CODEN [USA]: IAJPBB ISSN: 2349-7750

INDO AMERICAN JOURNAL OF
PHARMACEUTICAL SCIENCES

http://doi.org/10.5281/zenodo.3345022

Available online at: http://www.iajps.com *Research Article*

INFLUENCE OF COMPLEX PHYSIOLOGICALLY ACTIVE SUBSTANCES ON THE PECULIARITIES OF PHOTOSYNTHETIC PRODUCTIVITY OF WINTER WHEAT PLANTS

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Article Received: May 2019 **Accepted:** June 2019 **Published:** July 2019

Abstract:

Photosynthetic productivity is one of the most important factors determining the production process of plants. There is a direct connection between photosynthesis and crop yields, so the study of the characteristics of the photosynthetic activity of plants under the action of complex physiologically active substances is very important for understanding the mechanisms of their influence on yield formation. The aim of the research was to establish the features of the photosynthetic productivity of plants when using complex physiologically active substances in the technology of cultivation of winter wheat. The use of complex physiologically active substances in the technology of cultivation of winter wheat contributes to an increase in the relative content of chlorophyll. The best results in terms of the number of green pigments during vegetation on average were shown by Raykat Start (presowing treatment of seeds), both separately and in combination with other drugs (the excess compared to the control was 0.30-0.36 mg / g or 9.8 - 11.8%). The most stable excess of chlorophyll content in plants at the end of the growing season is demonstrated by options using Nutrivant zernovoy (the excess is 80-100%). The use of complex physiologically active substances in winter wheat crops contributes to an increase in the chlorophyll photosynthetic potential by 2.4-27.6%, depending on the preparations, the time of their use and combinations with each other. Regardless of the organomineral substances used, the proportion of individual plant organs in the total photopotential is almost unchanged (leaves - 61.2-63.7%, stems - 25.4-28.1% and ears of corn - 9.9-10.7%). The use of complex physiologically active substances in the technology of cultivation of winter wheat against the background of an increase in the size of the assimilation apparatus can both increase its efficiency and reduce it. As a rule, the use of Raykat Start, both individually and in combination with other drugs, leads to a decrease in the net productivity of photosynthesis by 3.7-13.3%. At the same time, with the use of Nutrivant zernovoy NPP, it either does not decrease or increases by up to 5.2%.

Keywords: *winter wheat, complex physiologically active substances, yield, photosynthetic productivity, chlorophyll content, photosynthetic potential, net productivity of photosynthesis.*

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Please cite this article in press Tikhon Simatin et al., ***Influence Of Complex Physiologically Active Substances On The Peculiarities Of Photosynthetic Productivity Of Winter Wheat Plants.,*** *Indo Am. J. P. Sci, 2019; 06(07).*

INTRODUCTION:

The development of new cultivation technologies and the improvement of existing ones in modern conditions should be aimed at improving the efficiency and stability of crop production. Physiologically active substances can act as sufficiently low-cost, with a wide spectrum of action and environmentally safe methods that allow to solve this problem to some extent [1, 2].

In recent years, along with physiologically active substances in the cultivation of crops began to use the so-called complex organo-mineral fertilizers. They consist of both directly physiologically active substances, and macro-, micro-elements and other organic compounds that have a beneficial effect on the plant organism. They activate growth, metabolic, synthetic processes, optimize nutrition, improve water metabolism, increase the reutilization of previously accumulated substances, increase plant resistance to adverse environmental factors, etc. [3].

Photosynthetic productivity is one of the most important factors determining the production process of plants. There is a direct link between photosynthesis and crop yields [4, 5, 6]. Therefore, the study of the peculiarities of the photosynthetic activity of plants under the action of complex physiologically active substances is very important for understanding the mechanisms of their influence on yield formation.

The aim of our research was to establish the features of the photosynthetic productivity of plants when using complex physiologically active substances in the technology of cultivation of winter wheat.

MATERIAL AND METHODS:

The work was carried out during the 2016-2018 years in the North Caucasus Federal Scientific Agrarian Center, located in the unstable humidification zone of the Stavropol Territory, the average annual air temperature is + 9.8 °C, and the average annual rainfall is 652 mm.

