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APPROBATION OF MODIFIED ORGANIC BIOPREPARATIONS ON SOME PLANT TYPES OF THE ASTANA BOTANICAL GARDEN

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Abstract

Scientists of the LLP "Institute of Coal Chemistry and Technology" developed and obtained a line of modified organic biopreparations (MOB) based on the organo-mineral fertilizer "Kazuglegumus", in combination with such elements as NPK components (nitrogen, phosphorus, potassium), molybdenum, iron, magnesium. The resulting biopreparations have a beneficial effect on the structure of the soil, as well as improve stress resistance. Laboratory studies of the MOB line on microgreens "Cress-salad" were carried out, then subsequent field tests on biological objects in the Botanical Garden of Astana, and an analysis of the composition of the soils before and after the tests was carried out. The most effective results from the entire line of MOBs were noted for the biopreparations "Potassium humate + NPK" and "Potassium humate + molybdenum", which manifested itself in their positive effect both on the growth of microgreens "Cress-salad" and on the biological objects of the Botanical Garden in the field trials. It is also worth noting the biopreparation "Potassium Humate + magnesium", which distinguished itself

by its effect when used on Blue Spruce (*Picea pungens*). This is evidenced by the results of the analysis in the agroecological testing center (laboratory) at the NJSC "Kazakh Agrotechnical University named after. S.Seifullin", namely, the indicators of the content of humus, nitrogen ($N\text{-}NO_3$), phosphorus (P_2O_5), potassium (K_2O), magnesium (Mg) have improved. The content of humus increased in 73.3% of the experimental groups, positive results were also observed for the rest of the above indicators.

Key words: humate; fertilizers; microgreens; Botanical Garden; the soil; plants; humic substances.

Introduction

In order to regulate the growth and productivity of agricultural crops, increase efficiency and reduce the environmental burden, it is necessary to use growth stimulants based on humic preparations. They have a positive effect on soil structure, protect plants from diseases and adverse climatic conditions. Humic preparations contain humic and fulvic acids, humates, micro and macro elements, which have a stimulating effect. In addition to the stimulating effect on plants, they activate the activity of soil microflora, which decompose sparingly soluble compounds of phosphorus, potassium and other elements by metabolic products, turning them into a state accessible to plants. Humic substances are dark-colored high-molecular substances, which are a complex mixture of macromolecules of variable composition. They participate in heterogeneous reactions with hydrophilic and hydrophobic groups capable of reacting with both metal ions and organic molecules [1-4].

Humic preparations also help to increase the number of adventitious roots, their length and thickness. Magnesium is an important element for the implementation of such basic functions in plants as photosynthesis, phosphorus transport, sugar synthesis, starch redistribution, fat formation, nitrogen fixation. The results of studies of humic preparations with magnesium showed that the treatment of plants with these solutions accelerates and improves the process of callus formation by almost 2.5 times [5, 6]. Iron is one of the most common elements in nature. However, plants often suffer from chlorosis, caused by a lack of it in the soil in an accessible form, this is especially true for carbonate soils. An important advantage of humic preparations containing a small amount of iron is its high resistance to Ca [7, 8]. The main role in the growth and development of plants is played by such components as N, P, K. The negative effect of nitrogen deficiency is manifested in the formation of a pale green pigment on the leaf surface, as well as a sharp cessation of growth. Nitrogen is the main component of protoplasm, passing into the structure of chlorophylls, amino acids, enzymes. Phosphorus is also one of the most important macronutrients, which, thanks to its activating effect, promotes the transfer of energy and respiration of plants and accelerates the transition of plants to the reproductive phase of development. Potassium is easily absorbed by plants, strengthens the immune system, increases winter hardiness and stress resistance of crops. A significant effect of molybdenum on the formation and accumulation of chlorophyll in plants, on nitrogen metabolism, the water regime of plants, etc. was revealed. In the case of molybdenum deficiency, plants experience inhibition in growth, development and reduce productivity [9-12].

Materials and Methods

We have developed and obtained modified organic biopreparations (MOB) based on the organo-mineral fertilizer "Kazuglegumus" produced by LLP "RPA "Kaztekhnougol" [13, 14], enriched with elements such as molybdenum, iron, magnesium, as well as NPK components (nitrogen, phosphorus, potassium).

