Methods and results of spring barley plants treatment with growth biostimulants

R V Shchuchka¹ and V A Gulidova
Bunin Yelets State University, Yelets, Russian Federation

¹ E-mail: romanelez@yandex.ru

Abstract. In the conditions of the Central Black Soil Region of Russia, spring barley plants experimental treatment with Polishans and Energoshans growth biostimulants, which had not previously been tested in the Central Black Soil Region of Russia concerning this crop, was carried out. The Vakula variety spring barley seeds were used for the work. Before planting, the seeds were treated with the fungicide TERRASIL Forte. The experiment was built on the randomized repetitions' method and is a rectangular scheme. It allows to have an options complete set in each repetition, and each of them occurs in the block (repetition) only once. Thanks to this feature, the method acquires the greatest stability and flexibility. The barley plants height assessment according to the vegetation phases, barley plants general and productive tillering, seeds weight per 1 m², barley productivity, barley seeds laboratory germination, protein content in barley seeds was carried out. Based on observations and calculations, it can be concluded that growth biostimulants and the way they are used can have a positive effect on the spring barley seeds yield and quality. The most positive effect is achieved when using drug Polishans. The profitability level increased by 4.1% with its application. This is the reason to recommend it as a foliar dressing for growing spring barley.

1. Introduction
Environmental safety is a fundamental factor in the technological processes' development in agriculture, which has relatively few ways and means to ensure. Among them, – is a growth stimulation technology that allows plants to develop resistance to diseases [1, 2].

The spring barley plants experimental treatment with the growth biostimulants Polishans and Energoshans, which were not previously tested in the Central Black Soil Region concerning this crop, will reveal the potential for increasing the spring barley yield.

The research purpose is to study the biostimulants Polishans and Energoshans effect and their application methods on the spring barley seeds yield and quality.

2. Materials and methods
The research objects were the growth biostimulants Polishans and Energoshans.

Biostimulant Polishans is a macro and microelements balanced mixture – essential amino acids based on seaweed extract, that is, an organomineral fertilizer in a chelated form. The drug advantages [1, 3, 4]:

- Non-toxic, environmentally friendly for the environment and humans.
- Significantly increases seeds laboratory and field germination and their resistance to diseases.
• Allows filling the nutrients' lack.
• Working on growing plants increases their resistance to disease and various stresses (frost, herbicides).
• It is highly effective in the fight against barley black rust and other similar fungal diseases.
• Promotes an increase in the plant growth rate as a whole.
• Promotes earlier (2-3 days) seeds awakening.
• A noticeable effect can be seen at 7-10 days.
• Improves the fruits quality characteristics and their keeping quality during storage.

Provides an increase in the ovaries number, protects against grains shedding.

The drug dosage is 0.3-0.4 l/ha (0.56 ml/16m²). The working solution consumption - 300 l/ha (5l/16m²).

Energoshans is a biostimulant containing auxins, polysaccharides, glucosides, betaines, as well as macro-, micro- and mesoelements extracted from seaweed. The drug is intended for the grain seeds treatment, legumes, industrial vegetables and ornamental crops, as well as roots when transplanting tree seedlings and seedlings of vegetable crops. The vegetative plants are also sprayed with Energoshans.

The drug advantages [1, 3, 5]:

• Improves seed germination and root development.
• Significantly reduces the plant survival time to 3-7 days after transplantation.
• Increases plant protection against stress factors: drought, frost, waterlogging.
• Promotes the plant improved root development, thereby nutrients better absorption.
• Accelerates the crop ripening.
• Increases the products' commercial quality.

The drug dosage is 0.1-0.2 l/ha (0.24 ml/1 6m²). The working solution consumption - 300 l/ha (5l/16m²).

For this experiment, we used the spring variety Vakula barley seeds. This variety has the following characteristics [6, 7]:

• Productivity (average) 33.7 kg/ha
• Seeding rate (germinating seeds/ha) - 5 million pcs/ha - with 15 cm row spacing
• The 1,000 grains mass is 46-52 g, in abundant moisture supply conditions and on irrigation it reaches 60 g.
• It responds well to high agronomic background and separate complex mineral fertilizers' application together with sowing seeds and during the plants growing season.
• Legal parameters: Included in the State Register of the Russian Federation in 2007.

Agricultural background. Main fertilization N30 P30 K30.

Disease resistance. Susceptible to diseases of dust brand and helminthosporiosis; Particularly susceptible to stem rust.

Protection features. Before sowing, the barley seeds were treated with TERRASIL Forte fungicide.

The use direction: feed, food, technical.

