

## THE VALUE OF BIOLOGICAL PREPARATIONS IN INCREASING THE PROFITABILITY OF GROWING WINTER BARLEY IN THE CONDITIONS OF THE SOUTHERN STEPPE OF UKRAINE

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**Formulation of the problem.** In the cultivation of any agricultural crop, the decisive importance belongs not only to obtaining high productivity, but also stable indicators of economic efficiency. It is necessary to choose such measures and elements of technology that would ensure profitability at low costs, which is especially important given the current capacity of farms. The purpose of the research was to determine the most cost-effective biological preparations that were used for foliar feeding of plants of 4 varieties of winter barley in the main periods of growth and development. We consider this question relevant.

**Analysis of recent research and publications.** From time immemorial and at the present time, winter barley is considered one of the high-yielding grain crops, which occupies a leading place in the grain balance of the country. It is grown in almost all soil and climatic zones of Ukraine, but compared to other grain crops, in particular wheat, barley is the most demanding of soil fertility and reacts most significantly to optimization of nutrition. This is primarily due to the intensive accumulation of organic biomass and the relatively weakly developed root system, which is highly sensitive to the concentration of salts in the soil solution. This happens especially at the initial stages of plant growth and development. Today, in connection with climate changes and significant warming, the selection of winter barley varieties adapted to the soil and climate zone, which provide high yield and are frost-resistant, is becoming important. The level of yield of its grain is an equally important feature of the variety for the realization of the genetic potential of productivity.

It is possible to balance the nutrition of this crop and obtain a high-quality and at the same time high yield of grain at minimal costs. For this, effective management of the processes of formation of productivity of winter barley on the basis of resource conservation due to the use of biological preparations in the main phases of plant growth and development is necessary. In addition to growth processes and yield levels, each technological measure must be economically feasible and ensure profitability and profit.

Grain production in Ukraine traditionally belongs to the strategic branches of development not only of agriculture, but also of its entire national economic complex. The grain industry remains a priority area of the state's agricul-

tural economy and it is an important source of profitability for agricultural enterprises of various forms of ownership [1]. From the point of view of food security, the successful development great national economic importance, since the production of high-quality grain depends on providing the population with food products, livestock – with balanced and nutritious feed and for export needs. In connection with the change in the priorities of the development of modern steppe agriculture, associated with the increase in the price of energy and material resources, the change in the climatic conditions of the zone, the frequent placement of winter barley after atypical predecessors, the expansion of its cultivated area by more than 5 million ha in recent years, it appears the problem of improving the elements of the technology of growing this culture to reduce the burden on the environment on an economically profitable basis.

Biological preparations have long been known as a promising and effective component of any nutrition system. Despite the small rates of application, they resist the processes of soil fatigue, increase the resistance of plants to diseases, adverse weather conditions, enhance the assimilation of nutrients, and increase the grain yield [2, 3]. The use of biological preparations has significant advantages in terms of efficiency, ease of use, cost-effectiveness, environmental friendliness, etc.

Barley grain is one of the three most common types of grain, second only to corn and wheat. It enjoys stable demand from domestic and foreign consumers. Observing the technology of growing barley provides not always high, but stable income. Producers worry not only about high yields, but also about the quality of grain, which determines its value. Recently, the use of effective and environmentally safe growth regulators, microbial preparations that increase the resistance of agricultural crops to disease, sharp changes in temperature and productivity potential is becoming more and more widespread. The issue of determining the economic efficiency of their use in winter barley cultivation technologies requires a separate analysis [4].

In order to save resources, increase yields, improve quality and obtain significant profits from grown products, in the current period, according to many researchers, it is most economically profitable to apply mineral fertilizers,

biological preparations, compatible with physiologically active substances and microelements [5, 6].

Increasing the economic efficiency of grain production in Ukraine is an extremely urgent problem. Most grains are grown in the southern zone, which is favorable for obtaining stable levels of high-quality crops. In the general structure of crops, winter wheat occupies larger areas in the region. For example, in the Mykolaiv region, wheat accounts for 39.8-46.3% in recent years, and winter barley 22.1-27.0% [7]. The author certifies that the issue of increasing the level of grain production efficiency should be resolved both at the state and regional levels. At the same time, the area of winter grain crops in the Mykolaiv region varies from 65.1 to 71.7% in most years, and according to methodological recommendations, their specific weight should not exceed 60% of the arable area [8].

