the average mass of marketable tubers (87.5 - 99.5 g), it is advisable to harvest potatoes for seeds during this period. The variant with the use of Hypergrin during planting and three treatments by vegetation in terms of yield exceeded the control by 444 g/m² due to the average mass of marketable tubers. This use of the drug has a positive effect.

From the analysis of potato yields by harvesting dates (table 1), it can be seen that, at the first term, an increase in control was given by the option of using Hypergrin during planting and its subsequent use during vegetation treatments.

Table 1. Potato biological yield by time of dynamic digging.

| Variant | Productivity, t/ha by harvesting time |
|---------|--------------------------------------|
|         | 1st decade of August | 1nd decade of August | 1st decade of September |
| 1 (control) | 28.17 | 35.24 | 38.07 |
| 2        | 24.70 | 39.68 | 42.23 |
| 3        | 31.42 | 32.76 | 40.90 |
| 4        | 28.82 | 33.31 | 39.42 |
| SSD 0.5  |         | 6.2   |        |

At the second harvesting period, only the variant with the use of the drug during planting and three treatments by vegetation exceeded the control in terms of yield.

In the third term, all options using Hypergrin exceeded control in terms of yield.

Figure 4. Two-year crop yield and marketability of seed potatoes.

An analysis of the yield of seed potatoes over two years (figure 4) showed that the use of the Hypergrin preparation reduces the harvesting time when growing potatoes for seed purposes and increases the yield and yield of marketable tubers when cultivated for food purposes.
In the arid conditions of the period 2017 - 2018 Hypergrin, acting indirectly through an increase in the labile part of humus and an increase in microbiological processes, stimulated tuberization, which led to an increase in the rate of seed reproduction.

4. Conclusion
The use of Hypergrin allows to reduce the harvesting time when growing potatoes for seed purposes and to increase the yield and yield of marketable tubers when cultivated for food purposes. The use of the biological stimulator Hypergrin with simultaneous etching during planting and the following two treatments during the growing season slightly increases the yield of potatoes compared to the control by 4.6 t/ha due to an increase in the number of tubers in the bush. Hypergrin in combination with chemicals showed anti-stress properties on potato plants. And the yield increase on options using this biological product is probably associated with this.

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