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Influence potassium humate and vostok EM-1 drugs on yield and quality of Soybean Variety Ivan Karamanov in the conditions of the Primorskiy Krai

ВЛИЯНИЕ ГУМАТА КАЛИЯ И ПРЕПАРАТА ВОСТОК ЭМ-1 НА УРОЖАЙНОСТЬ И КАЧЕСТВО СЕМЯН СОИ СОРТА ИВАН КАРАМАНОВ В УСЛОВИЯХ ПРИМОРСКОГО КРАЯ

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Abstract

The article presents the research results of the influence potassium humate and effective microorganisms on soybean variety Ivan Karamanov plants on survival, preservation, yield, crop structure and seed quality. The results were obtained as follows. The preservation ability of soybean plants in the control variant was 90%, it increased by 2% when treated with potassium humate and it increased by 3% when treated with Vostok EM-1. The use of potassium humate and effective microorganisms increases the soya leaf surface area. Treatment of soybean plants with growth regulators during the growing season beneficially affects the growth and development of the root system. The length of the main root and the mass of the root system increases when plants are treated with potassium humate. The number of nodules increases almost fourfold from 7.2 in the control variant and it increases to 27.9 in the variant with potassium humate. The attachment height of the lower bean increases by 2.2 cm when treating plants with potassium humate which reduces losses during harvesting. The productivity of a single plant

Аннотация

В статье представлены результаты исследования влияния гумата калия и эффективных микроорганизмов на соевые сорта растений Ивана Караманова на выживаемость, сохранность, урожайность, структуру культур и качество семян. Результаты были получены следующим образом. Консервативная способность растений сои в контрольном варианте составила 90%, увеличилась на 2% при обработке гуматом калия и увеличилась на 3% при обработке Востоком ЭМ-1. Использование гумата калия и эффективных микроорганизмов увеличивает площадь поверхности соевых листьев. Обработка растений сои регуляторами роста в течение вегетационного периода благотворно влияет на рост и развитие корневой системы. Длина основного корня и масса корневой системы увеличиваются при обработке растений гуматом калия. Количество конкреций увеличивается почти в четыре раза с 7,2 в контрольном варианте и увеличивается до 27,9 в варианте с гуматом калия. Высота прикрепления нижней фасоли

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increases from 4.73 g to 5.54 g when treated with potassium humate and to 5.16 g when treated with effective microorganisms. The yield of soya increases by 0.44 t / ha when treated with potassium humate compared to the control variant which corresponds to 19.7%, and when treated with effective microorganisms it increases by 12.6%. Treatment of plants with potassium humate and effective microorganisms contributes to the production of higher quality seeds. Laboratory seed germination without treatment was 88.0%, it was 96.5% when treated with potassium humate and it was 91.0 % when treated with effective microorganisms.

Keywords: soya, potassium humate, effective microorganisms, yield, structural indicators.

Introduction

Soya is one of the most important protein-oil crops in modern world crop production (Morokhovets, 2016). Soya farming in the Far Eastern economic region plays an important role in helping to solve the problem of protein deficiency in human nutrition and animal feeding (Baukova, Karpova, Krivoborod, 2018). The process of agricultural production is associated with a complex of factors of a different nature: systemic, technological, biological, socio-economic, climatic, reproductive, environmental (Siptits, Ganieva, Romanenko, Evdokimova, 2019). In modern agriculture tillage practice is of particular importance that allows to use the resource potential of the soil in full and provides active reproduction of fertility over time (Sukhorukov, Tilba, Volokh, Korotenko, 2009).

It should be noted that the climate of Primorye is characterized by uneven distribution of precipitation during the growing season. As a result, the biological activity of soils, the availability of food elements and as a consequence of this, the yield of agricultural crops is reduced (Koloskov, 1971). One of the reserves for reducing the adverse impact of abiotic environmental factors is the possibility of using biological stimulation methods - the application of humates and effective microorganisms in the cultivation of soya (Golubkina, Zamana, Tareeva, Mukhortova, Pivovarova, 2010).