The predecessor is black steam. The repetition of the experiment is threefold, the area of each plot is at least 25 m^2. In the experiments, we studied the following complex physiologically active substances: **Raykat Start** - seed treatment (o / s) at a dose of 0.5 l / t of seeds, **Aminokat** 10% - foliar feeding of crops at the fourth stage of organogenesis at a dose of 0.3 l / ha, **Atlante Plus** - foliar nutrition of crops at the VIII stage of organogenesis at a dose of 0.5 l / ha; **Nutrivant zernovoy** - foliar fertilization of crops at the beginning of the XI stage of organogenesis at a dose of 2 kg / ha, as well as all combinations of drugs in the relevant phases of growth and development of winter plants wheat.

The object of research - crops of winter wheat variety Bagheera (high-yielding variety, mid-season, resistant to lodging and grain shedding).

Indicators of photosynthetic productivity, calculated by conventional methods. The content of chlorophyll was determined by the method Ya.I. Milaeva and N.P. Primax using the Wintermans and De Mots equations [7]. The activity of nitrate reductase was studied by the method of Mulder in the modification of Tokarev [8]. Accounting of the harvest was carried out by direct combining.

RESULTS AND DISCUSSION:

Chlorophyll content is a fundamental indicator of photosynthetic productivity, which characterizes not only the size of the assimilation apparatus, but also the efficiency of synthetic plant processes. First, the greater the concentration of green pigments, the more active they are there. Secondly, the size of the photosynthetic apparatus determines both the amount of generated energy and the number of assimilates used in various reactions.

Our studies have shown (table 1) that the use of complex physiologically active substances has a significant impact on the content of chlorophyll in the organs of winter wheat plants.

Table 1: The effect of complex physiologically active substances on the relative content of chlorophyll (*a* + *b*) in winter wheat plants, mg / g, on average for 2016-2018.

Variant	**April 7**	**April 27**	**May 22**	**June 12**	**June 25**	**Average**
Control (without treatments)	7,97 ±0,32	3,69 ±0,15	2,45 ±0,1	0,89 ±0,04	0,34 ±0,01	**3,07 ±0,12**
Raykat Start (c)	8,33 ±0,33	4,10 ±0,16	2,76 ±0,11	1,01 ±0,04	0,65 ±0,03	**3,37 ±0,13**
Aminokat (IV)	7,97 ±0,32	4,13 ±0,17	2,61 ±0,1	1,01 ±0,04	0,64 ±0,03	**3,27 ±0,13**

Atlante Plus (VIII)	7,97 ±0,32	3,69 ±0,15	2,45 ±0,1	1,05 ±0,04	0,78 ±0,03	**3,19 ±0,13**
Nutrivant zernovoy (X)	7,97 ±0,32	3,69 ±0,15	2,45 ±0,1	0,89 ±0,04	0,61 ±0,02	**3,12 ±0,12**
Raykat Start (c)+Aminokat (IV)	8,33 ±0,33	4,22 ±0,17	2,75 ±0,11	1,01 ±0,04	0,49 ±0,02	**3,36 ±0,13**
Raykat Start (c)+Atlante Plus (VIII)	8,33 ±0,33	4,10 ±0,16	2,76 ±0,11	1,01 ±0,04	0,69 ±0,03	**3,38 ±0,14**
Raykat Start (c) + Nutrivant zernovoy (X)	8,33 ±0,33	4,10 ±0,16	2,76 ±0,11	1,01 ±0,04	0,60 ±0,02	**3,36 ±0,13**
Aminokat (IV) + Atlante Plus (VIII)	7,97 ±0,32	4,13 ±0,17	2,61 ±0,10	1,11 ±0,04	0,54 ±0,02	**3,27 ±0,13**
Aminokat (IV) + Nutrivant zernovoy (X)	7,97 ±0,32	4,13 ±0,17	2,61 ±0,10	1,01 ±0,04	0,67 ±0,03	**3,28 ±0,13**
Atlante(VIII) + Nutrivant (X)	7,97 ±0,32	3,69 ±0,15	2,45 ±0,10	1,05 ±0,04	0,46 ±0,02	**3,12 ±0,12**
Raykat (c) + Aminokat (IV) + Atlante(VIII)	8,33 ±0,33	4,22 ±0,17	2,75 ±0,11	1,17 ±0,05	0,51 ±0,02	**3,40 ±0,14**
Raykat (c) + Aminokat (IV) + Atlante(VIII) + Nutrivant (X)	8,33 ±0,33	4,22 ±0,17	2,75 ±0,11	1,17 ±0,05	0,69 ±0,03	**3,43 ±0,14**

Note: c - seed treatment, IV, VIII and X - stages of organogenesis (foliar dressing of crops).

