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BUCKWHEAT PRODUCTIVITY DEPENDS ON FERTILIZER SYSTEM AND SEED INOCULATION WITH BIOPREPARATION

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The issue of stable and efficient production of the necessary amount of high-quality agricultural products, including buckwheat grain, is becoming increasingly important. Achieving sustainable and high yields is also closely related to soil fertility, which depends on the intensity of biological processes in the soil. Therefore, improving buckwheat cultivation technologies through the combination of agrotechnological elements and biotechnological cultivation practices will contribute to the realization of its genetic potential.

Field research on determining the impact of fertilizer systems and biopreparation on buckwheat yield and productivity was conducted from 2020 to 2023 at the laboratory of agriculture at Institute of Agriculture of the Steppe, National Academy of Agrarian Sciences in stationary short rotation crop experiments.

was found that the fertilizer system had the most significant impact on buckwheat yield. Under the organic-mineral fertilizer system, buckwheat yield was the highest at 1.62 t/ha, while the mineral fertilizer system resulted in a grain yield of 1.46 t/ha, significantly exceeding the yield without fertilizer application, which was 1.07 t/ha (LSD_{05}= 0.07 t/ha).

The increase in yield due to the fertilizer system factor was the highest, with a growth of 0.56 t/ha or 50.7% for the organic-mineral system and 0.38 t/ha or 35.7% for the mineral system, compared to the no fertilizer variant. The most effective was the use of a biopreparation without fertilizer application, which contributed to an additional buckwheat yield of 0.19 t/ha

or 17.7%. The combined effect of the fertilizer system and biopreparation determined higher buckwheat productivity. Under the organic-mineral fertilizer system, seed treatment with the biopreparation resulted in the highest grain units yield, feed units, and digestible protein at 2.28 t/ha, 3.63 t/ha, and 0.29 t/ha, respectively. The fertilizer system had a more significant effect on buckwheat productivity, resulting in an additional yield of 0.67−1.11 t/ha of grain units yield, 2.85−3.40 t/ha of feed units, and 0.07−0.11 t/ha of digestible protein.

Key words: *yield, productivity, fertilizer system, biopreparation, buckwheat.*

Мащенко Ю.В., Соколовська І.М. Продуктивність гречки залежно від системи удобрення та інокуляції насіння біопрепаратом

Проблема стабільного та ефективного виробництва необхідної кількості якісної сільськогосподарської продукції, зокрема зерна гречки, набуває все більшої актуальності. Отримання сталих і високих врожаїв безперервно пов'язане також з родючістю ґрунту, яка залежить від інтенсивності процесів життєдіяльності організмів у ґрунті. Таким чином, удосконалення технологій вирощування гречки через поєднання дії елементів агротехнологій та біотехнологічних прийомі вирощування сприятиме реалізації її генетичного потенціалу.

Польові дослідження щодо визначення впливу систем удобрення та біопрепарату на урожайність та продуктивність гречки проводилися протягом 2020-2023 рр. на базі лабораторії землеробства Інституту сільського господарства Степу НААН в стаціонарних дослідах сівозмін короткої ротації.

Було встановлено, що найбільш істотно на урожайність гречки впливав фактор система удобрення. За органо-мінеральної системи удобрення урожайність гречки була найвищою, 1,62 т/га, мінеральна система удобрення забезпечувала збирання 1,46 т/га зерна гречки, що істотно перевищувало показники на фоні без використання добрив – 1,07 т/га ($НІР_{05}$=0,07 т/га). Приріст урожаю за фактором система удобрення був найбільший, + 0,56 т/га або 50,7% за органо-мінеральною та 0,38 т/га або 35,7% за мінеральною системою удобрення, відносно варіанту без добрив. Найбільш ефективним було використання біопрепарату на фоні без внесення добрив, що сприяло прибавці 0,19 т/га або 17,7% додаткового врожаю гречки. Комплексна дія системи удобрення та біопрепарату визначала вищу продуктивність гречки. На фоні органо-мінеральної системи удобрення за обробки насіння біопрепаратом отримали найвищій збір зернових, кормових одиниць та перетравного протеїну, 2,28 т/га, 3,63 т/га та 0,29 т/га відповідно. Більш ефективно на продуктивність гречки впливала система удобрення, за рахунок якої отримали додатково 0,67−1,11 т/га зернових, 2,85−3,40 т/га кормових одиниць та 0,07−0,11 т/га одиниць перетравного протеїну.

