

LENTIL HARVEST FORMATION USING DIFFERENT METHODS SOWING AND SEEDING RATES

Abstract

The article contains information on the study of the effect of seeding methods and rates on the structure of the lentil crop. Currently, the task has been set, both for science and in production, to revive lentils. As a result of research, the effect of sowing rates on plant productivity was established. The largest crop of lentil grains of the Shirayly variety was formed by sowing with a row width of 30 cm and a sowing rate of 1500 thousand pcs/ha, which amounted to 21.2 c/ha. Both with a decrease in the seeding rate to 1200 thousand pcs/ha, and an increase to 1800 thousand pcs/ha, this indicator decreases by 1.9-2.5 c/ha. When sowing with a row width of 15 cm, the yield of lentil grain Shyrayly decreases by 1.2-2.1 c/ha with sowing rates from 1200 to 1800 thousand pcs/ha.

The largest crop of Krapinka lentil grain was formed by crops with a row width of 15 cm and a seeding rate of 2000 thousand pcs/ha, which amounted to 15.9 c/ha. Both with a decrease in the seeding rate to 1500 thousand pcs/ha, and an increase to 2500 thousand pcs/ha reduces eta

Key words: lentils, adaptive technology, biological features. productivity, grain quality, yield.

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APPLICATION OF MINERAL AND ORGANIC BIOSTIMULANTS TO IMPROVE GROWTH INDICATORS AND LEAF SURFACE AREA IN APPLE ORCHARDS OF SOUTHEASTERN KAZAKHSTAN

Abstract

In the conditions of southeastern Kazakhstan, which is characterized by an arid climate and the need for irrigation, the use of organic biologically active preparations in horticulture represents a promising direction. This article presents the results of a study on the effects of the preparations Agroflorin, Al Karal, and Biosok Energy Plus on the biometric indicators of the Golden Delicious apple variety. Special attention is paid to the development of shoot length, branch diameter, leaf surface area, and other morphological traits of the plants.

The scientific novelty of this research lies in the development of a technology for the application of organic fertilizers and biopreparations that enhance the activity of soil microorganisms. These microorganisms regulate biological processes in the soil and improve the nutrient uptake of plant root systems.

Experimental studies conducted under the conditions of irrigated light chestnut soils of southeastern Kazakhstan revealed that organic fertilizers and biopreparations, particularly "BioSok Energy Plus", Agroflorin, and Alkaral, stimulate the vital activity of beneficial soil microorganisms and improve plant nutrition.

Soil microorganisms play a key role in mineralizing organic substances and synthesizing their cellular proteins by utilizing carbon and nitrogen. Microbial groups such as actinomycetes, mold fungi, and bacteria contribute to the replenishment of nitrogen in the soil by decomposing organic

matter. As a nitrogen source, they primarily require easily soluble nitrogen compounds, which are provided through the application of organic fertilizers and biopreparations.

The study established a positive effect of organic fertilizers, particularly BioSok Energy Plus and Agroflorin, on the population of ammonifying bacteria, pseudomonads, amylolytic bacteria, and micromycete flora in apple orchard soils. This, in turn, enhances the nutrition of the root system and improves the overall physiological condition of apple trees.

Keywords: *apple tree, biopreparations, leaf surface, biometrics, organic farming, Golden Delicious, southeastern Kazakhstan.*

Introduction

In the modern context of sustainable development of the agro-industrial complex, the development of biological farming systems is gaining particular relevance. This is due to increasing technogenic pressure on agroecosystems and growing global climate changes [1]. The foundation of such systems is the active use of natural biological resources and mechanisms in agricultural production [2–4]. The introduction of biologization methods in crop production contributes not only to the improvement of the ecological condition of agro-landscapes but also to the enhancement of soil fertility, crop yields, and overall economic efficiency of the industry [5]. The practice of applying biologized techniques in various regions of Kazakhstan has confirmed their high efficiency [6–10].

