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# ЗЕМЛРОБСТВО, РОСЛИНИЦТВО, ОВОЧІВНИЦТВО ТА БАШТАНИЦТВО

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## THE COMPLEX EFFECT OF BIOLOGICS AND AGROTECHNICAL TECHNIQUES ON THE DYNAMICS OF LINEAR MILLET DEVELOPMENT

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*The article presents the results of a scientific study on the influence of biological preparations and agrotechnical techniques, in the form of a variable indicator of row spacing, on the dynamics of growth processes of millet of the Denvikske variety. A comparative characteristic of the obtained research results with the declared main indicators of the selected millet sort is presented. The analysis of the effectiveness of the use of biological preparations has been carried out, taking into account their specific effects on plants and depending on the schemes of fertilization for the growth and development of millet plants. Special attention was paid to the determination of biometric indicators, such as plant height, leaf surface area, panicle length and aboveground mass, which became key indicators for assessing the general condition of plants and their productivity.*

*The article considers the issues of the effective use of biological preparations Humiam-01, Humicor, Helafit-Combi and Bio-gel on millet crops of the Denvikske sort in synergistic action with agrotechnical measures regulating the width of row spacing. According to the results of the study, the most effective biological preparations were determined, depending on the method of their application and the effect of changing the width of row spacing, which contributed to an increase in millet yield and ensured better grain quality. As a result, it was also found that the use of biological products reduced the chemical impact on the environment, which made it possible to ensure the transition to environmentally friendly methods of growing crops.*

*The presented material provides data that are of great practical importance for agricultural production, since they allow us to develop a new adaptive technology for growing millet to variable agro-climatic conditions. The principal direction of development of adaptation technologies is based on the search for new, more effective ways of growing typical crops of Ukraine.*

**Key words:** millet, biological preparation, Humiam-01, Humicor, Helafit-Combi, Bio-gel, agrotechnical practices, plant height, biometric indicators, yield.

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***Аверчев О.В., Нікітенко М.П. Комплексний вплив біопрепаратів і агротехнічних прийомів на динаміку розвитку проса лінійного***

*В статті приведені результати наукового дослідження щодо впливу біологічних препаратів та агротехнічних прийомів, у вигляді змінного показнику ширини міжрядь, на динаміку ростових процесів проса сорту Денвікське. Наведена порівняльна характеристика отриманих результатів дослідження із заявленими основними показниками обраного сорту проса. Проведено аналіз щодо ефективності використання біологічних препаратів з огляду їх специфіки дії на рослини та в залежності від схем внесення добрив на ріст і розвиток рослин проса. Особливу увагу приділяли визначенню біометричних показників, такі як висота рослин, площа листкової поверхні, довжина волоті та маса надземної частини, що стали ключовими індикаторами для оцінки загального стану рослин і їхньої продуктивності.*

*В статті розглянуті питання, ефективного використання біологічних препаратів Гуміам-01, Гумікор, Хелафіт-Комбі та Біо-гель на посівах проса сорту Денвікське у синергетичній дії з агротехнічними заходами, які регулюють ширину міжрядь. За отриманими результатами дослідження було визначено найбільш ефективні біопрепарати в залежності від способу їх внесення та вплив зміни ширини міжрядь посіву, які сприяли підвищенню врожайності проса та забезпечили кращу якість зерна. У результаті також було виявлено, що використання біопрепаратів зменшило хімічний вплив на навколишнє середовище, що дозволило забезпечити перехід до екологічно безпечних методів вирощування сільськогосподарських культур.*

*У представленому матеріалі наводиться данні, які мають важливе практичне значення для сільськогосподарського виробництва, оскільки дозволяють розробити нову адаптаційну технологію вирощування проса до змінних агрокліматичних умов. Принциповий напрямок розвитку адаптаційних технологій базується на пошуку нових, більш ефективних способів вирощування типових культур України.*

***Ключові слова:*** просо, біопрепарати, Гуміам-01, Гумікор, Хелафіт-Комбі, Біо-гель, агротехнічні прийоми, висота рослин, біометричні показники, урожайність.

**Problem statement.** One of the main tasks of modern agriculture is considered to be increasing the yield of crops, in particular millet. One of the ways to optimize the growth and development of millet is to use biological preparations that can stimulate plant growth, improve nutrient absorption and increase resistance to stressful conditions. Agrotechnical measures such as basic and pre-sowing tillage, crop density control, crop rotation and weed control also play an important role.

However, using only biological preparations or agrotechnical measures isn't enough to achieve maximum efficiency. There is a need to investigate their complex interaction, since the synergistic effect of the simultaneous application of these measures can significantly improve the dynamics of linear millet growth and its yield.