Development features. A mid-ripening variety, which growing season is 70-86 days, ripens 1-3 days earlier than the Gonar variety. In resistance terms to lodging, it is slightly inferior to the Gonar variety by one point. Has an average drought resistance. Grain fodder. The protein content ranges from 11.0-12.9%. Susceptible to diseases of dust brand and helminthosporiosis; Particularly susceptible to stem rust.
This variety average yield in the Central Black Soil Zone was 33.7 c/ha, increasing the average result by 2.4 c/ha. In the Belgorod and Tambov regions, the average yield was 31 c/ha. The maximum yield was shown on the Lipetsk region territory 82.2 c/ha obtained in 2005.

Before planting, the seeds were treated with the fungicide TERRASIL Forte. On a pre-sown field with a SZU-5.4 seeder with 15 cm row spacing, 12 plots were laid out. Each area was 4m2. Treatment with Polishans and Energoshans preparations was carried out when the plants were in the tillering phase in the evening. The treatment was done in four repetitions. To compare the results, some of the plots were not treated with any preparation. The measurements were taken in the growing season different phases and collected in tables. After harvesting, the crop was collected in sheaves and threshed with a special thresher. The crop weight and the 1000 seeds weight were determined for the options. Later, an analysis was carried out for the protein percentage in barley grains and a test for laboratory germination was performed.

The experiment was built on the randomized repetitions' method and is a rectangular scheme. It allows to have an options complete set in each repetition, and each of them occurs in the block (repetition) only once. Thanks to this feature, the method acquires the greatest stability and flexibility. Table 1 shows the experiment design.

| Table 1. Experiment design. |
|-----------------------------|
| 1  | 3  | 2  | 1  |
| 2  | 1  | 3  | 2  |
| 3  | 2  | 1  | 3  |

1 - Control - plants that have not been treated with growth stimulants.
2 - Polishans: plants processing.
3 - Polishans: plants processing.

3. Results and discussion
Plant height – is one of the most important parameters by which the plant development level can be determined (table 2).

| Table 2. Barley plants height by vegetation phases depending on treatment, cm. |
|-----------------------------------------------------------------------------|
| Vegetation phases | Options | Control | Polishans | Energoshans |
|-------------------|---------|---------|-----------|-------------|
| 2018 |
| Entering the tube phase | 41.8 | 40.1 | 38.8 |
| Flowering | 49.2 | 50.9 | 51.1 |
| Ripening | 55.5 | 52.1 | 54.4 |
| 2019 |
| Entering the tube phase | 57.8 | 54.9 | 56.3 |
| Flowering | 65.9 | 65.7 | 66.1 |
| Ripening | 67.9 | 69.7 | 68.9 |
| Average |
| Entering the tube phase | 49.8 | 47.5 | 47.6 |
| Flowering | 57.6 | 58.3 | 58.9 |
| Ripening | 61.7 | 60.9 | 61.7 |

This table shows the change in vegetative development plant height in various vases for 2018 and 2019. Measurements were carried out on each plot of 20 measurements, the results were recorded (table 3).
In 2018, the plant height was very low due to less snowy winters and drier summers, and the plants also got sick with dust brand.

In the entering the tube phase, the Control variant barley plants height was 41.8 cm, the Polishans variant plants – 40.1 cm, and the Energoshans variant plants – 38.8 cm.

In the flowering phase, the plants' height not treated with growth stimulants was at the level of 49.2 cm, samples treated with preparations showed a height of 50.9 cm (Polishans) and 51.1 cm (Energoshans).

In the ripening phase, measurements were taken before harvesting. Variants treated with drugs were found to be of lower height than Control. Polishans – 52.1 cm, Energoshans – 54.4 cm, Control – 55.5 cm.

Plants were taller in 2019 than in 2018 due to warmer springs and rainy summers. Measurements were carried out on each plot of 20 measurements, the results were recorded.

In the entering the tube phase, the Control was distinguished by a higher height than the plants treated with the drugs: Control – 57.8 cm, Polishans – 54.9 cm, Energoshans – 56.3 cm.

**Table 3.** Processing and measurements dates.

| Phases                  | 2018          | 2019          |
|-------------------------|---------------|---------------|
| Drug treatment          | 05.28.2018    | 05.29.2019    |
| Entering the tube phase | 06.14.2018    | 06.12.2019    |
| Flowering               | 06.28.2018    | 06.17.2019    |
| Ripening                | 07.30.2018    | 08.04.2019    |
| Harvesting              | 08.03.2018    | 08.07.2019    |

During flowering, the plants' height treated with Polishans was 65.7 cm, Energochans – 66.1 cm, Control – 65.9 cm.

Before harvesting, measurements showed the advantages of treatment with growth stimulants before untreated plots: Polishans – 69.7 cm, Energoshans – 68.9 cm, Control – 67.9 cm. On average, at the harvest time, the plants' height was at the following level: Control and Energoshans – 61.7 cm, Polishans – 60.9 cm.