The grain economy of Ukraine is a priority and competitive industry on the world and domestic markets, which determines the development and food security of each region. Winter barley is a reliable guarantor of strengthening the potential of the grain-forage balance. The main task is to increase the productivity of each hectare of land with high economic efficiency.

Scientists and agrarians have worked out the main elements of technologies for growing winter crops quite widely. In particular, the increase in grain yield of winter plants and economic efficiency are significantly influenced by the background of mineral nutrition, the predecessor, features of the variety, methods of soil cultivation, sowing dates, etc. [9-14]. The higher their yield, the more favorable the economic indicators will be [15-21].

In the Southern Steppe zone of Ukraine, there are years with unfavorable overwintering conditions for winter crops, then winter barley is replanted in its spring form. For this type of barley, the elements of the technology have also been worked out, which allow obtaining stable grain productivity and high indicators of economic efficiency [22-24].

However, significantly higher levels of grain yield are formed by winter barley, and especially with the selection of productive varieties, the improvement of the nutrition background, which was particularly established by our research [25-27]. Many studies with different types of agricultural crops have determined that a number of factors affect their productivity. It very significantly depends on the state of soil fertility, the use of mineral fertilizers [28-30], biopreparations [31-33], other elements of technology and the selection of varietal composition and weather [34, 35], and climatic conditions [36-38].

Of course, and we have already mentioned this, the higher the level of productivity of any agricultural crop, the more optimal will be the indicators of the economic efficiency of its cultivation. If the measures included in the technology elements are energy-saving, then with their participation the level of profitability will increase, which also applies to winter grain crops, winter barley in particular [39-41].

**The purpose and tasks of research.** The purpose of the research was to determine the impact of optimizing nutrition with modern biopreparations of four varieties of winter barley on the economic indicators of growing

this crop on southern chernozem in the conditions of the Southern Steppe of Ukraine.

**Research materials and methods.** Research was conducted with four varieties of winter barley during 2016-2019 at the Educational and Scientific Practical Center of the Mykolaiv National Agrarian University.

The varieties selected for study were sown at the optimum time for this climatic zone. The research was conducted at the Educational and Scientific Practical Center of the Mykolaiv National Agrarian University. The soil of the experimental plots is southern chernozem, which has an average supply of mobile nutrients, the content of humus in the 0-30 cm soil layer is 2.9-3.2%, pH-6.8-7.2. The scheme of the experiment included the following options: Factor A – variety: 1. Dostoyny; 2. Valkyrie; 3. Oscar; 4. Jason; Factor B – foliar feeding: 1. Control (water treatment); 2. Azotophyte; 3. Mikofrend; 4. Melanoriz; 5. Organic-Balance. Research with the latest biological preparation was carried out in 2017-2018 and 2018-2019. The rate of use of the drug was 200 g/ha, and the working solution was 200 l/ha. Foliar fertilizing of winter barley was carried out once in the phase of spring tillering and twice during the growing season, in addition to tillering, also at the beginning of the emergence of plants in the tube.

The area of the sown plot is 72 m<sup>2</sup>, the accounting area is 30 m<sup>2</sup>, the experiment is repeated four times. Winter barley was sown after peas. Taking into account the importance of the predecessor and the availability of soil nutrients, mineral fertilizers were not applied. The agricultural technique of growing winter barley was generally accepted for the Southern Steppe zone of Ukraine, except for the factors taken for study [42, 43].

**Research results.** We determined the main indicators of the economic efficiency of the use of biological preparations for the researched varieties of winter barley: the cost of gross production, the cost of growing a unit of production, the level of profitability of production. It has been established that the use of complex biological preparations twice in the main periods of winter barley plant development (in the phase of spring tillering and at the beginning of the emergence of plants into the tube) increases the efficiency of crop cultivation and ensures an increase in the level of profitability.

It was determined that the cost of gross production for the cultivation of winter barley varied to a certain extent depending on the varietal composition and biological preparations, which is associated with fluctuations in the grain yield levels according to the variants. With fertilizing, and especially in both phases, this indicator increased regardless of the variety (Table 1).