Before conducting field trials, experimental studies were carried out on the effect of the MOB line on the growth of microgreens in the laboratory. Watercress microgreen seeds were applied to 5 experimental and 1 control groups, under conditions of room temperature and partial sunlight to prevent damage to the greens from direct sunlight. Watering was carried out every 7 days, and collection on the 15th day. To study the effect of the obtained modified organic biopreparations, such as basic potassium humate, "Potassium humate + molybdenum", "Potassium humate + NPK", "Potassium humate + iron", "Potassium humate + magnesium" on biological objects, field studies were carried out in an open soil of the Botanical Garden of Astana. Root treatment was carried out by watering with 0.1% aqueous solutions of MOB every 10 days on the following experimental groups of plants: Blue Spruce (Picea pungens), Birch Dalekarlica (Betula pendula 'Dalecarlica'), Rose (Rosa), Nedzwiecki's apple tree obtained by micropropagation (Malus niedzwetzkyana Dieck), Pear (Pýrus), the control

group was irrigated with water.

Before and after the field tests, soil samples were taken from the experimental and control groups of biological objects for a comparative analysis of the influence of the MOB line on the soil composition. The analysis of the soil composition included the following indicators: the content of humus, nitrogen (N-NO_3), phosphorus (P_2O_5), potassium (K_2O), magnesium (Mg) and pH.

Results

The results of laboratory tests of the effect of the MOB line on the growth of microgreens are shown in Figures 1 and 2.

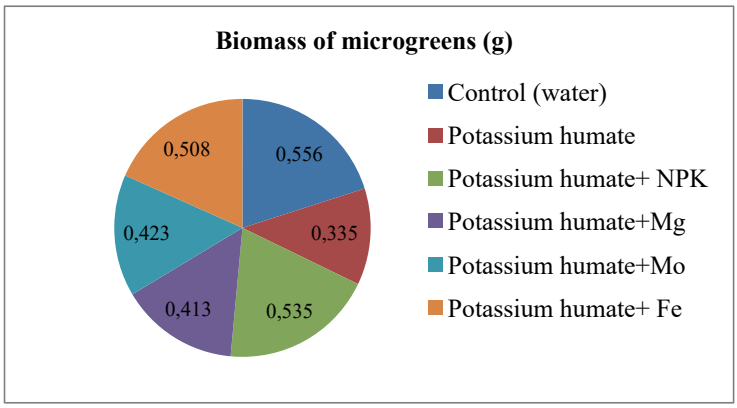

Figure 1 – Comparative diagram of the results of the microgreen biomass of the experimental and control groups

According to the results of a comparative analysis of the biomass of the microgreens "Cress-salad" from the entire line of the studied MOBs based on potassium humate, the best indicators were observed in the experimental groups "Potassium humate + NPK" and "Potassium humate + iron", which amounted to 0.54 g and 0. 51 g respectively.

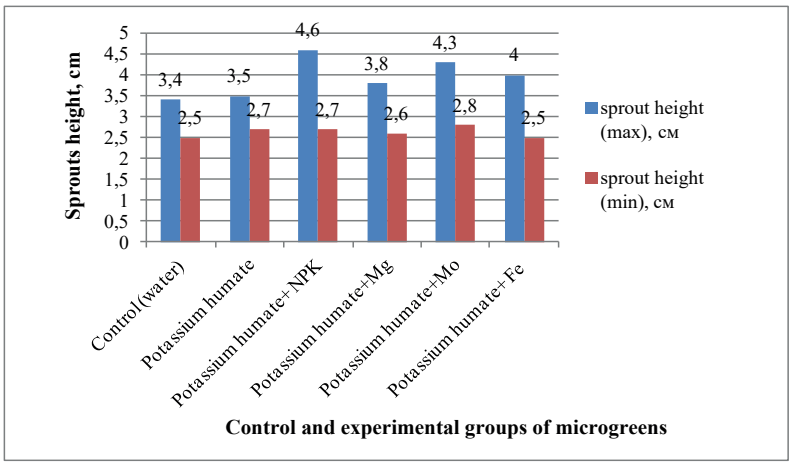

Figure 2 – Comparative diagram of the results of the height of microgreen sprouts of the experimental and control groups

As shown in Figure 2, the experimental groups "Potassium humate + NPK" – 4.6 cm, "Potassium humate + Molybdenum" – 4.3 cm and "Potassium humate + Iron" – 4 cm.

Of the total number of planted microgreen seeds, the highest germination rate of 92.6% was in the experimental groups "Potassium humate + NPK" and "Potassium humate + Iron".