увеличивается на 2,2 см при обработке растений гуматом калия, что снижает потери при уборке. Продуктивность одного растения увеличивается с 4,73 г до 5,54 г при обработке гуматом калия и до 5,16 г при обработке эффективными микроорганизмами. Урожай сои увеличивается на 0,44 т / га при обработке гуматом калия по сравнению с контрольным вариантом, что соответствует 19,7%, а при обработке эффективными микроорганизмами - на 12,6%. Обработка растений гуматом калия и эффективными микроорганизмами способствует производству более качественных семян. Всхожесть семян в лабораторных условиях без обработки составила 88,0%, при обработке гуматом калия - 96,5%, при обработке эффективными микроорганизмами - 91,0%.

Ключевые слова: соя, гумат калия, эффективные микроорганизмы, урожайность, структурные показатели.

The introduction of humic compounds is based on their ability to become quickly involved in the processes of metabolism at the cellular level, to activate and in stressful situations (drought, temperature rise and other deviations from the norm) to normalize biological processes and the flow of minerals into plants, mainly nitrogen causing plant growth improvement and yield enhancement (Yarchuk, 1968).

Vostok EM-1 drug is designed to vitalize the activity of soil microflora which optimally and comprehensively provides soybean plants with mineral nutrition elements by processing plant residues, organic fertilizers and soil humus, as well as mobilizing them from soil minerals in the right amount for plants without harm to the environment.

The goal of research is to study the effect of potassium humate and effective microorganisms on the yield and quality of soybean seeds.

Based on this goal the following tasks were being solved:

1. To study the effect of potassium humate and effective microorganisms on the growth and development of soybean plants;
2. To determine the effect of potassium humate and effective microorganisms on the development of the root system and the activity of nodule bacteria of soybean plants;
3. To establish the influence of potassium humate and effective microorganisms on the structural indicators and soya grain yield;

4. To identify the effect of potassium humate and effective microorganisms on seed quality of soybean seeds.

The object of research was soybean variety Ivan Karamanov (State register of selection achievements approved for use, 2016).

The scientific novelty and practical value of this work consists in the fact that for the first time the possibility of using potassium humate and effective microorganisms in soybean variety Ivan Karamanov in the conditions of the Experimental Training Farm of the Primorskaya SAA is assessed.

Research conditions and methods

Table 1.

Agrometeorological conditions of the growing season in year 2019 are presented in the table.

Temperature, °C	May	June	July	August	Sep.
1 ten-day period	11,7	15,6	17,6	24,5	21,1
2 ten-day period	13,2	15,1	19,7	19,9	13,9
3 ten-day period	15,7	16,5	23,3	19,4	14,7
Average a month	13,6	15,7	20,3	21,2	16,6
Average perennial	11,2	15,7	20,0	20,8	15,0
Precipitation, mm					
1 ten-day period	5,1	5,6	16,4	67,7	19,7
2 ten-day period	31,1	41,4	17,5	105,6	17,0
3 ten-day period	40,8	18,4	27,6	53,2	1,7
Total in month	77,0	65,4	61,9	226,5	38,4
Average perennial	63,0	84,0	93,0	121,0	106,0

Spring of year 2019 is early. In March the temperature rose to + 16°C and at night there was also a positive temperature. In the third decade of March a sharp cold snap came, snow fell, and night temperatures fell to -16°C. The first decade of April was cold and overcast with light snow and strong winds. The second half of April was relatively warm and sunny. Precipitation was almost non-existent. June was cold and rainy with rain falling regularly every week, although the total precipitation was less than the average annual values for this month. The average monthly air temperature in June also corresponded to the long-term average of 15.7 °C. The temperature in July was higher than the average annual values by 0.3 °C and was 20.3 °C. August was also warmer, the temperature was 21.2 °C, that is more than the average annual values of this month by 0.4 °C. In August a huge amount of precipitation fell (about 226.5 mm) which exceeded the average values of this month by 104.5 mm. The plants experienced severe

The experimental site is located on meadow and brown bleached soil. Meadow and brown soils have a slightly acidic reaction of the culture medium and a high exchange capacity. The soil absorbing complex is rich in calcium and magnesium. Soils are low-humus; in the A1 horizon its content is 2-3%.