In modern horticulture, one of the most effective types of industrial gardens is a high-density garden on dwarf clonal rootstocks. The density of such gardens reaches 4-5 thousand square meters of trees per hectare, which causes early entry into fertility, abundant and more regular harvests, and this leads to a large removal of nutrients. All this causes the need to create a high level of mineral nutrition in such plantings and an account of the application of fertilizers. Complete mineral nutrition leads to growth processes, enhances the laying of generative organs, accelerates and promotes fertility. At the same time, the agrochemical and economic efficiency of fertilizer application largely depends on compliance with a scientifically based nutrition system, allows not only to increase productivity without reducing its quality, but also to preserve soil fertility in the garden, and not to pollute the environment with excessive amounts of fertilizers. A scientifically based nutrition system is developed taking into account soil, climate and environmental factors, the system of land maintenance in gardens, variety-rootstock combinations and the standard level of fruit yield [11].

The growth and productivity of fruit trees in the garden depend on the provision of the soil with nutrients. Since fruit trees grow in the garden for decades and constantly absorb nutrients from the soil, their productivity decreases over time without fertilizing. Therefore, it is necessary to regularly replenish the supply of nutrients in the soil. In addition to the natural way, soil fertility must be maintained artificially: by adding organic and mineral fertilizers. Fertilizers give the best effect in combination with irrigation and other agricultural measures. In the nutrition of fruit plants during the growing season, two periods are distinguished - from the beginning of spring vegetation to the end of shoot growth and from the end of shoot growth to late autumn [12].

A key direction in the biologization of agriculture is the implementation of techniques aimed at preserving and enhancing soil fertility, activating its biological activity, and reducing the negative consequences of various forms of soil cover degradation [13]. One of the promising approaches is the use of methods that promote the accumulation of biological nitrogen, humus formation, and synthesis of humic substances, which is ensured through the microbiological mobilization of nutrients. The effective implementation of these tasks requires a rational combination of biological land reclamation methods with elements of chemicalization, implying the development of sustainable soil cultivation techniques. Such methods should ensure long-term positive impacts on soil biota and cropping systems under anthropogenic stress [14].

In the context of global climate change, intensive use of chemical fertilizers and pesticides in agriculture—especially in areas with irrigated lands—issues of ecology, agricultural sustainability, and restoration of natural soil fertility are becoming increasingly urgent. Against the background of growing demands for environmentally clean products and safe production, the increasing role of organic and biological fertilizers becomes evident [15]. One of the key elements of sustainable

agriculture is the optimization of plant nutrition using organic and biological fertilizers. The application of such fertilizers contributes not only to the improvement of soil structure and biological activity but also to the formation of healthier and more productive plants, which is especially important in arid climate regions such as the southeast of Kazakhstan. Problems of soil erosion, degradation, and fertility loss are highly relevant for this region, where an intensive irrigation system has traditionally been used [16].

In 2021, a research study was conducted at the Pomological Garden of the Institute of Fruit and Vegetable Growing of the Republic of Kazakhstan (Talgar branch) to evaluate the effects of various types of mineral and organic fertilizers on the biometric indicators of the Golden Delicious apple variety. The relationship between the type of fertilizer and the growth processes of apple trees is of critical importance for the development of sustainable agrotechnologies[17].

The research was conducted within the framework of two projects: “Development of new varieties of fruit and berry crops and grapes with specified traits, and the development of zonal technologies for high-yielding plantations using modern methodologies” (IRN BR22884599) and “Scientific support for the technological development of organic agricultural production in the Republic of Kazakhstan” (IRN BR22885418).

Scientific Novelty of the Research. This study presents, for the first time, a comprehensive investigation of the effects of mineral and bio-organic fertilizers on soil fertility, as well as on the growth and productivity of the «Golden Delicious» apple cultivar, under dark chestnut soil conditions. Furthermore, the research clearly highlights the importance of organic biopreparations in the context of environmentally sustainable agricultural production.

Objects and Methods of Research

The study was carried out during the period of 2022–2024 in the pomological orchard of the RF "Talgar" LLP "Kazakh Scientific Research Institute of Fruit and Vegetable growing" within the framework of the scientific and technical program project "Scientific support for the technological development of organic agricultural production in the Republic of Kazakhstan" (IRN № BR22885418). The experiments were conducted in three replications.

The apple orchard was established in 2022. The planting material of the 'Golden Delicious' (Malus Golden Delicious) variety was obtained from the certified nursery farm of KX “Badenko A.Yu.” (Certificate of accreditation: KZ60VDC00077658). The trees were grafted onto the clonal rootstock ARM-18. The experimental site is located in the foothill zone of the southeast of Kazakhstan at an altitude of 1050–1100 meters above sea level. The planting scheme used for the orchard is presented in Table 1.