As a result of tests of the MOB line for microgreens, it was shown that the best results were observed with the biopreparation "Potassium humate + NPK", which indicates its effectiveness. Biopreparations "Potassium humate + Iron" and "Potassium humate + Molybdenum" also distinguished themselves by good indicators for the growth of microgreens.

During the field testing of the MOB line at the biological objects of the Astana Botanical Garden, measurements of green spaces were carried out, as well as an analysis of the composition of the soils of the experimental and control groups before and after irrigation.

According to the research results, the best performance was observed in Blue Spruce (*Picea pungens*) when using the biopreparation "Potassium humate + Magnesium", used to take into account the needs of this biological object (Figure 3).

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Figure 3 – Blue Spruce (*Picea pungens*) before (a) and after (b) irrigation of the MOB "Potassium humate + magnesium"

Blue Spruce (*Picea pungens*) was chosen as one of the experimental groups of biological objects, which was characterized by an unhealthy appearance: a low number of needles, which had a yellowed color and a dry structure, the presence of areas affected by sunlight. After the end of the period of root feeding of the MOB, this biological object showed an improvement in the state of the plant, manifested in an increase in the number of needles that had a bright blue color.

During the period of research, significant external changes were recorded in other biological objects: the number of leaves increased, pear tree fruits were formed, rose bushes stood out with their lush buds. The results of the above results confirm the profitability and high efficiency of using this line of MOBs.

Soil samples were taken from the experimental and control groups before and after the tests in order to determine the effect of MOB during root cultivation. Analysis of soil composition included the content of the following indicators: humus, potassium, phosphorus, nitrogen, magnesium.

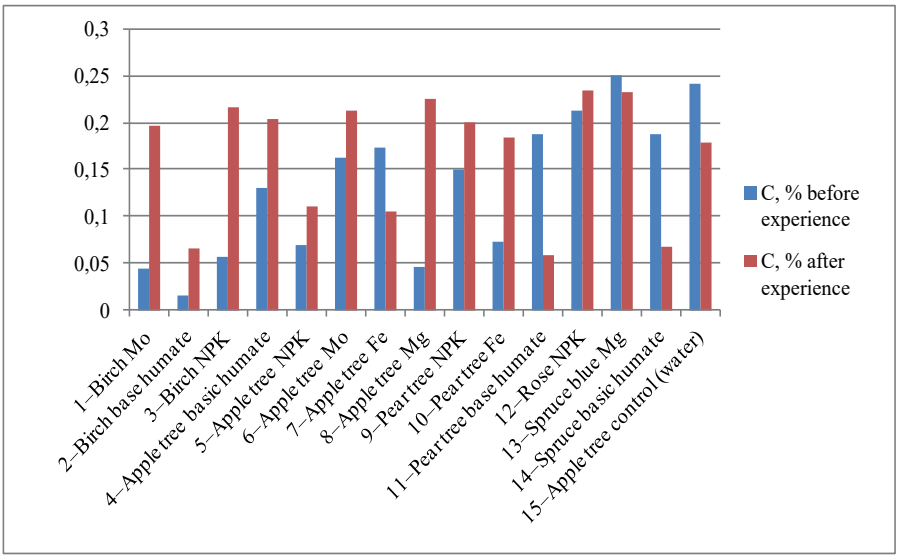

Figure 4 – Comparative histogram of the humus content in the soil before and after irrigation

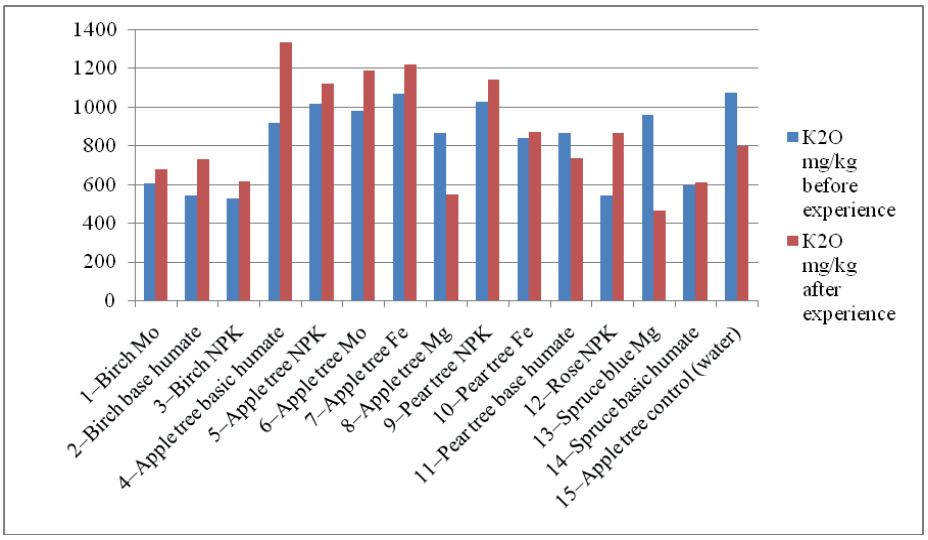

Figure 5 – Comparative histogram of potassium content in the soil before and after irrigation