The climate of the territory is monsoon. In summer southern and south-eastern winds of the Pacific monsoon dominate, carrying a large amount of moisture, and in winter they carry dry continental winds of northern directions. The warmest month is August (+19; + 22°C). The coldest month is January (-19; -22°C). The annual precipitation is 700-800 mm.

waterlogging and were in the water for a long time. During the period of ripening and harvesting the conditions were most favorable. September was characterized by an increased air temperature of 16.6 °C, which is more than the average annual values of 1.6 °C. Precipitation was three times less than normal (table 1).

Thus, we can come to a conclusion that, in general, the growing season of year 2019 was unfavorable for the growth and development of soya which had an impact on its productivity and product quality.

The field experiment was conducted on the test plot of the Primorskaya State Academy of Agriculture in year 2019 on the area of 2.5 hectares. Records and observations were made according to the Methods of State Crop Variety Testing (Methods of State crop variety testing. 1989).

The object of research is soybean variety Ivan Karamanov approved for application in the Far East territory.

The technology of soybean cultivation was generally accepted for the Primorye territory (Redkokashina, 2016). Before sowing soybean seeds were treated with the Fertigrain Start biostimulator in a dose of 1-2 l / t of seeds, the consumption of the working solution is 10 l / t. Soybean sowing was carried out on June 2 with a seeding rate of 120 kg / ha in an row-crop planting (15 cm).

The soil herbicide Bambu was introduced immediately after sowing which does not require embedding in the soil (ground spraying method). The rate of consumption of the drug is 0.2 l / ha, the working solution is 200 l / ha. The predecessor is oats.

Experimental Scheme:

1. Control variant (without treatment).
2. Treatment with potassium humate. Treatment was performed once during budding – the beginning of soybean flowering on August 5. The rate of consumption of 1 liter of mother liquor per 1 ha. Potassium humate (Protohumixtm) contains 10 % of humic substances (acids) from leonardite (naturally oxidized lignite) + 0.75% of potassium hydroxide + 89.25% of water. Manufacturer is AGROHIMMASH-ECO (Novosibirsk).
3. Treatment with Vostok EM-1 drug. Treatment was carried out in the phase of soybean seedlings in June.

Experimental data of the field experience were treated according to the method of dispersion analysis by B. A. Dospekhov (2011).

Records and observations in the experiment:

1. phenological observations (shoots, branching, budding, flowering, fruit formation, maturation);
2. harvesting and recording of grain harvest;
3. determination of biometric indicators and crop structure (plant height, attachment

- height of the lower bean, the number of beans per plant, the number and weight of seeds per plant, the number of seeds in a bean, the weight of 1000 pieces of seeds);
4. determination of the main root length and the root system mass;
5. determination of the number and mass of nodule bacteria;
6. determination of sowing qualities of seeds.

Soybean variety Ivan Karamanov is medium-ripened in 120-135 days depending on the hydrothermal regime. Plants are large-stemmed, tall up to 160 cm; slightly branching. Weight of 1000 seeds is 178-210 g. The protein content in seeds is 35-40 %, fat content is 20-22 %. The peculiarity of plants is the intensive growth of the first internodes before flowering. Rapid growth and large leaves provide increased competitiveness with weeds, in comparison with other zoned varieties. The variety is responsive to soil fertility and agrotechnical measures that ensure crop yield.

Results and discussion

Soya is a heat-loving crop. Seeds germinate at a temperature of 8-10°C. Taking into account these plant requirements and the weather conditions of year 2019, the sowing was carried out on June 2 in 2019. Conditions for germination of soybean seeds were favorable and the loop phase was observed 4 days later, on June 6.