Table 1 – Planting scheme of crops at the experimental site

Crop Type	Area (ha)	Planting Scheme
Pome crops		
Apple, cv. Golden Delicious (Malus Golden Delicious)	1	5 × 2 m

The climate of the region is sharply continental, characterized by significant daily and annual fluctuations in air temperature, with cold winters and prolonged hot summers. The duration of the warm period is 240–275 days. The sum of positive temperatures is 3450–3750°C. The average frost-free period lasts 140–170 days. The annual precipitation ranges from 350 to 600 mm. In 2022, the average air temperature was +2.1°C higher than the long-term norm, and precipitation was 120 mm below the average[18].

In the studies the obtained results of the influence of abiotic factors and the development of changes in the apple tree ecosystem revealed that the studied plants behave in full accordance with the established seasonal rhythm depending on the change in air temperature and the emerging ecological features inherent in the state of the ecosystem, when using innovative techniques and structured information obtained from IT sensors [19].

The soil in the study area is light chestnut, medium loamy in granulometric composition, slightly alkaline (pH 7.3–7.4), with humus content of 2.82%, total nitrogen 0.18–0.20%, total phosphorus 0.19–0.20%, available phosphorus 30–40 mg/kg, and exchangeable potassium 350–390 mg/kg.

Research Objective

To develop an organic fertilizer application system for fruit crops, evaluate and identify the most effective types of bioorganic fertilizers for use in organic fruit production. Research objects: Apple trees of the “Golden Delicious” variety, bioorganic and mineral fertilizers, biopreparations.

Research Materials

Alkaral, Agroflorin, BioSok Energy Plus, Biohumus, Mineral fertilizers. During the growing season, observations and measurements were conducted to assess the vegetative growth of apple trees, including trunk diameter, leaf surface area, annual shoot elongation, and the number of fruiting spurs. Each treatment variant was arranged in a randomized complete block design with three replications, comprising five trees per replicate, totaling 15 trees per treatment. Trunk diameter was measured using a caliper at a height of 20–25 cm from the soil surface annually in autumn after the end of the growing season. The research was conducted using standard methods:

- Methodology of experimental work (edited by B.A. Dospekhov, 1985) [20];
- Methodical recommendations of the Kazakh Research Institute of Fruit Growing and Viticulture, the All-Russian Research Institute of Horticulture named after I.V. Michurin;
- Agrochemical research methodology (Yudin F.A., 1980);
- Methodological recommendations “Transition from traditional to bioorganic farming in the Republic of Belarus” (ed. by K.I. Dovban, Minsk, 2015) [21].

Fertilizer Application Variants:

- Control (no fertilizers)
- N₁₁₀P₁₁₀K₁₂₀ (recommended dose)
- Agroflorin (2.5 ml/l water, 4 treatments per season)
- Alkaral (300 ml/50 l water, 4 treatments)
- BioSok Energy Plus (300 ml/5 l water + 400 g under the root, 4 treatments)
- Biohumus 3 t/ha

Before planting, seedlings were soaked in biopreparation solutions. Afterwards, the preparations were applied once to the root zone, twice by basal application, and twice by foliar spraying. Each variant was laid out in triplicate. The planting scheme for the apple orchard was 5 × 2 m. Fertilizers were applied according to manufacturer recommendations and agronomic requirements for southern regions of Kazakhstan.

Irrigation conditions at the experimental orchard: periodic irrigations with rates corresponding to the crop’s water deficit until soil moisture did not fall below 70% of field capacity.

Biometric Indicators Included:

- Shoot length (m)
- Shoot diameter (cm)
- Number of leaves (pcs)
- Area of one leaf (cm²)
- Total leaf surface area (dm²)

Results and Discussion

The study of biometric indicators plays a key role in assessing the physiological condition of plants, their response to agrotechnical practices, and the effectiveness of different fertilizers. Biometric parameters such as plant height, trunk diameter, number and length of shoots, as well as leaf surface area, reflect the intensity of growth, accumulation of vegetative mass, and the potential productivity of crops. Analyzing these indicators allows for the timely identification of the plants’ adaptive capacity to external environmental conditions, including nutrient availability, water supply, and temperature regimes.