Ключові слова: *урожайність, продуктивність, система удобрення, біопрепарат, гречка.*

Problem statement. The problem of stable and efficient production of the necessary amount of high-quality agricultural products, particularly buckwheat, is becoming increasingly relevant. The low yield of agricultural crops is mostly due to farmers not following scientifically based technological recommendations, especially regarding balanced mineral nutrition, insufficient use of plant protection products, biological agents that affect physiological processes in plants, and so on. Obtaining stable and high yields is also closely related to soil fertility, which depends on the intensity of organism activity in the soil. Therefore, improving buckwheat cultivation technologies through the combination of agrotechnological elements and biotechnological cultivation techniques will contribute to realizing its genetic potential.

Analysis of recent research and publications. Buckwheat is a versatile crop with a waste-free production technology. In recent years, the demand for buckwheat has sharply increased. Traditional uses of buckwheat include its production and use as a cereal and honey crop, while buckwheat straw is used to obtain biological bacterial fertilizer. In the near future, it can also be used for synthesizing food dye [1; 2; 3; 4; 5; 6].

Buckwheat yields are lower compared to crops such as barley and winter wheat due to its biological characteristics. High temperatures and dry weather during the flowering period are one of the reasons for unstable buckwheat yields. Prolonged rainfall and

strong winds also negatively affect its productivity. However, the genetic potential of the crop is quite high [7; 8; 9].

Increasing plant productivity can be achieved not only through breeding methods but also by applying the necessary doses of fertilizers and biological preparations as part of the complex technological operations of crop cultivation.

Mineral fertilizers greatly influence the increase in root mass of plants. Unlike most field crops, buckwheat can develop a powerful vegetative mass, which grows simultaneously with the development of generative organs and continues to grow almost until the end of vegetation. The possibility of obtaining a high yield decreases with excessive formation of vegetative mass, so the application of nitrogen fertilizers in particular should be justified [10; 11; 12; 13].

Compliance with optimal rates of mineral fertilizer application not only affects achieving a high level of crop yield but also the economic feasibility of their use in specific conditions [14].

The positive impact of organic fertilizer application on plant growth, yield, productivity, soil properties, and crop quality has been confirmed by numerous studies.

The implementation of nutrient management practices in agriculture is aimed not only at increasing crop yield but also improving the quality and composition of soils. For example, the use of intercropping legume crops can particularly enhance soil fertility and increase nitrogen content in the soil through the ability of rhizobacteria to fix nitrogen.

The efficiency of nutrient utilization can be increased by using mineral fertilizers, but the demand for them may be significantly lower [15].

The application of bio-preparations in buckwheat cultivation is one of the innovative techniques of biotechnology that significantly affects crop yield. By biologizing agriculture, the conditions for using mineral nutrients as fertilizers and in the soil are improved. The use of microbial preparations ensures the supply of beneficial microorganisms in the necessary quantity and in the required phase of plant growth and development [16; 17].

In recent years, farmers have often used bio-preparations for seed treatment. The comprehensive effectiveness of using bio-preparations and fertilizers depends on the biological characteristics of the variety in specific soil and climatic conditions. Mineral fertilizers play a significant role in regulating plant nutrient elements, but it should be noted that the interaction between them and microbial preparations and the impact of these factors on buckwheat productivity remains poorly studied.

Research task. To determine the yield and productivity level of buckwheat depending on the fertilization system and biopreparation.

Materials and methods of research. Field experiments were conducted from 2020 to 2023 at the laboratory of agriculture of the Institute of Agriculture of the Steppe, National Academy of Agrarian Sciences in stationary experiments of short rotation crop rotation.