On June 9 the germination phase was noted, one could notice the appearance of cotyledon leaves on the soil surface.

Soil moisture and optimal temperature are sufficiently important for the plant during this period. Then two simple primordial leaves develop. They are located symmetrical to each other and from the same node. All subsequent leaves are triplicate. The triplicate leaves are arranged only one at a node and alternately on the stem. When 3-4 real leaves appear, the cotyledons on the plant fall off and intensive branching begins (Pavlova, 2015). The branching phase of soya was marked on July 10 during carried out experiment.

Table 2.

Influence of potassium humate on the growth and development of soybean variety Ivan Karamanov plants, year 2019

Growth stage of soya	Experimental variants		
	Control variant (no-treatment)	Treatment potassium humate	Treatment effective microorganisms
Sprouts	9.06	9.06	9.06
Branching	10.07	10.07	10.07
Budding	5.08	5.08	5.08
Flowering	10.08	10.08	9.08
Green ripeness	26.08	25.08	25.08
Grayish-blue ripeness	15.09	14.09	13.09
Brown ripeness	1.10	29.09	28.09

Then generative buds develop in the leaf axils and the budding phase is marked from the moment of formation of the first buds on the plant. Budding of soybean variety Ivan Karamanov was noted on August 5.

Maturation begins with the browning of the lower beans and ends with the maturation of all beans on the plant. By the end of maturation the seeds on the entire plant become hard, they also acquire the appropriate color of the variety, and the leaves turn yellow and fall off. The maturation phase is divided into green, gray and brown ripeness. In the given experiment soya maturation began on August 26 in the control variant and it started a day earlier in the treated variant. Brown ripeness in the variant without plant treatment occurred on October 1 but when treated with potassium humate it appeared on September 29 and when treated with Vostok EM-1 it occurred on September 28.

Thus, as a result of the conducted tests, it can be concluded that treatment of soybean plants with such drugs as potassium humate and Vostok EM-

1 contributes to a faster maturation phase passage by plants and, accordingly, shortens the length of the growing season as a whole.

The main condition for the formation of a highly productive soybean agrocenosis is the creation of optimal plant density which has a significant impact on growth processes, plant height and weight, crop structure and timing of development phases.

Accounting records of the standing density of soybean plants in the experimental studies were conducted twice – the first time in the phase of full germination and the second time just before harvesting when the seeds are fully matured.

Agrocenosis formation analysis of soybean varieties Ivan Karamanov showed that field germination largely depends on the weather conditions of the year and the biological characteristics of the variety. Field germination was 84-85% and did not depend on the experimental variant in the carried out tests (table 3).

Table 3.

Influence of potassium humate and Vostok EM-1 on field germination, survival and conservation of soybean variety Ivan Karamanov plants, 2019.

Indicator	Experimental variants		
	Control variant (no-treatment)	Treatment potassium humate	Treatment Vostok EM-1
Seed application rate, pc./m ²	65,0	65,0	65,0
Standing plant density after full sprouts, pc./m ²	55,0	54,8	55,1
Field germination, %	85	84	85
Standing plant density before harvesting, pc./m ²	49,7	50,6	51,0
Plant survival, %	76	78	78
Plant preservation, %	90	92	93

The density of standing plants determined before harvesting depends on the survival of plants. Survival rate is the number of plants remaining at the time of harvesting expressed as a percentage of the germinated seeds. Analysis of the research shows that treatment of soybean plants with potassium humate and Vostok EM-1 during vegetation increased the survival rate of soybean plants by 2% compared to the control variant. The survival rate was 78% in the treatment variants.

Another important indicator that characterizes the state of crops is the preservation of plants by the end of the growing season. It shows the number of plants remaining at harvest time expressed as a percentage of seeds that have sprung up. In the carried out investigations, the preservation ability of soybean plants in the control variant was 90%, when treated with

potassium humate the preservation ability increased by 2% and when treated with Vostok EM-1 it increased by 3% (table 3). Thus, treatment of soybean plants with organic drugs contributes to the improvement of indicators such as survival and persistence of plants which ultimately affects the yield.