Millet belongs to high-yielding, cereal, food and fodder crops. In particularly dry years, millet yields exceed those of other food crops. Farmers usually use millet as an insurance crop in case of a failure of winter crops, and also successfully grow it as a post-harvest and post-harvest crop. The best natural conditions for growing millet are the northwestern and northern regions of the steppe zone of Ukraine. However, with the use of innovative technologies and modern agricultural machinery, high yields are achieved in sorts soil and climatic conditions.

The beneficial properties and amount of nutrients in the millet depend on its sort and growing conditions. The resulting plant products from millet are environmentally friendly and require little investment in production, which is of particular importance in modern conditions.

**Formulation of the problem.**

Different from other cereals, millet is characterized by high drought resistance and lower yield losses due to lack of moisture, compared with other spring crops. At the initial stages of development, from germination to sowing, the plant loses water minimally,

which ensures high resistance to drought. The most critical period for millet with respect to water requirements is the time between the phase of throwing out the panicle and the beginning of grain filling.

The effective use of organic and biological fertilizers, provided that the soil is sufficiently moistened, helps to increase crop yields. To obtain a high-quality millet harvest, it is recommended to introduce nutrients during the most productive period of plant development – from tillering to flowering. The introduction of easily digestible nutrients contributes to a more efficient and economical assimilation of fertilizers and the removal of available moisture from the soil. A well-chosen and balanced set of nutrients contributes to the better development of plants, both in dry and wet conditions. Taking into account all the important biological features of the culture under study, as well as climatic conditions and the process of their changes, which are typical not only for the southern part of Ukraine, adaptation processes in a complex system of influencing factors were studied to obtain the most useful synergistic effect.

The use of biofertilizers and multifunctional complex preparations enriches the soil with beneficial microorganisms, bacteria and other macro- and microelements, activating their biological activity, plant productivity increases, as it contributes to the more efficient operation of other fertilizers.

Thus, the chemical burden on the environment is reduced and a gradual transition to biotechnological cultivation of millet or other agricultural crops is carried out.

#### **The main part.**

The study was based on the study of the characteristics of the development of millet (*Panicum miliaceum* L) of the Denvikske sort, a sort of Aureum. It was derived by individual selection from a hybrid combination Mironovske 51 x Veselopodolyanske 176. The sort is suitable for growing food grains and for forage purposes.

This sort belongs to the middle-ripening group, with a growing season of 85-95 days. The average height of plants is in the range of 100-115 cm, has a resistance to lodging and increased drought resistance. The millet of the Denvikske sort is characterized by high resistance to millet diseases common in Ukraine, such as melanosis (blackening of the nucleus), as well as to spotty bacteriosis and damage by the millet mosquito.

Research program, the task was set to study the effect of pre-sowing treatment with biopreparations and foliar top dressing on the biometric parameters of millet plants in order to optimize cultivation technologies, increase yields and crop resistance to natural stressful conditions. Sorts types of biological fertilizers and multifunctional complex preparations were selected for research, a scientific review of which allowed us to conclude about their effectiveness and positive reaction to other crops that hadn't previously been used in millet.

During the period of scientific research, the influence of biological fertilizers and multifunctional complex preparations Humicor, Humiam-01, Bio-gel and Helafit-Combi on research crops of millet of the Denvikske sort was analyzed. The general effect of which is aimed at stimulating growth processes and protecting plants from stressful conditions. In the initial phases of development, they contribute to better formation of the root system, activate metabolic processes and improve the process of photosynthesis in plants. Depending on the critical periods of millet, the moment when the plant most needs nutrients to support its development, it is recommended to introduce biologics in foliar top dressing. The experiment provided for the introduction of biopreparations into the development phases of seedlings, tillering and discarding of the panicle.

To create optimal conditions at the beginning of plant development, pre-sowing seed treatment with Humicor and Humiam-01 fertilizers was carried out, preparations

that are based on humic acids, amino acids, macro- and microelements give the culture enhancing energy for germination and stimulate the growth of the root system in the early stages of development. As a factor, the change in the width of the row spacing on millet crops was an indicator of its influence on the development of the vegetative mass of plants, the formation of the root system and, as a result, on the general condition of crops.

Taking into account the main characteristics and composition of biological products, the use of which was envisaged in the study, their direct positive effect on the biometric indicators of plants during the growing season of the crop and the yield of millet in general was noted. Biometric indicators of plants are necessary to assess the overall health, development and yield. In terms of plant height, the number of leaves, the biomass of the aboveground and root systems of plants indicate their growth and potential productivity. Determining these indicators allows you to better understand the condition of plants and make decisions regarding their care, fertilization and other aspects of plant cultivation.

The growth and development of millet according to the conditions of the experiment depended on the planned complex of agrotechnical techniques. In order to identify the influence of factors on the formation of biometric indicators of millet, the height of plants, the area of their leaf surface, the length of the panicle, the dynamics of accumulation of aboveground mass and the distribution of the root system over soil layers were determined.