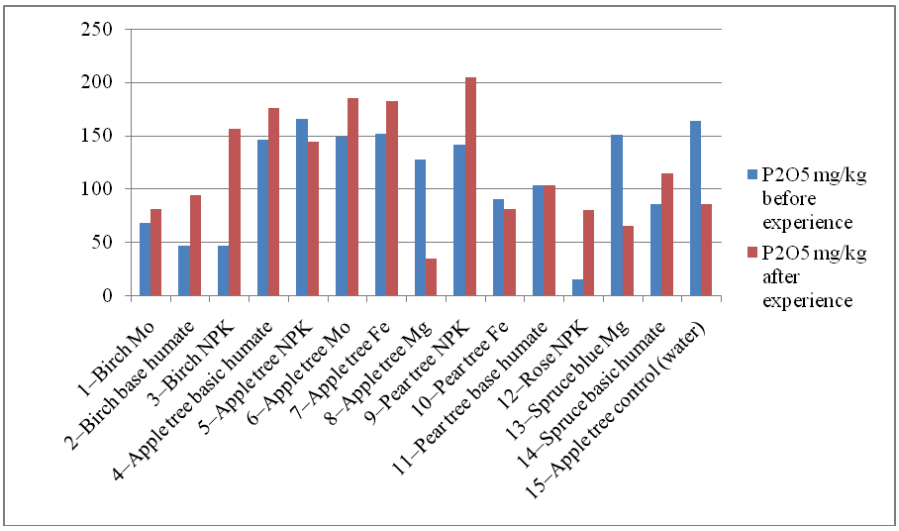

Figure 6 – Comparative histogram of phosphorus content in soil before and after irrigation

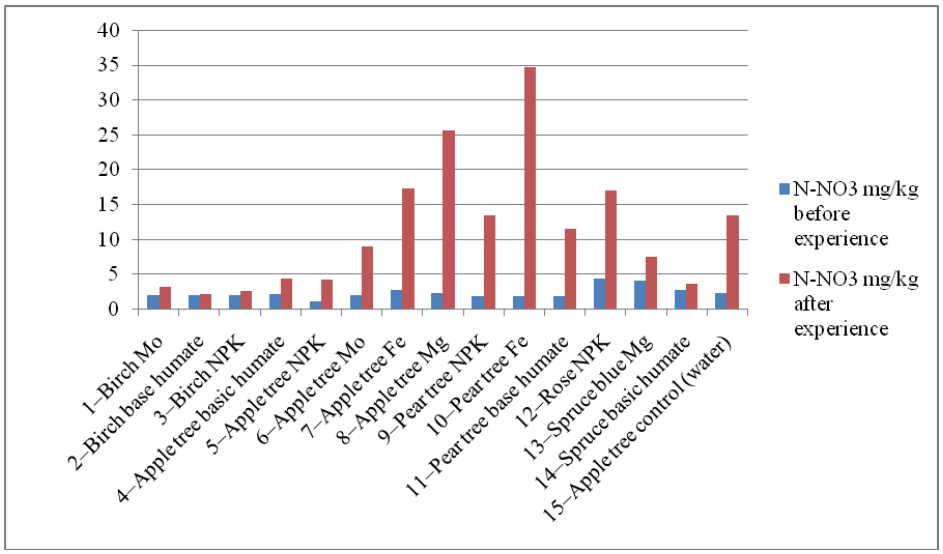

Figure 7 – Comparative histogram of nitrogen content in the soil before and after irrigation