So on average during the growing season the relative content of chlorophyll in winter wheat plants was in the range of 3.03-3.43 mg / g. It should be noted that all variants of the experiment with the use of complex physiologically active substances showed an increase in the concentration of green pigments in the unit of dry biomass. The greatest increase in this indicator is observed on the options Raykat Start (c) + Atlante Plus (VIII), Raykat (c) + Aminokat (IV) + Atlante (VIII) and Raykat (c) + Aminokat (IV) + Atlante (VIII) + Nutrivant (X), in which the average chlorophyll content in plants during the growing season was higher than in the control by more than 0.31 mg / g.

Attention is drawn to the fact that all of these options present seed treatment with Raykat Start and foliar feeding in the earing of Atlante Plus. But if on the variant using only Raykat Start an increase in the relative content of chlorophyll on average during the growing season compared to the control variant was 0.30 mg / g, then using only Atlante Plus at the VIII stage of organogenesis the increase was estimated to be only 0.12 mg / g . Therefore, it can be assumed that the main contribution to the increase in the relative content of chlorophyll in winter wheat plants on average during the growing season when used in the cultivation technology of the studied complex physiologically active substances belongs to the processing of Raykat Start seeds and this excess is 0.30-0.36 mg / g or 9.8-11.8%.

The use of the drug Nutrivant zernovoy in the technology of cultivation of winter wheat at the XI stage of organogenesis (milky-waxy ripeness) in our experiments did not increase the relative content of chlorophyll in plant organs as much as other drugs. However, this increase was estimated at over 3.5%. If we consider that the processing of Nutrivant zernovoy crops occurs at the very end of the growing season, when the response of plants to its use is very limited in time, then our results are quite significant. They are also because the conditions for the passage of the generative period determine the value of the future harvest and its quality.

Analysis of chlorophyll content in winter wheat plants at the eleventh stage of organogenesis (approximately 7 days after Nutrivant zernovoy treatment) showed that all variants of our experience exceeded control by this indicator (Figure 1).