The dynamics of linear growth of millet plants depends on a set of factors, among which pre-sowing seed treatment, foliar fertilization with biological products, row spacing, soil quality and climatic conditions are of particular importance. Optimizing these conditions can significantly improve the growth and development of plants, increasing their productivity.

With the help of planned agrotechnical techniques, pre-sowing seed treatment was carried out with biological preparations such as Humiam-01 and Humicor, which contributed to improving the initial growth of plants and the active development of the root system, this ensured more intensive linear growth at the initial stages of vegetation. (Fig. 1) the content of macro- and microelements in the soil directly affected the availability of nutrients necessary for linear plant growth. Humic acids and amino acids, which are part of biological products such as Humiam-01, help to better absorb nutrients and improve the physiological state of plants due to their ability to form stable complexes with metal ions and organic compounds. This contributed to a better transport of nutrients inside the plant and increased its resistance to stressful conditions.

The analysis of the stem height is used to determine ideal conditions in order to create high-yielding millet plants. It was also found that when using biofertilizers and multifunctional complex preparations, growth processes were enhanced and such plants had higher values compared to the control variant (water treatment). The best effect on the linear parameters of millet plants during the entire growing season was noted when using the biological preparation Humicor.

The variable width of the row spacing affected the space for plant growth and the availability of resources. For example, a reduced row spacing (15 cm) led to denser sowing, which stimulated greater linear plant growth due to competition for light and nutrients. Sowing row spacing (30 cm) provided more space for the development of millet plants, so the height of the plants was less.

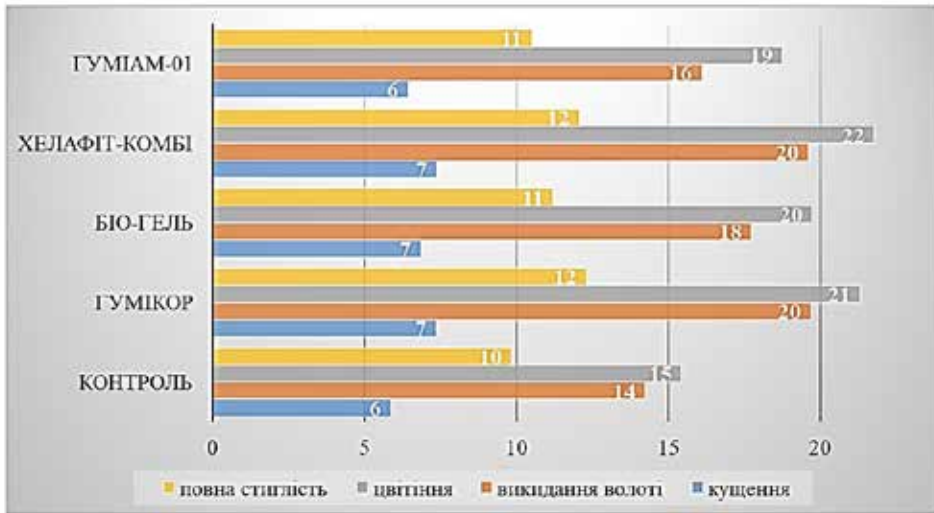


Fig. 1. Linear growth of millet plants of the Denvikske sort according to the main phases of development, depending on the biological preparations used in pre-sowing seed treatment and control



Fig. 2. Linear growth of millet plants of the Denvikske sort according to the main phases of development, depending on the change in the width of the rows of sowing

The use of foliar top dressing with biological preparations such as Humicor, Bio-gel, Helafit-Combi and Humiam-01 had a positive effect on the linear growth of millet, improving the absorption of nutrients and activating their photosynthetic activity. Due to the peculiarity of millet development, linear plant growth was observed most actively in the early stages (in the phases of germination and tillering). After that, the growth rate decreased depending on the availability of resources and the influence of agrotechnical and climatic conditions. The special effect of the biologics used was noticeable during the critical phases of development (tillering and discarding of the panicle), the effective action of which stimulated rapid plant growth and contributed to achieving the optimal height of the declared varietal characteristics of the crop.

