

# Biostimulants of growth in the production process of grain crops

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**Abstract.** The role of biostimulants of growth of various natures in the production process of spring wheat variety Zlata was studied, depending on nitrogen nutrition conditions, and was carried out under field conditions. The experiments assessed the activity of the plant assimilation apparatus and the formation of the yield of wheat plants using biostimulants of various natures by spraying vegetative plants. The studies found that the greatest effectiveness of the studied drugs was observed under conditions of optimal provision of nitrogen nutrition to wheat plants. It has been established that the preparations Epin-Extra, Emistim and Hardy increase the efficiency of the assimilation apparatus of spring wheat plants, which led to the receipt of large increases in grain weight under conditions of optimal provision of wheat plants with nitrogen nutrition.

## 1 Introduction

Spring wheat, as one of the main crops, is the main food crop not only in the Russian Federation, but also throughout the world. Wheat grain, having a favorable amino acid composition and a high content of essential nutrients, brings the greatest benefit for human nutrition and farm animals [1]. Spring wheat grain is used in the baking industry, as well as for the production of pasta and cereals. Bread made from high-quality spring wheat grain is characterized by good taste and nutritional value; its kilocalories are similar to meat (100 g of bread corresponds to 250 kcal, 100 g of pork - 240 kcal). The amino acid composition of grain and the content of essential amino acids in it are also of great importance [1].

Spring wheat is a long-day crop that requires little heat, but is demanding on soil fertility [2]. It is also known that spring wheat does not tolerate drought well, and therefore there is a need to use various fertilizers and biological products that increase the plants resistance to moisture deficiency in the soil [3-7].

One of the main factors that ensure the realization of the high productivity potential of spring wheat plants is the formation of the assimilation apparatus and its photosynthetic activity during the growing season. Photosynthetic activity of plants is the most important process of assimilation of light energy and its use for the synthesis of organic compounds from carbon dioxide and water [8,9]. The assimilates accumulated during photosynthesis

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are the basis for the formation of grain productivity of high quality composition. The main elements for the active passage of photosynthetic processes in plant leaves are chlorophyll complexes. The pigment apparatus of plant leaves, which includes chlorophyll a, b, carotenoids and other pigments, is located in thylakoid membranes, which are closely related to the protein-lipid components of chloroplast membranes [10]. The nature of this relationship has been little studied. It is known that it is weaker than a covalent bond and is easily destroyed when exposed to polar organic solvents or critical plant growing conditions, which leads to oxidative stress in plants, which results in the synthesis of reactive oxygen species in plant cells and tissues and denaturation of the protein part of the photosynthetic membranes [11, 13].

The organization and functioning of the photosynthetic apparatus of plants is controlled by both endogenous factors (genetic and hormonal) and exogenous factors (illumination, CO<sub>2</sub> and O<sub>2</sub> concentrations, temperature and others) [14-16].

To characterize the organization and functioning of the photosynthetic apparatus, as well as to assess the mechanisms of regulation of photosynthesis, integral indicators are used, among which are the overall intensity of photosynthesis, biomass accumulation, pigment content and their distribution in leaves, etc. An important condition for conducting research is to take into account the physiological state plants under specific growing conditions [17].

To induce physiological processes, biological products of various natures are used. Natural and synthetic growth regulators activate the processes of growth and development, which helps to increase productivity and increase the overall viability and resistance of plants to stress reactions. The active ingredients of growth regulators can be various groups of chemical compounds, such as gibberellins, cytokines, auxins and others. The mechanism of action of various drugs is the activation of cell division processes, stimulation of the growth of the root system, as well as an increase in leaf surface area and the ability to form and develop flowers and fruits [4,5,18,19].

Bioregulators have significant benefits and can be an effective tool for improving the sustainability and productivity of crops. It should be noted that in order to obtain the greatest effectiveness of various drugs, it is necessary to conduct additional studies to more fully study the mechanisms of their action and optimize their use in various conditions [20].

In this regard, the goal of our research was to study the role of growth bioregulators in the production process of spring wheat variety Zlata. The study examined the influence of various growth bioregulators on photosynthetic activity and the formation of grain yield in spring wheat plants.

## 2 Materials and methods

To resolve the issues raised, an experiment was carried out in the field at the experimental site of the Russian State Agrarian University-Moscow Agricultural Academy named after K.A. Timiryazev. The object of research was spring soft wheat (*Triticum aestivum L.*) variety Zlata (Variety originator: Federal State Budgetary Institution Federal Research Center "Nemchinovka" together with the Ryazan Research Institute of Agriculture. Laureate of the exhibition "Golden Autumn", Patent № 5404).