Research methods: field and laboratory-field experiments.

The object of research: fertilization systems, bio-preparation.

The buckwheat variety Yaroslavna was grown in a short rotation grain-row crop rotation with a 40% soybean saturation, which had the following rotation: soybean, winter wheat, soybean, corn for grain, buckwheat.

The technology of buckwheat cultivation is widely used in the Steppe zone, except for the techniques that are currently being studied. Buckwheat was sown using wide-row planting method in the first decade of May, with a seeding rate of 2.25 million seeds per hectare, under three fertilizer systems:

1. Without fertilizers;
2. Mineral fertilizer system ($N_{20}P_{20}K_{20}$);
3. Organic-mineral fertilizer system ($N_{20}P_{20}K_{20}$ and by-products of the previous crop).

Buckwheat seeds were treated with the biopreparation Mycofriend (1.0 L/ton). The general technology of buckwheat cultivation included primary tillage, starting with stubble plowing to a depth of 22–25 cm. Pre-sowing soil preparation consisted of cultivation to a depth of 5–8 cm. Crop care included post-sowing harrowing and inter-row cultivation at the beginning of the flowering stage of buckwheat plants. Pest and disease control was carried out according to the existing recommendations in the zone.

The establishment and conduct of the experiments were carried out in accordance with field research methodology.

The weather conditions during the research period had a significant impact on the productivity of buckwheat. Overall, the conditions were dry and not favorable for achieving high productivity levels of buckwheat. While the conditions in 2021 and 2022 were favorable from sowing to flowering, in 2023 there was a moisture deficit even during seed germination and early stages of growth and development (the amount of rainfall in May was 2.7 times below normal) and air temperature reached 27–29°C. In all years of the study, high air and soil temperatures were observed from June to August, as well as a significant moisture deficit during the flowering and ripening period of buckwheat.

Research results. The main components of obtaining high yields of field crops are creating optimal conditions for their cultivation. The weather conditions during the research years not only affected the overall condition of buckwheat plants, the intensity of physiological processes, but also determined the complex interaction of all factors that were provided by the cultivation technology of the crop. This factor was of significant importance during the years of research.

The highest yield of Yaroslavna buckwheat variety was obtained in the conditions of 2023, using the organic-mineral fertilizer system and seed treatment with the biopreparation Mycofriend, this indicator was the highest – 2.19 t/ha. Without using the preparation, the lowest yield of buckwheat was obtained, which was 1.98 t/ha (Figure 1).