Characteristics of agrocenosis photosynthetic activity of soybean variety Ivan Karamanov depend on soil and climatic conditions and agricultural cultivation techniques including the application of various growth regulators.

As a result of the research conducted in 2019, we established the positive effect of treating soybean plants with potassium humate and effective microorganisms on the phytometric indicators of soybean variety Ivan Karamanov (table 4).

Table 4.

Influence of potassium humate and Vostok EM- 1 drug on the productivity of photosynthetic apparatus of soybean variety Ivan Karamanov.

Experiments	Leaf surface area, sm ² /1 plant	Number of plants per 1 m ²	Leaf surface area, m ² /ha
Control variant (no-treatment)	447,8	49,7	22258
Treatment potassium humate	506,9	50,6	25649
Treatment Vostok EM-1	471,9	51,0	24066

The leaf surface is the main indicator of the crop's agrocenosis state in terms of their photosynthetic activity (Xiaomei, Sinegovskaya, 2009).

According to the results of the research, potassium humate and effective microorganisms activate the photosynthesis process increasing the leaf surface area of the soybean plant.

The maximum leaf area in all variants of the experiment was formed by the seed filling phase and varied from 22.3 to 25.6 thousand m² / ha. It reached the lowest value in the control variant and the highest in the variant with the use of potassium humate for plant vegetation.

The most intensive formation of leaf area in soybean plants occurred in the variant with potassium humate plant treatment. Plants of this variant formed a leaf area of 25649 m² / ha which

exceeds the control variant by 15%. When treating soybean plants with effective microorganisms, this indicator increased by 8% compared to the control variant.

The use of potassium humate contributed to the improvement of the soya leaf apparatus. The amount of photosynthetic potential depended on both the rate of leaf area formation and the duration of its functioning (Sinegovskaya, Sukhorukov, Xiaomei, 2009). All techniques aimed at improving the nutrition conditions of soybean plants led to improving the growth of the leaf surface and the duration of its operation. The growth of the green mass of soya occurs slowly before the formation of beans and intensively during the pod formation - the filling of seeds. The maximum value of this indicator was reached by the phase of full seed filling (table 5).

Table 5.

Effect of potassium humate and EM-drug on leafage and green mass yield of soybean variety Ivan Karamanov.

Experiments	Green mass 1 m ² , g	Leaf mass per 1 m ² , g	Leafage, %	Green mass yield, t/ha
Control variant (no-treatment)	1769	341	18	17,7
Treatment potassium humate	2105	433	21	21,1
Treatment Vostok EM-1	2073	386	19	20,7

This indicator was the lowest in the control variant and amounted to 17.7 t / ha. The maximum green mass yield was formed by the phase of full seed filling period in the variant with potassium humate treatment of plants for vegetation and amounted to 21.1 t / ha. The yield of soy green mass with the use of effective microorganisms was 20.7 t / ha. The process of accumulation of dry matter by soybean plants was more dependent on the operation of the photosynthetic apparatus.

In general, the main indicators of photosynthetic activity of soybean crops were higher in variants where organic preparations such as potassium humate and effective microorganisms were used. Soybeans are widely cultivated economically valuable fodder and leguminous crops the yield of which directly depends on bacterial microsymbionts (Roumiantseva, 2019). Soya has a fairly high nitrogen-fixing capacity. Observations of the nodule formations on soybean roots have shown that they are formed two weeks after the emergence of seedlings. Legume root nodules form better at pH 6.5 (Lukin, Zavalin, Sokolov, Shmyreva, 2019).