The productive tillering indicator shows how many fruit-bearing shoots one barley grain can give (table 4). The total productive bushiness was calculated shortly before harvesting the plants. The measurements were carried out as follows: a wooden frame with sides 25*25 cm was laid on the plot and the plant bushes number in the resulting cage was counted. In each bush, the shoots and fruiting shoots total number was calculated. The results in table 4 were obtained from the ratio of the average number of fruit-bearing and total shoots per number of plants. The higher the productive tillering, the more yield can be obtained from one hectare.

**Table 4.** The barley plants total and productive tillering depending on treatment with growth stimulants.

| No i.o. | Option   | Tillering total | productive |
|---------|----------|-----------------|------------|
| 1       | Control  | 2.4             | 1.7        |
| 2       | Polishans| 2.4             | 2.0        |
| 3       | Energoshans | 2.3           | 1.8        |

The table shows that the plants treated with Polishans gave the highest productive tillering at the level of 2; Energy chance – 1.8; Control – 1.7.

The seeds mass from 1 m2 is a quantitative indicator by which one can see the growth stimulants effect (table 5).
Table 5. Seeds mass from 1 m², g.

| No i.o. | Option   | Research years |         |         | Average |
|--------|----------|----------------|---------|---------|---------|
|        |          | 2018           | 2019    |         |         |
| 1      | Control  | 173.5          | 481.8   |         | 327.6   |
| 2      | Polishans| 196.9          | 521.0   |         | 356.6   |
| 3      | Energoshans| 192.1      | 491.0   |         | 343.9   |

The seeds mass from plants treated with Polishans in 2018 is 23.4 grams higher than the Control variant indicators and 4.8 grams higher than the Energoshans variant. In 2019, the difference was more significant. This is due to warmer springs and rainy summers. The seeds mass from plants treated with the Polishans growth stimulator was 521 grams, which is 39.2 grams higher than the Control option and 30 grams higher than the Energoshans option. On average, the difference between Polishans and Control was 29 grams, and Energoshans – was 12.7 grams. The variant treated with Polishans showed great efficiency.

The barley yield is one of the main indicators by which the growth stimulants action can be determined (table 6).

The barley yield in 2018 was very low. With the Vakula variety average yield of 33.7 c/ha recorded in the State register, the result without treatment with preparations showed 17.4 c/ha. Plants treated with drugs gave the following results: Polishans – 19.7 c/ha, Energoshans – 19.2 c/ha. In 2019, the result was noticeably better. Plants treated with the Polishans stimulator gave a yield of 45.6 c/ha, Energoshans allowed harvesting 43 c/ha, and plants not treated with preparations gave 42.2 c/ha. On average for 2 years, the yield was: Polishans – 32.4 c/ha, Energoshans – 31.4 c/ha, Control – 29.8 c/ha. On average, the increase was about 2.6 c/ha for the variant treated with Polishans and 1.6 c/ha for the one treated with Energoshans.

Table 6. The barley productivity depending on the treatment with growth stimulants, kg/ha.

| No. i.o. | Option   | Research years |         | Average |
|---------|----------|----------------|---------|---------|
|         |          | 2018           | 2019    |         |
| 1       | Control  | 17.4           | 47      | 32.2    |
| 2       | Polishans| 19.7           | 50.9    | 35.3    |
| 3       | Energoshans| 19.2        | 48      | 33.6    |
| SSD0.5  |          |                |         | 2.3     |

Finding the mass of 1,000 seeds allows determining the nutrients' amount in barley grains (table 7). The higher the mass of 1,000 seeds of the same crop, the higher the seeds' quality.

By the mass of 1,000 seeds, in 2018 the variant without drug treatment dominates, Control, it is 0.5 grams heavier than the variant treated by Polishans and 1.2 grams heavier than seeds obtained with Energoshans. In 2019, the situation has changed. Here the drug Polishans is the leader, it made it possible to obtain barley heavier grains than Energoshans by 3.3 grams and 3.6 grams heavier than the Control option. The grains obtained in 2019 have a more rounded shape and larger size than in 2018, which determines the difference in weight over the years.

Table 7. Weight of 1,000 seeds, g.

| No. i.o. | Option   | 2018 | 2019 | Average |
|---------|----------|------|------|---------|
| 1       | Control  | 43.8 | 48.9 | 46.4    |
| 2       | Polishans| 43.3 | 52.5 | 47.9    |
| 3       | Energoshans| 42.6 | 49.2 | 45.9    |
Laboratory seed germination is the germinated seeds number relative to those laid down for germination expressed as a percentage (table 8).