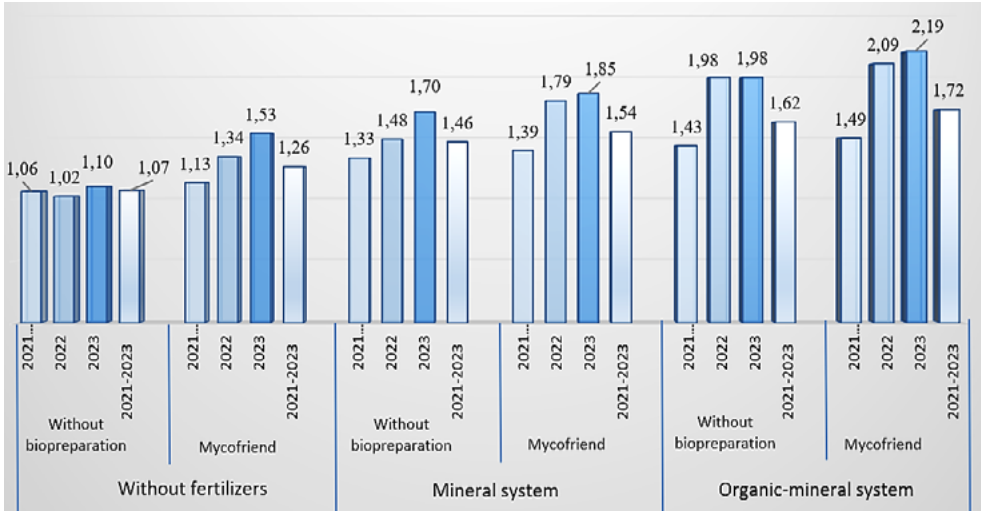

Fig. 1. Yield of Yaroslavna buckwheat variety, t/ha

Against the background of mineral plant nutrition, the yield of buckwheat in this year was at the level of 1.70 t/ha, and due to the action of the biopreparation, an additional 0.15 t/ha of grain was obtained, and this increase was significant (LSD_{05} = 0.04 t/ha).

It should be noted that in 2023, the yield of buckwheat without the use of fertilizers, but only due to the action of the biologically active preparation, exceeded the indicators of 2021 (1.06−1.49 t/ha).

The tendency towards buckwheat yield formation under the influence of fertilization systems and seed treatment with a biopreparation was observed in other years of research as well. For example, in 2022, a higher yield was obtained using the organic-mineral fertilizer system − 2.09 t/ha and 1.98 t/ha with the use of the biopreparation and without its use, respectively. The yield indicators of buckwheat against the background of mineral nutrition significantly exceeded the variant without the use of fertilizers − 1.48−1.79 t/ha and 1.02−1.34 t/ha, respectively.

Analysis of the obtained buckwheat yield results shows that weather conditions determined the variability limits of this indicator. It has been proven that favorable conditions for the crop increase the range of yield variation, while unfavorable conditions decrease the limits of the indicators. For example, in 2023, which was characterized as the most favorable in terms of weather conditions for this crop, the buckwheat yield ranged from 1.10 to 2.19 t/ha, with a variation range of 1.09 t/ha. In contrast, in 2021 (with a long drought in the second half of the vegetation period and high temperatures), these limits were 1.06−1.49 t/ha with a variation range of 0.43 t/ha. Natural precipitation during critical periods for the crop and optimal temperatures contributed to the increased intensity of other factors, such as agronomic practices, and enhanced their combined effect.

Over the years of research, it has been established that the highest buckwheat yield was obtained with the organic-mineral fertilizer system. The application of the biopreparation Mycofriend provided the highest yield indicator − 1.72 t/ha. The yield of buckwheat whose seeds were not treated with the biopreparation was at the level of 1.62 t/ha. However, it should be noted that the largest yield increase − 0.54 t/ha − was obtained in this experimental variant (Table 1).

Under the mineral fertilizer system, an average buckwheat grain yield of 1.46 t/ha was obtained, which increased to 1.54 t/ha with the use of the biopreparation. The use of the biopreparation also significantly influenced the yield of buckwheat grain, with the highest additional production obtained when the crop was grown without fertilizer application − +0.19 t/ha or 17.7% at a significance level of 0.06 t/ha. It should be noted that seed treatment with the biopreparation, in combination with mineral fertilizers, contributed to an increase in buckwheat yield, but the effect of its application was the lowest in the study − +0.09 t/ha or 6.1%.

Thus, the analysis of buckwheat yield results for 2021-2023 indicates that the largest significant increase in yield was achieved through the factor of fertilizer system, with +0.54 t/ha or 50.7% for the organic-mineral system and +0.38 t/ha or 35.7% for the mineral system at a significance level of 0.07 t/ha.

The productivity of the crop is an important criterion for evaluating its cultivation efficiency. By using an optimal set of agronomic practices, the negative impact of unfavorable environmental factors can be reduced. We have found that fertilizer systems had a significant impact on buckwheat productivity.