Biometric studies are particularly important in the comparative evaluation of the effects of mineral and organic biologically active substances. They allow not only to track the overall growth

dynamics but also to determine the optimal conditions for the full realization of the crop's genetic potential. Southeastern Kazakhstan provides favorable conditions for fruit cultivation; however, periods of water stress and soil fertility limitations necessitate adaptive nutrient and irrigation strategies.

Analysis of the obtained data shows a pronounced influence of applied mineral and organic biological fertilizers on the main biometric indicators of the Golden Delicious apple variety. Significant differences were observed especially in parameters such as the length of annual shoots, number of leaves, and total leaf surface area, which are directly related to growth intensity.

In the control variant (without fertilizers), plants showed the lowest values in all measured parameters. The shoot length was 1.82 cm, the number of leaves was 47.33, and the total leaf area amounted to only 37.33 cm². These results can be considered baseline and used for comparison with the effects of fertilizer application. The low indicators are explained by the lack of additional nutrition and stimulation, which under irrigated but moderately nutrient-supplied soil conditions limits growth processes.

Biometric indicators were studied during the vegetation seasons of 2022 and 2023, and average values over these two years are presented in the tables below. The experiments were conducted in three replications, and statistical processing included Least Significant Difference (LSD or HCP) at $p \leq 0.05$ for reliability (Table 2).

Biometric parameters such as plant height, trunk diameter, number and length of shoots, and leaf surface area reflect the growth intensity and productivity potential. These indicators are crucial for evaluating the effectiveness of mineral and organic fertilizers, particularly under the challenging environmental conditions of Southeast Kazakhstan.

Table 2. Results of Biometric Measurements of Golden Delicious Apple Trees (Average for 2022–2023)

Experiment variant	Trunk diameter, cm	Shoot length, cm	Number of leaves, pcs	Average leaf area, cm ²	Total leaf area, cm ²
Control	1,63	1,82	47,33	2,86	37,33
Mineral NPK fertilizers	1,70	1,85	52,00	2,90	43,68
Agroflorin	1,49	1,61	53,00	2,52	41,67
Alkaral	1,40	1,67	49,33	2,62	39,67
Biosok Energy Plus	1,77	1,70	51,33	2,36	45,33
Biohumus	1,68	1,75	50,00	2,80	42,00
LSD _{0.05}	0.25	0.16	3.63	0.38	5.05

The application of mineral fertilizers at recommended doses ensured a stable improvement in all studied parameters. In the NPK variant, shoot length reached 1.85 cm, the number of leaves increased to 52, and the total leaf surface area rose to 43.68 cm². This indicates the high effectiveness of the classical nutrition system, which supplies plants with essential macronutrients. However, when compared to organic biopreparations, mineral nutrition was inferior in some aspects (particularly in total leaf area) to the variant with the “Biosok Energy Plus” preparation.

The “Agroflorin” preparation, applied at a concentration of 2.5 ml/l of water in four treatments, showed a strong stimulating effect on apple tree growth. Despite a relatively smaller trunk diameter (1.49 cm) and shoot length (1.61 cm), this variant had the highest number of leaves — 53. The total leaf area was 41.67 cm², which is 11.6% higher than the control value. This suggests the potential role of “Agroflorin” in enhancing leaf formation and activating the photosynthetic apparatus.

The application of the “Alkaral” biopreparation provided improvements in biometric indicators compared to the control, though to a lesser extent than in other variants. With a trunk diameter of 1.40 cm and shoot length of 1.67 cm, the number of leaves was 49.33, and the total leaf surface was 39.67 cm². These data indicate a positive but moderate effect of the preparation. The reasons may lie in its

less pronounced biostimulating activity or specific interactions with the soil and the apple variety. Nevertheless, in all parameters, the “Alkaral” variant outperformed the control.

The highest results were obtained with the use of “Biosok Energy Plus,” which demonstrated a comprehensive impact on growth processes. Shoot length reached 1.70 cm, with the highest trunk diameter of 1.77 cm. The number of leaves was 51.33, and the total leaf surface area reached 45.33 cm² — the highest among all variants. The 21.4% increase in leaf area compared to the control highlights the high efficiency of this preparation under the light chestnut soils of southern Kazakhstan. Likely, “Biosok” actively stimulates metabolism, promotes cell division, and enhances leaf tissue growth.