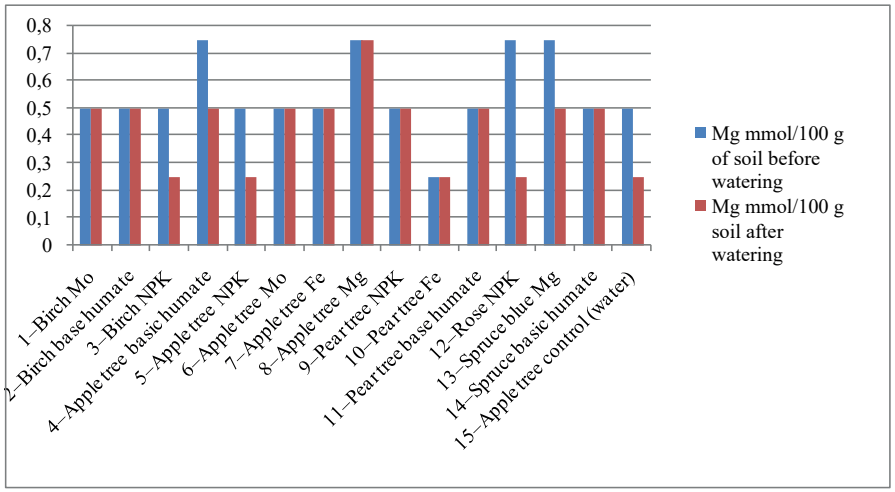

Figure 8 – Comparative histogram of magnesium content in the soil before and after irrigation

As shown in Figure 4, after watering biological objects with MOB solutions, 73.3% of the experimental groups showed an increase in the humus content in the soil. High results of humus content were noted in the experimental groups "Potassium humate + molybdenum" – 0.20% and "Potassium humate + NPK" – 0.22% on the biological object Dalecarliyskaya Birch (*Betula pendula 'Dalecarlica'*). The content of humus in the soil also increased markedly in the experimental group "Potassium humate + magnesium" at the bioobject Nedzvetsky Apple tree (*Malus niedzwetzkyana Dieck*), which became higher by 0.18% than before irrigation with MOB solutions. In the control group, where irrigation was carried out only with water, after field trials, a decrease in humus content by 0.06% was observed.

According to the results of a comparative analysis of the soil in terms of potassium content (Figure 5), high results were recorded in the biological object Nedzwiecki Apple tree (*Malus niedzwetzkyana Dieck*) when irrigated with a solution of basic potassium humate and amounted to 1331.90 mg/kg, which is higher than the control group by 535.18 mg/ kg. Also, in the experimental group "Potassium humate + NPK" when watering roses (*Rosa*), the content of potassium in the soil increased to 865.19 mg/kg.

The content of phosphorus in soils after field tests (Figure 6) significantly increased in the experimental group "Potassium humate + NPK" on biological objects Dalekarliyskaya Birch (*Betula pendula 'Dalecarlica'*) – 156.48 mg/kg, Rose (*Rosa*) – 80.35 mg/kg and Pear (*Pýrus*) – 204.22 mg/kg. An increase in the amount of nitrogen in soils after testing was noted in all experimental groups (Figure 7). The amount of magnesium in the soil after the study remained unchanged in most experimental groups, however, there is a decrease in their content in five experimental groups.

Discussion

In the course of laboratory and field tests of the obtained MOB line based on potassium humate, we revealed positive results of their influence on biological objects. The most effective results from the entire line of MOBs were noted for the biopreparations "Potassium humate + NPK" and "Potassium humate + Molybdenum", which manifested itself in their positive effect both on the growth of microgreens "Cress-salad" and on the biological objects of the Botanical Garden in the field tests. It is also worth noting the biological product "Potassium humate + Magnesium", which distinguished itself by its effect when applied to blue spruce (Picea pungens). This type of biological object was depleted and poor in vegetation, however, after the application of a biopreparation enriched with magnesium, a noticeable change in appearance was observed, manifested in an increase in splendor and acquisition of a bright color. Thus, the results obtained indicate a positive effect of magnesium on coniferous trees, while the use in combination with potassium humate is more effective.

Conclusion

The results of laboratory and field tests of a line of modified organic biopreparations based on potassium humate showed a positive effect on the growth and development of plants. With

regard to watercress microgreens, beneficial effects were seen in biomass, sprout height, and seed germination. In the experimental groups of green spaces of the Botanical Garden, an increase in splendor, the manifestation of bright pigment, the ripening of fruits, as well as an increase in the amount of elements necessary for plant growth in the soil, were noted. Based on the results of the research, it can be argued about the effectiveness of the application of the obtained line of MOBs enriched with such elements as molybdenum, iron, magnesium, as well as NPK components (nitrogen, phosphorus, potassium).