In our study, the highest grain units yield from the buckwheat crop of Yaroslavna variety was obtained under the organic-mineral fertilizer system, with 2.70 t/ha without the use of the biopreparation and 2.89 t/ha with seed inoculation using the

Table 1

Buckwheat yield indicators for Yaroslavna variety, average for 2021–2023

Fertilization system (Factor A)	Biopreparation (Factor B)	Yield, t/ha	Difference, Factor A		Difference, Factor B	
			t/ha	%	t/ha	%
Without fertilizers	Without biopreparation	1,07	–	–	–	–
	Mycofriend	1,26	–	–	0,19	17,7
Mineral	Without biopreparation	1,46	0,38	35,7	–	–
	Mycofriend	1,54	0,28	22,4	0,09	6,1
Organic-mineral	Without biopreparation	1,62	0,54	50,7	–	–
	Mycofriend	1,72	0,46	36,5	0,11	6,6
LSD_{05} Factor A		0,07	–	–	–	–
LSD_{05} Factor B		0,06	–	–	–	–
LSD_{05} Interaction of factors AB		0,11	–	–	–	–

Mycofriend preparation. However, the use of organic substances from the previous crop by buckwheat plants somewhat mitigated the effect of the biopreparation, and the yield increase in this variant was the most significant – +1.11 t/ha or 69.6% (significance level of 0.27 t/ha) (Table 2).

Table 2

Grain units yield of Yaroslavna variety buckwheat, average for 2021–2023

Fertilization system (Factor A)	Biopreparation (Factor B)	Grain units yield, t/ha	Difference, Factor A		Difference, Factor B	
			t/ha	%	t/ha	%
Without fertilizers	Without biopreparation	1,59	–	–	–	–
	Mycofriend	2,00	–	–	0,41	25,7
Mineral	Without biopreparation	2,27	0,67	42,2	–	–
	Mycofriend	2,53	0,52	26,1	0,26	11,5
Organic-mineral	Without biopreparation	2,70	1,11	69,6	–	–
	Mycofriend	2,89	0,89	44,3	0,19	6,9
LSD_{05} Factor A			–	–	–	–
LSD_{05} Factor B			–	–	–	–
LSD_{05} Interaction of factors AB						

Under the mineral fertilizer system, the grain units yield was slightly lower at 2.27 t/ha and 2.53 t/ha, while higher yields were obtained with seed treatment using the biopreparation. Additionally, the effectiveness of the fertilizers was also higher than that of the biopreparation. The use of mineral fertilizers resulted in an additional production of 0.67 t/ha or 42.2%, while the biopreparation led to an increase of 0.52 t/ha or 26.1%, which was also significant (LSD_{05}= 0.05).

The most significant increase in grain units was observed without seed treatment using the biopreparation, although the yield of this crop increased with the application of the biopreparation. The highest yield increase was obtained without fertilizer application, with an additional production of 0.41 t/ha or 25.7%, while the increase in grain units under the organic-mineral fertilizer system was insignificant, with +0.19 t/ha or 6.9% at a significance level of 0.22 t/ha.

Thus, the use of mineral and organic-mineral fertilizer systems contributed to an increase in buckwheat grain units yield, ranging from 2.27−2.53 t/ha to 2.70−2.89 t/ha compared to the variant without fertilizer application (1.59−2.00 t/ha). Seed treatment with the Mycofriend biopreparation promoted an increase in yield, but the additional grain yield decreased significantly, with +0.41 t/ha or 25.7% without fertilizers, +0.26 t/ha or 11.5% under the mineral system, and +0.19 t/ha or 6.9% under the organic-mineral system.

In our experiments, a similar trend was observed in terms of feed unit yield. The highest yield of this product was obtained under the organic-mineral fertilizer system, with 3.40 t/ha and 3.63 t/ha for seed treatment with the biopreparation (Table 3).