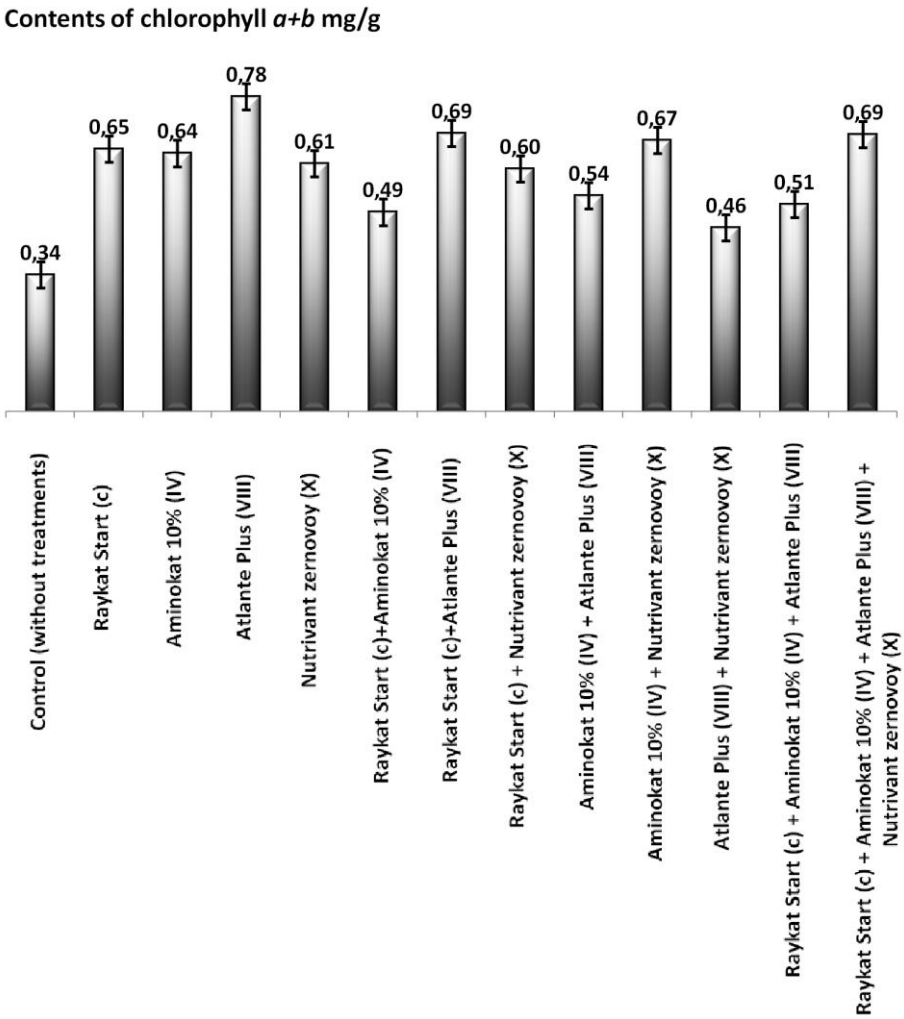

Figure 1: Relative chlorophyll content in winter wheat plants (grain filling), mg/g, average for 2016-2018

The results obtained by us showed that the use of the studied complex physiologically active substances separately gives the maximum increase in the concentration of green pigments in winter wheat plants at the end of the growing season. This is especially evident when foliar dressing in the earing of Atlante Plus (the content of chlorophyll in plants exceeded control by 130%). However, the most stable excess of the amount of green pigments in plants in our experiments was demonstrated by the variants using Nutrivant zernovoy - the excess is 80-100%. An exception is the variant Atlante Plus (VIII) + Nutrivant zernovoy (X), which, by the amount of chlorophyll, the unit of biomass at the XI stage of organogenesis exceeded control by only 34%.

Thus, the use of complex physiologically active substances in the technology of cultivation of winter wheat contributes to an increase in the relative content of chlorophyll. The best results in terms of the number of green pigments during vegetation on average were shown by Raykat Start (presowing treatment of seeds), both separately and in combination with other drugs (the excess compared to the control was 0.30-0.36 mg / g or 9.8 -11.8%). The most stable excess of chlorophyll content in plants at the end of the growing season is demonstrated by options using Nutrivant zernovoy (the excess is 80-100%).

For the productivity of agricultural crops, an important role is played not only by the size of the photosynthetic sowing apparatus, but also by the time of its functioning. Characteristics of the photosynthetic activity of sowing, reflecting the size of the assimilation apparatus, its change during the growing season and the time of active functioning, is the photosynthetic potential.

Studies have shown that the use of complex physiologically active substances in the technology of

cultivation of winter wheat has an impact on the chlorophyll photosynthetic potential (Figure 2).