Observations of the nodule formation dynamics and condition have shown that the activity of the symbiotic apparatus varies significantly during the growing season. The greatest activity of nodule bacteria on soybean roots was observed during the flowering - fruiting phase. Accordingly, the determination of the nodule number and their mass was carried out during

the period of their greatest formation – flowering formation of beans on soybean plants (Xiaomei, 2007).

It was found in the carried out experiments that the treatment of soybean plants with growth regulators during the growing season significantly affected the growth and development of the root system. Thus, when treating soya with potassium humate the length of the main root increased by 3.6 cm compared to the non-treated variant and was 20.7 cm against 17.1 cm. The root mass in this variant increased by 0.4 g and amounted to 4.2 g against 3.8 g (table 10).

Treatment of soybean plants with Vostok EM-1 also led to an increase in root length from 17.1 cm to 19.5 cm and weight from 3.8 g to 4.1 g (table 6). In general, it can be noted that both the length of the main root and the weight of the root system of soya in research year is significantly less than it is typical for this species, which is primarily due to extremely unfavorable conditions of moisture in the second period of plant vegetation. Soybean crops were in conditions of severe waterlogging of the soil, which contributed to a decrease in the oxygen content in the soil pores and, as a result, a decrease in the length of the main root and the number of lateral roots. Nevertheless, in such adverse conditions, a reliable positive effect of the studied drugs on these signs was established (table 6).

Table 6.

Effect of potassium humate and Vostok EM-1 on the growth and development of the root system of soybean variety Ivan Karamanov and the activity of nodule bacteria.

Experiments	Length of the main root, sm	Weight of the roots, g/ 1 plant	Number of nodules, pc./ 1 plant	Mass of nodules, g/ 1 plant
Control variant (no-treatment)	17,1	3,8	7,2	0,034
Treatment potassium humate	20,7	4,2	27,9	0,132
Treatment Vostok EM-1	19,5	4,1	12,8	0,063

Moreover, in addition to improving the soya root system activity the studied drugs had a beneficial effect on the formation of the symbiotic apparatus of soybean plants. Nodule bacteria on the roots of soybean plants perform the function of fixing atmospheric nitrogen and providing it to plants. Thus, their increased quantity contributes to increasing the yield of both grain and green mass of plants and reducing the cost of nitrogen fertilizers (Tilba, 1972).

It was in studies revealing that the treatment of soybean plants with potassium humate during vegetation contributed to a significant increase in the nodule number on the roots of plants. Their number increased almost fourfold from 7.2 in the control variant to 27.9 in the experimental variant (table 6).

Soybean plant treatment for vegetation with Vostok EM-1 also affected these indicators but to a lesser extent. The number of nodules increased from 7, 2 in the control variant and it increased to 12.8 in the experimental variant. Their weight in comparison with the control variant increased almost twice and amounted to 0.063 g against 0.034 g per plant (table 6).

The treatment effect with potassium humate and Vostok EM-1 on soybean plants of Ivan

Karamanov variety productivity can be discussed more in detail considering the structure of the crop. The elements of soya harvest structure include indicators such as plant height, number of lateral branches per plant, height of attachment of the lower bean, the number of beans and seeds per plant, number of seeds per pod, weight of 1000 seeds and grain weight per plant.

The height of plants is an important sign that determines the yield. According to I. M. Shindin and V. V. Bochkarev the average height of soybean varieties cultivated in the Far East ranges from 60 to 90 cm and depends on the growing conditions.

The conducted test showed that the height of soybean plants in the control and experimental variants was from 81.4 to 83.1 cm (table 7). There is no reliable effect of the studied drugs on this trait. The number of side branches on a plant is an important feature that determines the number of beans, and ultimately the yield of seeds. In our experiment treatment of soybean plants with potassium humate and Vostok EM-1 contributed to an increase in the number of branches on the plant from 2.4 in the control variant and an increase to 2.9 and 2.8 in the experimental variant respectively (table 7).

Table 7.
Structural indicators of soybean varieties Ivan Karamanov.