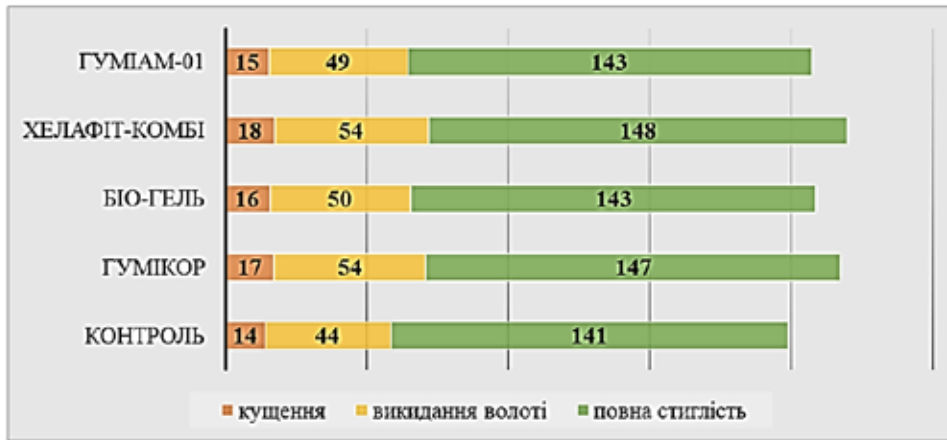


Fig. 3. Linear growth of millet plants of the Denvikske sort according to the main phases of development, depending on the biological preparations used in foliar fertilization and control

In addition to the specified plant height parameter, the effect of biological preparations was assessed by the formation of the leaf surface area of crops. The leaf area indicator has a significant impact on the formation of the crop, since a large leaf area provides a larger surface for photosynthesis and, accordingly, a larger amount of synthesized organic substances that are deposited in the form of a crop. In addition, the plant's resistance to adverse environmental conditions, such as drought, high temperature conditions or soil salinization, is ensured. A large leaf area allows the plant to use moisture and nutrients more efficiently.

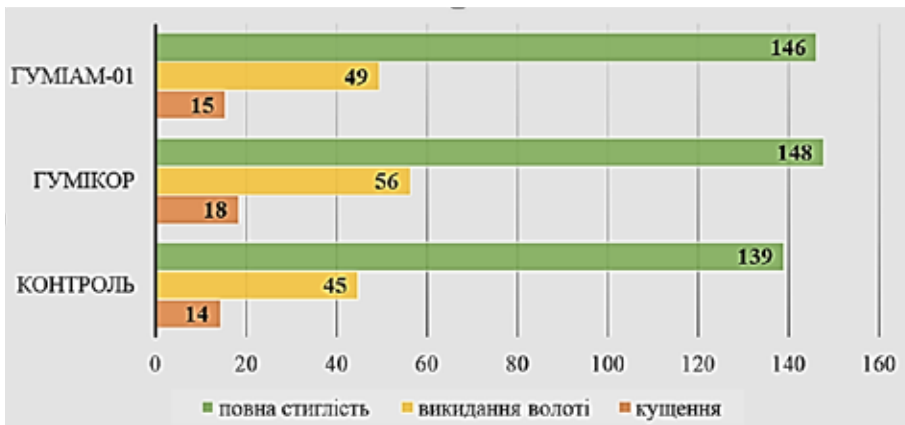


Fig. 4. Dynamics of the leaf surface area of millet plants of the Denvikske sort according to the main phases of development, depending on the biological preparations used in pre-sowing seed treatment and control

From the beginning of development in the germination phase, the leaf surface doesn't have a significant size, and doesn't significantly affect the development of the

plant, because at this time all the necessary nutrients are provided at the expense of the root system. With the onset of the tillering phase, the rapid development of leaf growth begins and this process continues until the flowering phase, which is characterized by the maximum value of the leaf surface area. However, during the period of full ripeness, the leaf area of millet plants significantly decreased in size due to the intensive outflow of nutrients from vegetative organs (leaves, stems) to the grain. The main process that occurs at the end of the growing season is the filling and maturation of grain, which is provided by the accumulation of nutrients in it. Therefore, the need for intensive photosynthesis decreases and the leaf area decreases.



*Fig. 5. Dynamics of the leaf surface area of millet plants of the Denvikske sort according to the main phases of development, depending on the biological preparations used in foliar fertilization and control*

Foliar fertilization of plants with biological preparations significantly stimulated the development of the leaf surface, compared with the control variant where the treatment was carried out with clean water. One of the main factors that affects the amount of crop yield formation is photosynthesis, thanks to this process, up to 95% of the accumulation of natural energy in plants occurs. The attitude to the created natural conditions and the influence of various agrotechnical techniques used during the growing period are characterized by the ability of plants to carry out photosynthesis, as the main physiological indicator of development.

Comparing the indicators of leaf surface development in conditions of different row spacing widths, they don't have a significant difference, but lower leaf area indicators were noted in thickened crops with a row spacing of 30 cm.

The use of biologics for pre-sowing seed treatment and top dressing during the critical phases of the growing season of the crop ensures greater plant resistance to stressful conditions and contributes to the overall physiological condition of plants. Pre-sowing seed treatment stimulates active germination, ensures better development of the root system and allows you to get all the necessary nutrients at the initial stages of plant development. Foliar top dressing during critical phases for millet, such as tillering and panicle release, helps to increase photosynthetic activity and absorb nutrients more efficiently, which as a result affects the formation of more hardy and productive plants.

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