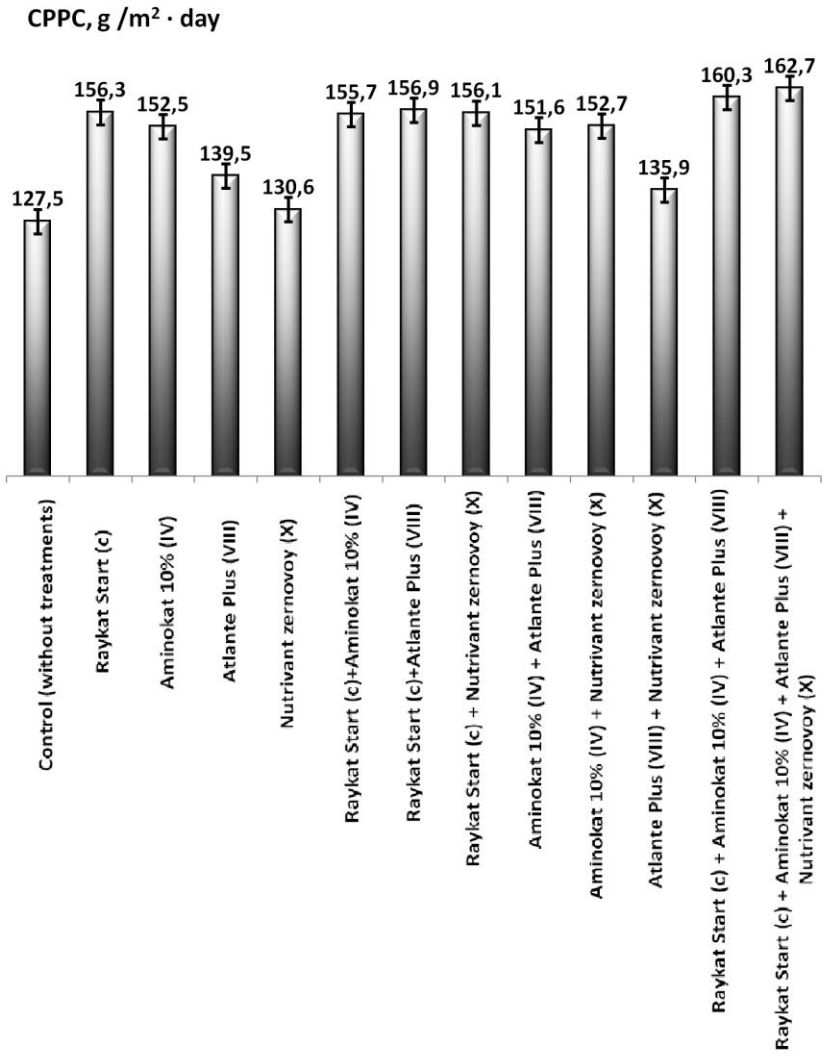

Figure 2: Chlorophyll photosynthetic potential of winter wheat crops, g / m^2 • day, average for 2016-2018

The highest value of this indicator, we noted when using all the studied drugs Raykat Start (c) + Aminokat 10% (IV) + Atlante Plus (VIII) + Nutrivant zernovoy (X) - 162.7 g / m^2 • day. The smallest values of this indicator were obtained on the options Nutrivant zernovoy (X), Atlante Plus (VIII) + Nutrivant zernovoy (X) and Atlante Plus (VIII), which exceeded the control version of 2.4, 6.5 and 9.4% respectively.

It should be noted that in the variants with a separate application of the studied complex physiologically active substances, a proportional decrease in the value of the chlorophyll photosynthetic potential is observed as the time interval from sowing to the moment of application of a particular drug increases. So the use of Raykat Start as a pre-sowing treatment of seeds in our experiments contributed to an increase in chlorophyll photo potential compared to the control by 22.5%, the use of Aminokat 10% during the spring tillering period - by 19.6%, Atlante Plus by heading - by 9.4 %, and Nutrivant zernovoy in the phase of milky-wax ripeness - only 2.4%. The results can be explained by the fact that the increase in the duration of action of drugs contributes to a more favorable course of processes associated with the growth and development of plants. On the other hand, the established pattern indicates a prolonged action of the studied complex physiologically active substances.

The contribution of various plant organs to the total photosynthetic potential can be assessed by its structure. In our experiments, the share of leaves accounted for 61.2-63.7% CPPC (Figure 3). Almost a third (25.4-28.1%) in the total Photopotential is the share of stems, and the ears only belong to 9.9-10.7% in CPPC plants.

Analysis of the obtained data allows to conclude that the use of complex physiologically active substances in the technology of cultivation of winter wheat contributes to a proportional change in the chlorophyll photo potential for all plant organs, while the ratio of the activity of the photosynthetic function of leaves, stems and ears does not change.