Experiments	Height of plants, cm	Number of branches, pc./1 plant	Height of attachment of the lower bean, sm	Number, pc./1 plant		Number of seeds in a bean, pc.	Mass of seeds by 1000 pc., g	Mass of a seed per plant, g
				beans	seeds			
Control variant (no-treatment)	81,4	2,4	11,6	16,9	32,3	1,91	147,03	4,73
Treatment potassium humate	83,1	2,9	13,8	17,8	36,0	2,02	154,08	5,54
Treatment Vostok EM-1	82,6	2,8	11,7	17,4	33,6	1,93	153,6	5,16

The height of attachment of the lower bean in soybean plants is of great importance for mechanized harvesting. The higher the attachment height of the lower bean, the less losses during harvesting, the higher the yield, respectively (Adaptive and progressive technologies of soybean and corn cultivation in the Far East, 2009). In the carried out researches, treatment of crops with potassium humate contributed to an increase in the attachment of

the lower bean in soya by 2.2 cm in comparison with the control variant. Treatment of crops with Vostok EM-1 did not affect this indicator (table 7).

The number of beans per plant depends on the height of the plant and the number of side branches and directly affects the yield. When studying the drugs, it was found that soybean plant treatment with Vostok EM-1 increases the

number of beans by 0.5 pieces in comparison with the check, and treatment with potassium humate increases the number of beans by 0.9 pieces. The number of seeds in a bean is also an important indicator of productivity. Soya treatment with potassium humate contributed to an increase in the number of seeds in the bean by 0.11 pieces when compared to the check. Treatment with Vostok EM-1 did not affect this indicator. The last two indicators depend on the weight of grain per plant, which characterizes its

productivity. In the conducted studies, the weight of grain from one soybean plant when treated crops with potassium humate exceeded the control variant by 0.81 g, and when treated with Vostok EM-1 it exceeded by 0.43 g (table 7).

The main indicator that characterizes the effect of the studied drugs on soybean plants is the yield. Data on the effect of potassium humate and Vostok EM-1 on the yield of soybean varieties Ivan Karamanov are presented in table 8.

Table 8.

Influence of potassium humate and Vostok EM-1 on the yield of soybean variety Ivan Karamanov.

Experiments	Yielding capacity at harvesting moisture, t/ha	Grain harvesting moisture, %	Yielding capacity at standard moisture, t/ha
Control variant (no-treatment)	2,34	18	2,23
Treatment potassium humate	2,80	18	2,67
Treatment EM drug	2,63	18	2,51
HCP ₀₅		0,15	

It was found in the carried out experiments that treatment of soybean crops of variety Ivan Karamanov with potassium humate at the beginning of flowering increases the yield of soya in terms of standard moisture by 0.44 t / ha compared to the control variant, which corresponds to 19.7%. Treatment of soybean plants with Vostok EM-1 at the beginning of the growing season of soybean plants (the germination phase) also affected the yield of soya. The grain yield was 2.51 t / ha at the standard moisture of 14% which is 12.6% higher than the control variant without plant treatment. Thus, the studied drugs had a significant impact on the yield of soybean plants but the effect of potassium humate on this indicator significantly exceeded the effect of the Vostok EM-1 drug.

The main indicators of seed quality are germinating energy and laboratory germination. Germination ability is the ability of seeds to produce normally developed seedlings. The germination of soybean seeds was determined in the laboratory by sprouting them under favorable conditions. The germinating energy was established simultaneously with viability – the ability of seeds to germinate quickly and evenly.

To determine the germinating energy and laboratory germination of soybean seeds, four samples of 50 seeds each were selected for the control and experimental variants.

The experiment was laid on October 30 in a thermostat in Petri dishes between layers of filter paper under conditions corresponding to this crop according to GOST 12038-84 Seeds of agricultural crops. Methods for determining germination (with Amendments № 1, 2, and Amended). Soya seeds were sprouted in the dark at a constant temperature of 25°C.