The application of the organic fertilizer biohumus at a rate of 3 t/ha also had a positive impact. The trunk diameter was 1.68 cm, shoot length — 1.75 cm, number of leaves — 50, and the total leaf surface area — 42.00 cm². These indicators confidently exceeded the control and approached the results of mineral fertilization. Biohumus enriches the soil with humic substances, improves soil structure, and activates soil microflora, creating more favorable conditions for plant growth.

Table 3. Photosynthetic Activity of Golden Delicious Apple Leaves Depending on Fertilizer Variants (Average for 2022–2023)

Experiment variant	Net photosynthetic productivity (mg CO ₂ /dm ² /h)	Chlorophyll a+b content (mg/g fresh weight)
Control	5,3	1,42
Mineral NPK fertilizers	6,8	1,83
Agroflorin	6,2	1,76
Alkaral	5,9	1,68
Biosok Energy Plus	7,1	1,92
Biohumus	6,6	1,80
LSD _{0.05}	1.17	0.31

Analysis of the Photosynthetic Activity of Golden Delicious Apple Leaves. The analysis of photosynthetic activity in the leaves of Golden Delicious apple trees revealed significant differences among the fertilizer variants. The highest net photosynthetic productivity (NPP) was recorded in plants treated with the biological preparation Biosok Energy Plus — 7.1 mg CO₂/dm²/h. This indicates a high intensity of photosynthetic processes, which ensures more active accumulation of organic substances and, consequently, positively influences plant growth and development.

A comparable result was shown by the variant with mineral fertilizers (NPK) — 6.8 mg CO₂/dm²/h, confirming the effectiveness of traditional mineral nutrition in enhancing the physiological activity of leaves. Slightly lower but still high values were observed with the use of Biohumus (6.6 mg CO₂/dm²/h) and Agroflorin (6.2 mg CO₂/dm²/h), indicating the beneficial effect of organic fertilizers on the photosynthetic function of the plants.

The variants with Alkaral (5.9 mg CO₂/dm²/h) and the control (without fertilizers — 5.3 mg CO₂/dm²/h) demonstrated the lowest levels of photosynthetic activity. It is particularly notable that the control variant had the lowest NPP values, illustrating the dependence of photosynthesis intensity on the supply of nutrients and external stimulating factors.

Alongside the measurement of photosynthetic activity, the total chlorophyll content (a + b) in the leaves was also determined as an indicator of the physiological state of the plants. The highest chlorophyll content was also observed in the Biosok Energy Plus (1.92 mg/g fresh weight) and mineral NPK (1.83 mg/g) variants, which aligns with the high NPP values. This confirms the close relationship between chlorophyll pigment levels and the intensity of photosynthetic processes.

Conclusions Based on Table 3:

- All variants with fertilizer application (both mineral and organic) improved the biometric parameters of the apple trees compared to the control.
- The greatest effect in terms of total leaf area and trunk diameter was shown by Biosok Energy Plus, suggesting a high potential of this preparation as a plant growth biostimulant.

- Mineral fertilizers had a predictably positive effect but were inferior to organic preparations in several physiological parameters, especially in photosynthetic activity, including net photosynthetic productivity and chlorophyll content.
- The photosynthetic activity of plants treated with Biosok Energy Plus and NPK was the highest, indicating enhanced metabolic processes and increased physiological activity of the leaves.
- Biohumus demonstrated consistent efficiency in both biometric and photosynthetic parameters, confirming its value as an environmentally friendly source of nutrition in organic horticulture.
- No significant differences were found between the variants in terms of shoot length, number of leaves, or leaf area; however, the variants with biopreparations showed a trend toward increased leaf surface area and chlorophyll content, which collectively contributed to higher photosynthetic activity of the plants.

Conclusion

The conducted research on the effects of mineral and organic biologically active substances on biometric parameters and the formation of leaf surface area in Golden Delicious apple trees under light chestnut irrigated soils of southeastern Kazakhstan yielded important scientific and practical results.

Experimental data demonstrated that the application of various types of fertilizers significantly influenced the growth, development, and photosynthetic activity of apple trees under moderate irrigation and medium soil fertility conditions. Among them, the strongest stimulating effect on growth processes, leaf apparatus formation, and enhancement of photosynthetic potential was observed with organic biologically active preparations, particularly Biosok Energy Plus, which ensured:

- the largest total leaf area;
- the maximum trunk diameter;
- the highest net photosynthetic productivity (7.1 mg CO₂/dm²/h);
- the greatest chlorophyll content (1.92 mg/g fresh weight).