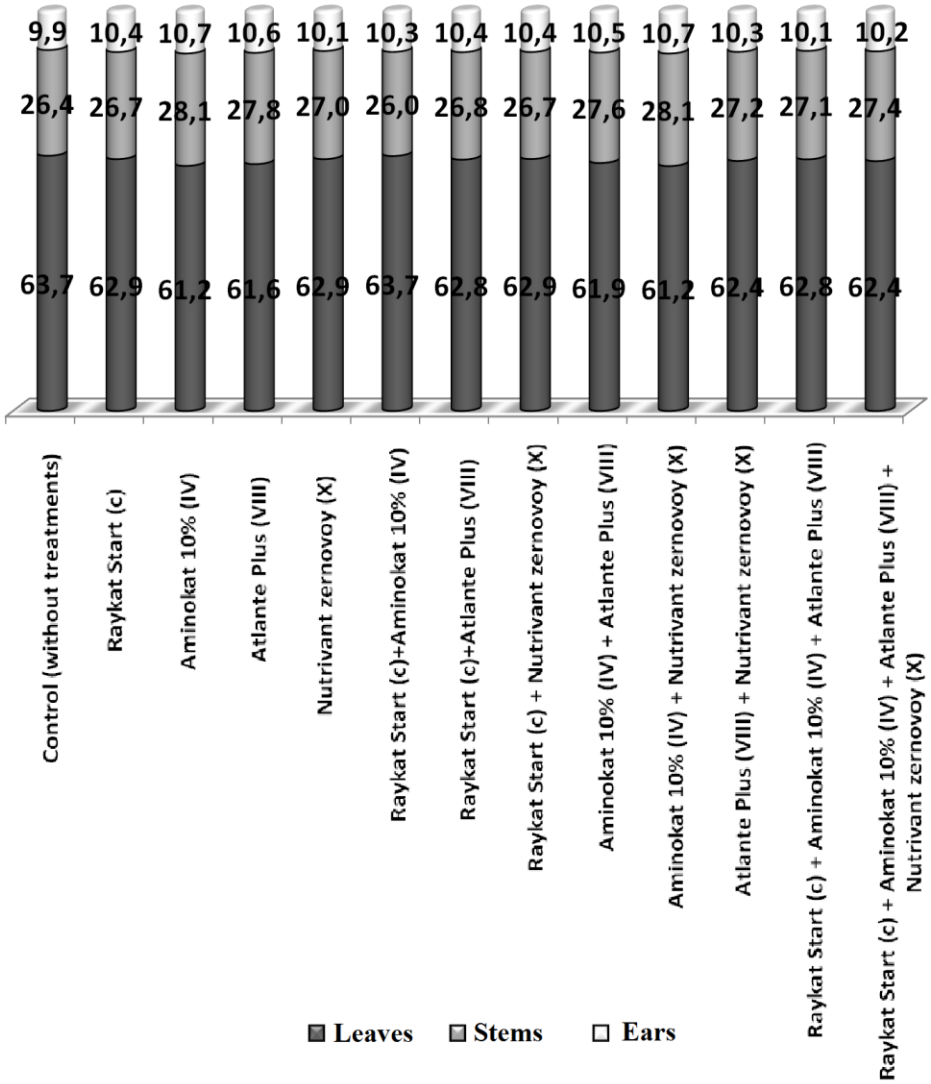

Figure 3: Structure of the chlorophyll photosynthetic potential of winter wheat crops,%, on average over the years of research (2016-2018).

Thus, the use of complex physiologically active substances on winter wheat crops contributes to an increase in chlorophyll photosynthetic potential by 2.4-27.6%, depending on the drugs, the time of their use and combinations with each other. Regardless of the organomineral substances used, the proportion of individual plant organs in the total photopotential is almost unchanged (leaves - 61.2-63.7%, stems - 25.4-28.1% and ears of corn - 9.9-10.7%).

It is used as the net photosynthesis productivity (NPP) [9–12]. The value of NPP makes it possible to estimate which way the crop is being formed, depending on the technological methods of cultivation, intensive or extensive. If the value of the net productivity of

photosynthesis increases from the applied care measures, then the activity of the photosynthetic apparatus increases, and its intensity of work increases. If NPP decreases, but there is an increase in both the size of the assimilation apparatus and the productivity of sowing, then the crop is created in an extensive way.

Our research has shown that the use of complex physiologically active substances in the cultivation of winter wheat can both reduce the efficiency of the photosynthetic apparatus in creating an organic mass and increase it (Figure 4). The greatest decrease in Net Productivity of photosynthesis was observed when only Raykat Start was used for presowing treatment of seeds (a decrease of 13.3%). NPP in our experiments decreased in such variants as Aminokat 10% (IV) - by 7.0%, Atlante Plus (VIII) - by 3.7%, Raykat Start (c) + Aminokat 10% (IV) - by 7.7%, ikat Start (c) + Atlante Plus (VIII) - by 6.3%, Raykat Start (c) + Aminokat 10,% (IV) + Atlante Plus (VIII) - by 6.0%. Analysis of the data obtained allows us to conclude that the use of Raykat Start, both separately and in combination with other complex physiologically active substances, as a rule, helps to reduce the net productivity of winter wheat sowing.