The studies were carried out according to generally accepted methods [21]. The total area of the plot was 1.44 m<sup>2</sup>. The registration area of the plot was 1 m<sup>2</sup>. The location of plots on the experimental plot is randomized. The soil of the experimental plot is a cultivated soddy-shallow podzolic profile-gleyic deep-arable, light loamy in granulometric composition with the following agrochemical characteristics pH<sub>KCl</sub> - 6.2 (GOST R 58594-2019), hydrolytic acidity (Hg) - 0.37 mg-eq/100 g ( GOST 26212-2021), sum of absorbed bases (S) – 23.6 mg-eq/100 g of soil (GOST 27831-2020), degree of soil saturation with

bases (V) – 98%, content of alkaline hydrolyzable form of nitrogen (Nahl) – 80 mg/kg of soil (class I according to Kornfield), the content of mobile forms of phosphorus was 251 mg/kg of soil (class 6 according to Kirsanov, GOST R 54650-2011), the content of mobile forms of potassium was 186 mg/kg of soil (5 class according to Kirsanov, GOST R 54650-2011).

The studies examined drugs of various natures: Biodux. Epin-Extra, Emistim, Ferovit, Hardy. The preparations were applied by spraying plants at stages 5 and 6 of organogenesis of wheat plants.

The drugs were studied under various nitrogen nutrition conditions. For this purpose, plants were grown under conditions of natural fertility. When fertilizers were not applied - N0 and when nitrogen fertilizers were applied N90. Ammonium nitrate (NH<sub>4</sub>NO<sub>3</sub>) was used as nitrogen fertilizer.

The sowing was sown with dry seeds at the rate of 500 seeds per plot. The experiment was repeated 4 times.

To assess the photosynthetic activity of spring wheat, the area of the assimilation surface of plants (cm<sup>2</sup>) and the net productivity of photosynthesis (g/m<sup>2</sup>-day) were determined. The harvest was harvested when the plants reached full ripeness using the continuous method. During harvesting, the weight of grain (g/1 m<sup>2</sup>), the number of grains and spikelets in an ear, and the weight of 1000 grains were analyzed.

Statistical processing of the obtained results was carried out using the one-factor method of analysis of variance [21].

### 3 Results and discussion

The photosynthetic activity of plants primarily depends on the formation of the size of the assimilation apparatus and its effective operation. Plant leaves perform the function of photosynthesis and transpiration, while absorbing solar energy and converting it into chemical bond energy [22].

The research results showed that when using nitrogen fertilizers, the assimilation surface area of plants and the net productivity of photosynthesis increase compared to options without the use of fertilizers (Table 1).

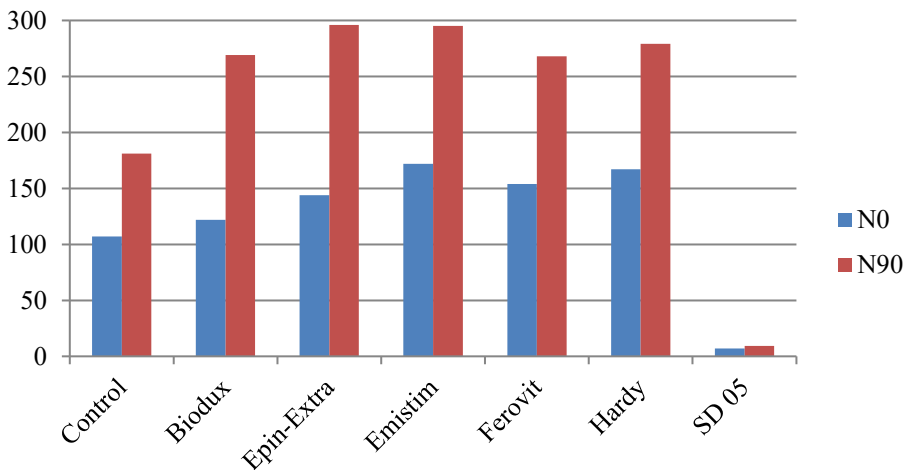
**Table 1.** Photosynthetic activity of spring wheat crops depending on treatment with bioregulators