Table 3

Feed unit yield from buckwheat crop of Yaroslavna variety, average for 2021−2023

Fertilization system (Factor A)	Biopreparation (Factor B)	Feed units yield, t/ha	Difference, Factor A		Difference, Factor B	
			t/ha	%	t/ha	%
Without fertilizers	Without biopreparation	2,00	–	–	–	–
	Mycofriend	2,52	–	–	0,51	25,7
Mineral	Without biopreparation	2,85	0,85	42,2	–	–
	Mycofriend	3,17	0,66	26,1	0,33	11,5
Organic-mineral	Without biopreparation	3,40	1,39	69,6	–	–
	Mycofriend	3,63	1,11	44,3	0,24	6,9
LSD_{05} Factor A		0,34	–	–	–	–
LSD_{05} Factor B		0,27	–	–	–	–
LSD_{05} Interaction of factors AB		0,48	–	–	–	–

Under the mineral system, these indicators were slightly lower, at 2.85 t/ha and 3.17 t/ha respectively. Without the application of fertilizers, the feed unit yield did not exceed 2.00−2.25 t/ha.

The fertilizer systems had the most significant impact on the formation of buckwheat feed units, with the organic-mineral fertilizer system resulting in the highest increase of +1.36 t/ha or 69.6%. Under the mineral system, the additional production amounted to 0.85 t/ha or 42.2%. The use of the biopreparation reduced the activity of nutrient accumulation in plants, and in combination with mineral nutrition, the effect of using the biopreparation was the lowest, with an increase of +0.66 t/ha or 26.1%, but it was also significant (LSD_{05}=0.34 t/ha).

The highest increase in feed unit yield was observed when using the biopreparation without the application of fertilizers, with a growth rate of 0.51 t/ha or 25.7%. When mineral fertilizers were applied, this indicator decreased to 0.33 t/ha or 11.5%. The organic-mineral fertilizer system resulted in a negligible increase feed unit yield of +0.24 t/ha (LSD_{05}=0.27).

The factors we investigated had a slightly smaller impact on the increase in buckwheat productivity in terms of digestible protein collection. The highest indicator was obtained under the organic-mineral fertilizer system, at 0.27−0.27 t/ha. The application of mineral fertilizers provided a collection of 0.23−0.25 t/ha of digestible protein. There was a significant decrease in buckwheat productivity without the application of fertilizers, at 0.16−0.20 t/ha (Table 4).

The most significant increase in digestible protein yield was observed without the application of the biopreparation, with a growth rate of 0.11 t/ha or 69.6% for the organic-mineral fertilizer system and 0.07 t/ha or 42.2% for the mineral fertilizer system. The effectiveness of the biopreparation was significant, but the increase was smaller at 0.02−0.04 t/ha for LSD_{05}=0.02 t/ha.

Thus, the combined effect of fertilizer system and biopreparation determined higher buckwheat productivity. In the organic-mineral fertilizer system, the highest grain units yield, feed units, and digestible protein was obtained with seed treatment using the biopreparation, at 2.28 t/ha, 3.63 t/ha, and 0.29 t/ha respectively.

Table 4

Yield of digestible protein from buckwheat crop of Yaroslavna variety, average for 2021−2023

Fertilization system (Factor A)	Biopreparation (Factor B)	Digestible protein yield, t/ha	Difference, Factor A		Difference, Factor B	
			t/ha	%	t/ha	%
Without fertilizers	Without biopreparation	0,16	–	–	–	–
	Mycofriend	0,20	–	–	0,04	25,7
Mineral	Without biopreparation	0,23	0,07	42,2	–	–
	Mycofriend	0,25	0,05	26,1	0,03	11,5
Organic-mineral	Without biopreparation	0,27	0,11	69,6	–	–
	Mycofriend	0,29	0,09	44,3	0,02	6,9
LSD_{05} Factor A		0,03	–	–	–	–
LSD_{05} Factor B		0,02	–	–	–	–
LSD_{05} Interaction of factors AB		0,04	–	–	–	–

The mineral and organic-mineral fertilizer systems had a more effective impact on buckwheat productivity, resulting in an additional yield of 0.67−1.11 t/ha of grains, 2.85−3.40 t/ha of feed units, and 0.07−0.11 t/ha of digestible protein under these conditions.