Information on financing

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АСТАНА БОТАНИКАЛЫҚ БАҒЫ ӨСІМДІКТЕРІНІҢ КЕЙБІР ТҮРЛЕРІНДЕ МОДИФИКАЦИЯЛАНҒАН ОРГАНИКАЛЫҚ БИОПРЕПАРАТТАРДЫ СЫНАҚТАН ӨТКІЗУ

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Түйін

«Көмір химиясы және технологиясы институты» ЖШС ғалымдары NPK компоненттері (азот, фосфор, калий), молибден, темір, және магний сияқты элементтермен біріктірілген «Казуглегумус» органо-минералды тыңайтқышы негізінде модификацияланған органикалық биопрепараттар (МОБ) желісін жасап шығарды. Алынған биопрепараттар топырақтың құрылымына жақсы әсер етеді, сонымен қатар өсімдіктердің стреске төзімділігін арттырады. "Кресс-салат" микрожасылдарында МОБ желісіне зертханалық зерттеулер жүргізілді, содан кейін Астана қаласының Ботаникалық бағындағы биообъектілерде кейінгі далалық сынақтар жүргізілді, сондай-ақ сынақтарға дейін және одан кейін топырақ құрамына талдау өткізілді. МОБ желісінің ең тиімді нәтижелері «калий гуматы + NPK» және «калий гуматы + молибден» биопрепараттарында көрсетілді, бұл олардың «Кресс-салат» микрожасылдарының өсуіне де, далалық сынақтарда Ботаникалық бақтың биообъектілеріне де оң әсерін көрсетті. Сондай-ақ, «калий гуматы + магний» биопрепаратты атап өткен жөн, ол көк шыршаға (*Picea pungens*) қолданған кезде өзінің әсерімен ерекшеленді. Бұл туралы «С.Сейфуллин атындағы Қазақ агротехникалық зерттеу университеті» КеАҚ-ға жататын агроэкологиялық сынақ орталығында (зертханада) алынған талдау нәтижелері куәландырады. Атап айтқанда, гумустың, азоттың ($N\text{-}NO_3$), фосфордың (P_2O_5), калийдің (K_2O), магнийдің (Mg) көрсеткіштері жақсарды. Гумустың мөлшері 73,3% тәжірибелік топтарда көбейді, жоғарыда аталған көрсеткіштердің қалған бөлігі бойынша да оң нәтижелер байқалды.

Кілт сөздер: гумат; тыңайтқыштар; микрожасылдар; ботаникалық бақ; топырақ; өсімдіктер; гуминді заттар.

АПРОБАЦИЯ МОДИФИЦИРОВАННЫХ ОРГАНИЧЕСКИХ БИОПРЕПАРАТОВ НА НЕКОТОРЫХ ВИДАХ РАСТЕНИЙ АСТАНИНСКОГО БОТАНИЧЕСКОГО САДА

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Аннотация

Учеными ТОО «Институт химии угля и технологии» была разработана и получена линейка модифицированных органических биопрепаратов (МОБ) на основе органоминерального удобрения «Казуглегумус», в комплексе с такими элементами, как NPK-компонентов (азот, фосфор, калий), молибден, железо, магний. Полученные биопрепараты оказывают благоприятное воздействие на структуру почвы, а также улучшают стрессоустойчивость. Были проведены лабораторные исследования линейки МОБ на микрозелени «Кресс-салат», затем последующие полевые испытания на биообъектах в Ботаническом саду г. Астаны, а также проведен анализ состава почв до и после испытаний. Наиболее эффективные результаты из всей линейки МОБ, были отмечены у биопрепарата «Гумат калия + NPK» и «Гумат калия + молибден», что проявилось в их положительном влиянии как на рост микрозелени «Кресс-салат», так и на биообъекты Ботанического сада в полевых испытаниях. Также стоит отметить биопрепарат «Гумат калия + магний», который отличился своим эффектом при применении на голубой ели (Picea pungens). Об этом свидетельствуют, полученные результаты анализа в агроэкологическом испытательном центре (лаборатории) при НАО «Казахский агротехнический исследовательский университет им. С.Сейфуллина», а именно улучшились показатели содержания гумуса, азота (N-NO3), фосфора (P2O5), калия (K2O), магния (Mg). Содержание гумуса увеличилось у 73,3% опытных групп, по остальным вышеперечисленным показателям также наблюдались положительные результаты.

Ключевые слова: гумат; удобрения; микрозелень; ботанический сад; почва; растения; гуминовые вещества.