Option	N0		N90	
	Plant assimilation surface area, cm <sup>2</sup>	Net productivity of photosynthesis g/m <sup>2</sup> -day	Plant assimilation surface area, cm <sup>2</sup>	Net productivity of photosynthesis g/m <sup>2</sup> -day
Control	33.5	5.0	47.7	7.0
Biodux	29.6	6.5	46.5	9.1
Epin-Extra	76.8	20.3	88.7	28.4
Emistim	69.8	14.7	77.0	20.6
Ferovit	41.7	8.0	49.0	11.2
Hardy	58.7	13.6	47.7	19.0
SD <sub>05</sub>	17.7	0.5	16.9	0.7

It was established that treatment of plants with biostimulants of growth Epin-extra and Emistim contributed to a significant increase in the assimilation surface area by 1.5-2 times, both with natural soil fertility and with the use of nitrogen fertilizers. At the natural level of soil fertility (N0), the assimilation surface area was 76.8 cm<sup>2</sup> in the application of the Epin-Extra drug, and 69.8 cm<sup>2</sup> in the application of the Emistim drug. Under nitrogen supply conditions, N90 is 88.7 cm<sup>2</sup> and 77.0 cm<sup>2</sup>, respectively.

The net productivity of photosynthesis is an indicator that allows us to evaluate the efficiency of the assimilation apparatus of plants. As the research results showed, the highest value of net productivity of photosynthesis was characterized by the variants where the preparations Epin-Extra, Emistim and Hardy were used, which indicates the greatest efficiency of the plant assimilation apparatus under these growing conditions. It was noted that providing wheat plants with nitrogen nutrition contributed to an increase in the efficiency of the plant assimilation apparatus. Thus, we can conclude that the greatest effectiveness of all studied drugs was obtained under conditions of optimal supply of nitrogen nutrition to plants. The preparations Epin-Extra, Emistim and Hardy, used by foliar treatment of plants, stimulated the maximum activity of the assimilation apparatus both under natural conditions of soil fertility (without the use of nitrogen fertilizers) and under optimal conditions of nitrogen nutrition.

The most important indicators that determine the economic value of annual crops are the quantitative and qualitative parameters of the crop. Observations during the experiments revealed that crop productivity depends on the level of nitrogen nutrition and the drugs used (Figure 1).



**Fig. 1.** The influence of drugs of various nature on the yield of spring wheat depending on nitrogen nutrition conditions.

The research results made it possible to identify the most effective preparations that made it possible to obtain the greatest increase in yield, both under natural conditions of soil fertility and when using the optimal level of nitrogen nutrition. It should also be noted that the use of an optimal level of nitrogen nutrition contributed to a significant increase in wheat yield. The increase in grain weight in the control variant was 1.69 times compared to the variant without the use of nitrogen fertilizers. It was found that the studied drugs showed the greatest effectiveness when grown under conditions of natural soil fertility. The increase in grain productivity under natural soil fertility conditions was 14% when treating vegetative plants with Biodux, Epin-Extra - 38%, Emistim - 61%, Ferovit - 44%, Hardy - 56%. Under conditions of optimal provision of plants with nitrogen nutrition, high increases in grain weight were also obtained - 27%, 64%, 63%, 48%, 54%, respectively, compared to the control option without the use of drugs. The high effectiveness of the drug in these conditions is due to the active substance of the studied drugs.

Thus, we can conclude that the studied drugs are highly effective when used to treat plants during the growing season. To obtain the highest possible yield of spring wheat, it is necessary to use optimal levels of nitrogen nutrition.

## 4 Conclusions

1. It was found that biostimulants used in optimal doses by spraying vegetative plants help to activate the processes of growth of the assimilation surface of plants. The preparations Epin-Extra, Emistim and Hardy have a significant impact not only on the size of the assimilation surface, but also on the efficiency of its work. The drugs had a significant effect on increasing the net productivity of photosynthesis by 1.5-2 times.
2. It has been established that the studied preparations of different nature determine the yield of spring wheat depending on the conditions of nitrogen nutrition. It is noted that in order to obtain the greatest effectiveness of the drugs, it is necessary to create optimal conditions for nitrogen nutrition. It was with the use of nitrogen fertilizers that the maximum increases in grain yield were obtained in the variants where plants were treated with Epin-Extra and Emistim (64% and 63%, respectively, compared to the control variant).
3. It has been shown that when using the preparations Biodux, Ferovit and Hardy under conditions of optimal nitrogen supply to plants, comparable increases in grain weight were obtained compared to natural growing conditions (without the use of nitrogen fertilizers).

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