Conclusions. The results of field research conducted from 2021 to 2023 in the conditions of the northern Steppe determined the influence of fertilizer system and the use of a biopreparation on the yield and productivity of buckwheat variety Yaroslavna. The following findings were established:

1. In favorable conditions for the crop in 2023, the yield of buckwheat ranged from 1.10 to 2.19 t/ha, while in 2022, it ranged from 1.02 to 2.09 t/ha. The least favorable conditions for buckwheat yield formation were observed in 2021, with a yield of 1.06 to 1.49 t/ha. The weather conditions of the study years determined the variability limits of buckwheat yield.

2. The fertilizer system had the most significant impact on buckwheat yield. The organic-mineral fertilizer system resulted in the highest yield of buckwheat at 1.62 t/ha, while the mineral fertilizer system provided a yield of 1.46 t/ha, significantly exceeding the yield without fertilizer application at 1.07 t/ha (LSD_{05}=0.07 t/ha).

3. The increase in yield due to the fertilizer system factor was highest at +0.56 t/ha or 50.7% for the organic-mineral system and +0.38 t/ha or 35.7% for the mineral system. Seed treatment with the biopreparation slightly reduced the effectiveness of fertilizer action, resulting in an additional yield of 0.46 t/ha or 36.5% and 0.28 t/ha or 22.4%, respectively, but the increase in yield was still significant (LSD_{05}=0.11 t/ha).

4. The most effective use of the biopreparation was observed without the application of fertilizers, resulting in an additional yield of buckwheat of 0.19 t/ha or 17.7%. Increasing nutrient content in the soil mitigated the effect of the biopreparation, and on the background of the organic-mineral fertilizer system, the increase in buckwheat yield was within the range of significant difference at +0.11 t/ha or 6.6%.

5. The combined effect of the fertilizer system and the biopreparation determined higher buckwheat productivity. In the organic-mineral fertilizer system, the highest grain units yield, feed units, and digestible protein was obtained with seed treatment using the biopreparation, at 2.28 t/ha, 3.63 t/ha, and 0.29 t/ha, respectively. The mineral and organic-mineral fertilizer systems had a more effective impact on buckwheat productivity, resulting in an additional yield of 0.67−1.11 t/ha of grain units, 2.85−3.40 t/ha of feed units, and 0.07−0.11 t/ha of digestible protein under these conditions.

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ОСОБЛИВОСТІ ПРОЯВУ АЛЬТЕРНАРІОЗУ НАГІДОК ЛІКАРСЬКИХ (*CALENDULA OFFICINALIS*) В УМОВАХ ЛІСОСТЕПУ УКРАЇНИ

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Однією з найбільш перспективних культур в сучасному лікарському рослинництві є нагідки лікарські. Їх суцвіття мають ряд властивостей: ранозагоюючі, протизапальні, бактерицидні, седативні, антитоксичні, спазмолітині та сечогінні, що робить їх важливою сировиною для фармацевтичної, косметичної та харчової промисловості.

У статті описано особливості прояву альтернаріозу на нагідках лікарських його збудників та проаналізовано вплив метеорологічних чинників на поширеність та розвиток даної хвороби.

Дана хвороба є однією з найбільш шкодочинних на нагідках лікарських, адже становить загрозу як для кількості так і для якості сировини. У роботі наведена інформація щодо основних збудників альтернаріозу нагідок лікарських, їх біологічних та екологічних особливостей розвитку, а також симптомах прояву.

Метою проведення досліджень було вивчення біологічних особливостей, поширеності і розвитку альтернаріозу нагідок лікарських для можливості в подальшому прогнозувати розвиток даної хвороби та ефективно її контролювати.

Систематичний моніторинг за фітосанітарним станом посівів лікарських культур є важливим елементом в системах захисту, адже необхідність контролю поширення та розвитку альтернаріозу є важливим кроком для прогнозування хвороби та вчасного застосування захисних засобів, в першу чергу біологічних фунгіцидів.

Найбільш поширеними збудниками альтернаріозу нагідок є гриби Alternaria zinnia і Alternaria calendulae. Також, трапляється ураження нагідок лікарських фітопатогенними грибами Alternaria alternata та Alternaria porri.