In 2018, the control variant showed the best result - 85.8%. The plants' seeds treated with Energoshans showed a result of 84.3%, which is 1.5% lower than the Control. In third place are barley grains obtained from plants treated with Polishans, their germination rate is 79.5%, which is 6.3% lower than the Control variant.

In 2019, laboratory germination was significantly better. The Polishans preparation showed the best results, the plants treated with it gave seeds with 94.7% germination. The result obtained without the drugs’ use gave 89.7% germination, which is 5% less than the version obtained from plants treated with Polishans. Seeds from plants on which they worked with energy chance showed a germination rate of 94%, which is 4.3% higher than the Control variant and 0.7% lower than Polishans.

Table 8. The barley seeds laboratory germination, %.

| No i.o. | Option     | Research years | Average |
|--------|------------|----------------|---------|
|        |            | 2018  | 2019  |         |
| 1      | Control    | 85.8  | 89.7  | 84.6    |
| 2      | Polishans  | 79.5  | 94.7  | 90.3    |
| 3      | Energoshans| 84.3  | 94.0  | 89.2    |

On average, over the years, the second option (Polishans) is leading, followed by the third option (Energoshans) and the Control option is in third place.

This experience showed that in 2018 laboratory germination was lower than in 2019. This is because barley in 2018 has a dust brand disease, thus the seeds turned out to be more pikey and lost in germination, as well as the impact could have other weather conditions.

In addition to yield per hectare, protein content (table 9) is an important indicator that determines the barley cultivation benefits. After all, it is the protein that determines what the crop will be used for and what profit it will bring.

Table 9. Protein Content in barley seeds, %.

| No i.o. | Option     | Research years | Average |
|--------|------------|----------------|---------|
|        |            | 2018  | 2019  |         |
| 1      | Control    | 8.4   | 9.5   | 8.95    |
| 2      | Polishans  | 10.8  | 10.3  | 10.55   |
| 3      | Energoshans| 11.6  | 9.8   | 10.70   |

The plant samples seeds treated with growth promoters received a significant increase in the average results for years relative to untreated plants: 1.75% of Energoshans and 1.6% of 8,068 Energoshans. The results of 2018 and 2019 differ from each other. The control version in 2018 showed worse results than in 2019, and the third option (Energoshans) on the contrary in 2018 showed a protein content higher than in 2019. The second variant (Polishance) shows the results greatest stability: the protein content changes by 0.5% in different years, while the Control changes by 1.1%, and the Energoshans by 1.8%.

The greatest benefit is the barley cultivation for brewing purposes, but for the protein content must be within 9-12.5%. The drug Lichance will allow even in unfavourable years, such as 2018, to get a stable result.

4. Conclusions
Based on observations and calculations, it can be concluded that growth biostimulants and the way they are used can have a positive effect on the spring barley seeds yield and quality.
The most positive effect is achieved when using drug Polishans. The profitability level increased by 4.1% with its application. This is the reason to recommend it as a foliar dressing for growing spring barley.

It is necessary to remember, to achieve positive results, it is not enough to use only plants chemical treatment. Success is achieved in a combination of agrochemical and agro-technical techniques.

References
[1] Avdeenko A P 2015 The modern growth stimulants effect on the spring barley productivity in the Rostov region International Research Journal 7(38) 2 103-6
[2] Demina A V 2019 Effectiveness of Drugs of Polishans and Energoshans on the Winter Wheat Sowing in the Orenburg Predural Conditions (In the collection: Students and graduate students in science. An articles' collection on the annual intercollegiate scientific and practical conference materials) p 10-3
[3] Firsova T I, Filenko G A and Dontsova A A 2016 The reaction of the spring barley variety Leon to the use of growth stimulants in conjunction with a seed treater Agricultural science of the Euro-North-East 2(51) 20-3
[4] Vorontsov V A 2018 Effectiveness of basic soil processing and chemical treatment in barley cultivation in the Central Black Soil region Agriculture 84 36-9
[5] Kursakova V S, Stupina L A and Khizhnikova T G 2016 Influence of a growth stimulator, mycorrhiza and associative bacteria on the yield of spring barley in the conditions of the kolochnaya steppe of the Altai Territory Proc. XI Int. Scientific and Practical Conf. "Agricultural Science for Agriculture" vol 2 (Barnaul, Russia: Altai State Agrarian University) p 149-51
[6] Torikov V V 2010 Productivity and Brewing Qualities of Grain of Spring Barley New Varieties (Bryansk, Russia: Bryansk State Agricultural Academy)
[7] Danilov A V and Evdokimov M A 2017 The crops processing influence by growth stimulants on the spring barley yield in the conditions of the Republic of Mari El Agricultural products production and processing improving the technology Current issues 19 7-10
[8] Dubovik D V 2018 The crops' quality depending on agrotechnical techniques and climatic conditions Agriculture 2 9-13