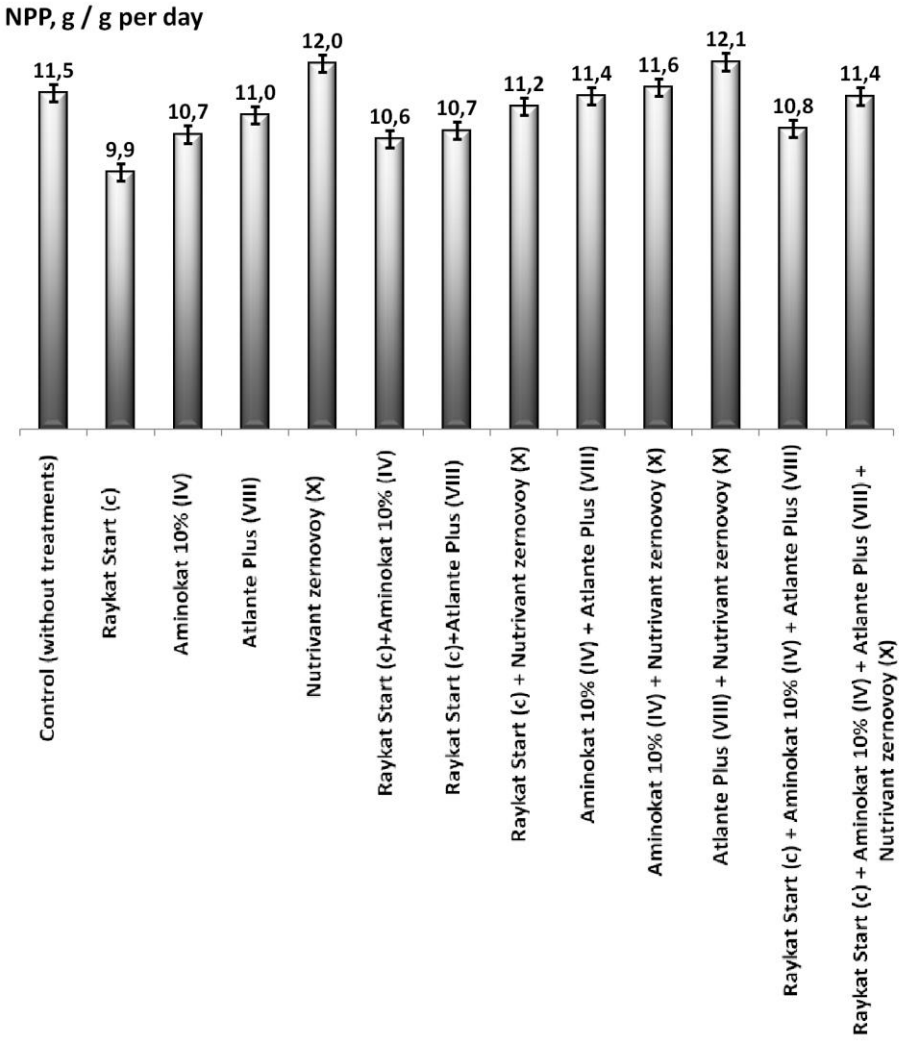

Figure 4: Net productivity of photosynthesis of winter wheat crops, g / g per day, on average over the years of research (2016-2018)

In our experiments on variants using Nutrivant zernovoy, both individually and in combination with other drugs, the net productivity of photosynthesis either remained at the level of control or tended to increase. So the use of this drug in the phase of milky-wax ripeness increased the NPP value by 0.5 g / g per

day. On the variant of the experiment, where Atlante Plus was used in earing and Nutrivant zernovoy at the XI stage of organogenesis, this excess was 5.2%.

Thus, the use of complex physiologically active substances in the technology of cultivation of winter wheat against the background of an increase in the size of the assimilation apparatus can both increase its efficiency and reduce it. As a rule, the use of Raykat Start, both individually and in combination with other drugs, leads to a decrease in the net productivity of photosynthesis by 3.7-13.3%. At the same time, with the use of Nutrivant zernovoy NPP, it either does not decrease or increases by up to 5.2%.

CONCLUSION:

1. The use of complex physiologically active substances in the technology of cultivation of winter wheat contributes to an increase in the relative content of chlorophyll in plants. The best results on average during the growing season were shown by the variants where Raykat Start was used (the excess compared to the control was 0.30-0.36 mg / g or 9.8-11.8%). At the end of the growing season, the highest amount of green pigments was observed in the variants with Nutrivant zernovoy (the excess compared to the control is 80-100%).
2. The use of complex physiologically active substances on winter wheat crops contributes to an increase in chlorophyll photosynthetic potential by 2.4-27.6%, depending on the drugs, the time of their use and combinations with each other.
3. Complex physiologically active substances, as a rule, reduce the net productivity of photosynthesis. The greatest decrease was noted with the use of Raykat Start, both individually and in combination with others - by 3.7-13.3%. When using the drug Nutrivant zernovoy on winter wheat crops either does not reduce or increase NPP by up to 5.2%.

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