The conducted research on the effects of mineral and organic biologically active substances on biometric indicators and the formation of leaf surface area in *Malus domestica* 'Golden Delicious' apple trees under light chestnut irrigated soils of southeastern Kazakhstan revealed significant scientific and practical outcomes.

Application of organic biopreparations, especially Biosok Energy Plus, resulted in:

1. Trunk diameter increase by 8.6% compared to the control (from 1.63 cm to 1.77 cm);
2. Total leaf surface area increased by 21.4% (from 37.33 cm² to 45.33 cm²);
3. Net photosynthetic productivity (NPP) rose from 5.3 to 7.1 mg CO₂/dm²/h (+33.9%);
4. Chlorophyll content rose from 1.42 to 1.92 mg/g (+35.2%).
5. Mineral fertilizers (N110P110K120) at recommended doses significantly improved shoot length (1.85 cm vs. 1.82 cm in control), number of leaves (52 vs. 47.33), and NPP (6.8 mg CO₂/dm²/h), confirming their effectiveness in increasing vegetative growth and photosynthesis. However, they were somewhat inferior to Biosok in total leaf area and physiological activity.
6. Biohumus also demonstrated strong efficacy: trunk diameter of 1.68 cm, total leaf area of 42.00 cm², and NPP of 6.6 mg CO₂/dm²/h — outperforming control and approaching mineral fertilizer results, while being environmentally sustainable.
7. Agrofloxin and Alkaral contributed to increased leaf number and moderate improvement in trunk and shoot growth, suggesting their supporting role in vegetative development and leaf biomass formation.

Based on the conducted study, the following conclusions can be drawn:

1. All fertilizer variants had a positive effect on biometric and physiological parameters of the plants compared to the control.
2. The most pronounced growth and physiological effects were observed with the use of Biosok Energy Plus, making it a promising candidate for inclusion in organic horticulture technologies.

3. Agroflorin and Alkaral showed consistent positive effects, contributing to increased leaf mass and stable vegetative development.

4. Mineral fertilizers provide predictable improvements, including in photosynthetic activity, but can be effectively replaced or supplemented with organic biopreparations when transitioning to ecologically oriented agriculture.

5. The obtained data confirm the feasibility of integrating biopreparations into fruit crop cultivation systems to enhance resilience, physiological activity, and environmental sustainability of horticultural production in the southeastern regions of Kazakhstan.

The results of this study can be used in the development of technological maps for organic fruit crop cultivation, in the scientific justification of agro-technologies, and in further research into the mechanisms of action of biologically active substances on the morphophysiological development of fruit plants.

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ҚАЗАҚСТАННЫҢ ОҢТҮСТІК-ШЫҒЫСЫНДАҒЫ АЛМА БАҚТАРЫНДА ӨСУ КӨРСЕТКІШТЕРІН ЖӘНЕ ЖАПЫРАҚ БЕТІНІҢ АУДАНЫН ЖАҚСARTU YШІН МИНЕРАЛДЫ ЖӘНЕ ОРГАНИКАЛЫҚ БИОСТИМУЛЯТОРЛАРДЫ ҚОЛДАНУ

Аңдатпа

Қазақстанның оңтүстік-шығысындағы құрғақ климат пен суару қажеттілігімен сипатталатын жағдайларда бақ шаруашылығында органикалық биологиялық белсенді препараттарды қолдану болашағы зор бағыт болып табылады. Бұл мақалада Агрофлорин, Al Karal және Биосок Energy плюс препараттарының Голден Делишес сортының алма ағашына биометриялық көрсеткіштерге әсерін зерттеу нәтижелері келтірілген. Зерттеуде негізгі назар өсімділер ұзындығының, бұтақтардың диаметрінің, жапырақ бетінің ауданының және өсімдіктердің басқа да морфологиялық белгілерінің қалыптасуына аударылды.

Бұл зерттеудің ғылыми жаңалығы – топырақ микроорганизмдерінің белсенділігін арттыратын органикалық тыңайтқыштар мен биопрепараттарды қолдану технологиясын әзірлеуде болып табылады. Бұл микроорганизмдер топырақтағы биологиялық үдерістерді реттеп, өсімдіктердің тамыр жүйесі арқылы қоректік заттарды тиімді сіңіруіне ықпал етеді.