Evaluation and recording of sprouted seeds in determining of the germinating energy and viability were carried out on the third and seventh days, respectively. Viability rate and seed germination energy were calculated as a percentage. The analysis result was taken as arithmetic mean of the results of determining the germination ability of all analyzed samples, if when determining the seed viability for four samples the deviations of the analysis results of individual samples from the arithmetic mean did not exceed the permissible values. The analysis results are presented in table 9.

Table 9.
Influence of potassium humate and Vostok EM-1 on the sowing quality of soybean seeds of variety Ivan Karamanov.

Experiments	Seed germinating energy, %	Laboratory germination, %	The length of root, sm
Control variant (no-treatment)	69,5	88,0	8,0
Treatment potassium humate	75,0	96,5	10,0
Treatment EM drug	71,5	91,0	8,3

According to the requirements of GOST 52325-2005 Seeds of agricultural plants, varietal and sowing qualities, laboratory germination of original and elite soybean seeds must be at least 87%, reproduction - at least 82% and commodity – at least 80%.

The laboratory germination rate of seeds without treatment was 88.0% in the carried out research. This indicator increased by 8.5% and was 96.5% when treating plants for vegetation with potassium humate. The seeds germinated in this variant very quickly and evenly. The germinating energy was 75.0% compared to 69.5% in the control variant. The length of the root was also the largest and composed 10.0 cm which is 2 cm more than in the control variant. Treatment of soybean plants with effective microorganisms also contributed to an increase in seed germination energy by 2% and laboratory germination by 3% compared to the control variant. The Vostok EM-1 drug did not significantly affect the length of the root.

Conclusion

Thus, based on the conducted research, the following conclusions can be drawn:

1. The growth and development of soybean plants, as well as the yield and seed quality, largely depend on the climatic conditions of the test year. In general, the growing season of year 2019 was characterized by excessive precipitation in the second half of summer and was unfavorable for the growth and development of soybeans.
2. Treatment of soybean plants during the growing season with potassium humate and effective microorganisms accelerates the maturation of soybean seeds which allows harvesting two days earlier.
3. The application of potassium humate and effective microorganisms increases the area of the soybean leaf surface and improves the photosynthetic apparatus. The maximum

leaf area in all variants of the experiment was formed by the seed filling phase and varied from 22.3 in the control variant to 25.6 thousand m² / ha in the variant with the use of potassium humate for plant vegetation.

4. It was found in the conducted studies that the treatment of soybean plants with growth regulators during the growing season significantly affected the growth and development of the root system. Thus, when treating soya with potassium humate the length of the main root increased by 3.6 cm compared to the non-treated variant and was 20.7 cm against 17.1 cm. The root weight in this variant increased by 0.4 g and amounted to 4.2 g against 3.8. Treatment of soybean plants with Vostok EM-1 also contributed to an increase in root length from 17.1 cm to 19.5 cm and weight from 3.8 g to 4.1 g.
5. Treatment of soybean plants with potassium humate during vegetation contributed to a significant increase in the number of nodule bacteria on plant roots. Their number increased almost fourfold from 7.2 in the control variant to 27.9 in the variant with potassium humate.
6. Treatment of soybean crops of variety Ivan Karamanov with potassium humate increases the yield of soya by 0.44 t / ha compared to the control variant which corresponds to 19.7%. Treatment of soybean plants with Vostok EM-1 allows to obtain a yield of 2.51 t / ha which is 12.6% higher than the control variant.
7. The laboratory germination rate of seeds without treatment was 88.0% in the carried out experiment. Moreover, this indicator increased by 8.5% and amounted to 96.5% when treating plants for vegetation with potassium humate. The seeds germinated in this variant quickly and evenly. The germinating energy was 75.0% compared to 69.5% in the control variant. The length of the root was also the largest and composed 10.0 cm which is 2 cm more than in the

control variant. Treatment of soybean plants with effective microorganisms also led to an increase in seed germination energy by 2% and laboratory germination by 3% compared to the control variant.

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