Оңтүстік-шығыс Қазақстанның суармалы ашық қоңыр топырақтарында жүргізілген тәжірибелік зерттеулер органикалық тыңайтқыштар мен биопрепараттардың, әсіресе «БиоСок Energy Plus», Агрофлорин және Alkaral препараттарының, пайдалы топырақ микроорганизмдерінің тіршілік белсенділігін арттырып, өсімдіктердің қоректенуін жақсартатынын көрсетті.

Топырақ микроорганизмдері органикалық заттарды минералдандыру және көміртек пен азотты пайдалана отырып, жасушалық ақуыздарды синтездеу үдерісінде маңызды рөл атқарады. Актиномицеттер, зең саңырауқұлақтары және бактериялар секілді микробтар топтары органикалық заттарды ыдырату арқылы топырақтағы азот қорын толықтырады. Олар үшін азоттың негізгі көзі – тез еритін азот қосылыстары, бұл органикалық тыңайтқыштар мен биопрепараттарды енгізу арқылы қамтамасыз етіледі.

Зерттеу нәтижесінде, әсіресе БиоСок Energy Plus пен Агрофлорин органикалық тыңайтқыштарының, аммонификациялаушы бактериялар, псевдомонадтар, амилолитикалық бактериялар және микромицеттер флорасының санына оң әсер ететіні анықталды. Бұл өз

кезегінде алма ағаштарының тамыр жүйесінің қоректенуін жақсартып, олардың жалпы физиологиялық жағдайын күшейтеді.

Кілт сөздер: алма ағашы, биопрепараттар, жапырақ беті, биометрия, органикалық егіншілік, Голден Делишес, Қазақстанның оңтүстік-шығысы.

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ПРИМЕНЕНИЕ МИНЕРАЛЬНЫХ И ОРГАНИЧЕСКИХ БИОСТИМУЛЯТОРОВ ДЛЯ УЛУЧШЕНИЯ ПОКАЗАТЕЛЕЙ РОСТА И ПЛОЩАДИ ЛИСТОВОЙ ПОВЕРХНОСТИ В ЯБЛОНЕВЫХ САДАХ ЮГО-ВОСТОЧНОГО КАЗАХСТАНА

Аннотация

В условиях юго-востока Казахстана, характеризующихся засушливым климатом и необходимостью орошения, использование органических биологически активных препаратов в садоводстве представляет собой перспективное направление. В статье представлены результаты исследования влияния препаратов Агрофлорин, Al Karal и Биосок Energy плюс на биометрические показатели яблони сорта Голден Делишес. Основное внимание уделено формированию длины побегов, диаметра ветвей, площади листовой поверхности и другим морфологическим признакам растений.

Научная новизна данного исследования заключается в разработке технологии применения органических удобрений и биопрепаратов, способствующих активности почвенных микроорганизмов. Эти микроорганизмы регулируют биологические процессы в почве и улучшают усвоение питательных веществ корневыми системами растений.

Экспериментальные исследования, проведенные в условиях орошаемых светлокаштановых почв юго-востока Казахстана, показали, что органические удобрения и биопрепараты, особенно «БиоСок Energy Plus», Агрофлорин и Alkaral, стимулируют жизнедеятельность полезных почвенных микроорганизмов и улучшают питание растений.

Почвенные микроорганизмы играют ключевую роль в минерализации органических веществ и синтезе клеточных белков с использованием углерода и азота. Такие микробные группы, как актиномицеты, плесневые грибы и бактерии, способствуют пополнению азота в почве за счёт разложения органических веществ. В качестве источника азота они в первую очередь нуждаются в легкорастворимых азотсодержащих соединениях, которые обеспечиваются за счёт применения органических удобрений и биопрепаратов.

Исследование установило положительное влияние органических удобрений, особенно БиоСок Energy Plus и Агрофлорина, на численность аммонифицирующих бактерий, псевдомонад, амилотических бактерий и микромицетной флоры в почвах яблоневых садов. Это, в свою очередь, способствует лучшему питанию корневой системы и улучшению общего физиологического состояния яблонь.

Ключевые слова: яблоня, биопрепараты, листовая поверхность, биометрия, органическое земледелие, Голден Делишес, юго-восток Казахстана.