In the control, and especially with the cultivation of the Yason variety, this indicator was the lowest – 18.4 thousand/ha, and when using the biological preparation Organic-Balance on sowing the Valkyrie variety in both phases, it increased to 26.5 thousand/ha or by 44.0% and was the maximum. Cultivation of the Oscar variety provided these indicators at the levels of 26.3 thousand/ha and 42.9%.

The highest value of gross production on average for all variants over the years of research – 23.9 thousand/ha was provided by the cultivation of the Oscar winter barley vari-

Table 1

Cost of gross output when growing winter barley grain, depending on the varietal composition and growth-regulating preparations, (average for 2017-2019 yrs) UAH thousands / ha

Nutrition variant (factor B)	Varieties (factor A)				
	Dostoiny	Valkyrie	Oscar	Jason	Average for B
Control (water treatment)	18,7	20,1	21,1	18,4	19,6
Azotophit I	21,4	24,0	24,2	20,6	22,5
Azotophit I+II	22,6	25,0	25,0	22,3	23,7
Mycofriend I	21,2	22,8	23,1	20,1	21,8
Mycofriend I+II	21,6	23,7	24,5	20,8	22,7
Melanoriz I	19,8	21,3	22,3	19,2	20,6
Melanoriz I+II	20,3	22,5	22,8	20,3	21,5
Organic-Balance I	20,4	25,2	25,8	22,6	23,5
Organic-Balance I+II	21,4	26,5	26,3	23,5	24,4
Average for A	20,8	23,4	23,9	20,9	22,3

Note: foliar top dressing with growth-regulating biologics:  
 I – in the spring tillering phase;  
 I + II – in the tillering phase and at the beginning of stooling

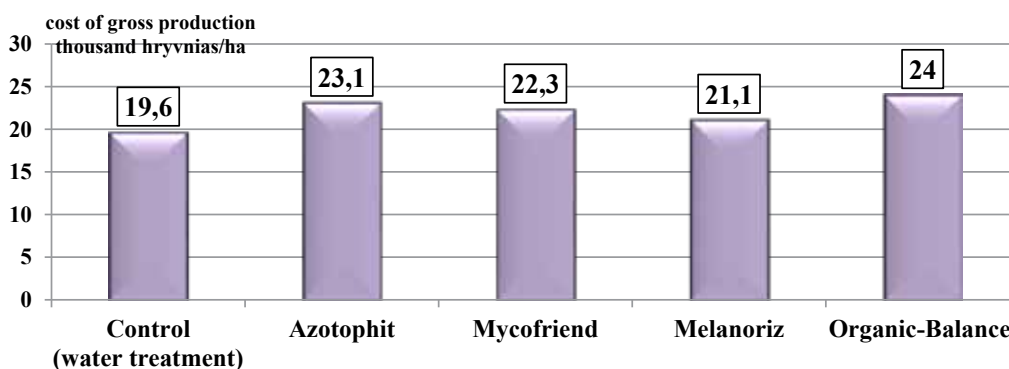


Fig. 1. Cost of gross products under the influence of biological preparations (average by varieties for 2017-2019), thousand UAH/ha

\*for 2017-2019 yrs.

ety. In the Valkyrie variety, it amounted to 23.4 thousand/ha, and in the Dostoiny variety, it decreased to 20.8 thousand hryvnias/ha, or by 14.9%. Practically the same amount was determined for the cultivation of Yason winter barley – 20.9 thousand/ha.

Fertilization with Organic-Balance biological preparation twice during the growing season ensured an increase in the value of gross production for all varieties to UAH 24.4 thousand/ha, which is 24.5% more compared to the control option (treatment of crops with water).

The effectiveness of the use and advantages of biological preparations, which are taken for research, is illustrated in Fig. 1, which shows the average values of the cost of grown products for carrying out one and two treatments of weeding plants.

The cost of growing 1 ton of winter barley grain is a minimum of UAH 1.7 thousand. determined by the Valkyrie variety after a one-time sowing treatment with the drug Azotophit (Table 2). This indicator increased to 2.29 thousand hryvnias/t or by 32.9% when growing the Yason variety treated with the same biological preparation in the spring budding phase.

In terms of varietal composition, Valkyrie and Oscar varieties had an advantage in forming the minimum cost values of 1 ton of sunflower seeds at the level of 1.87 thousands UAH. On other varieties studied, this indicator increased up to 2.15 UAH thousands / ton, or by 14.9%.

On average, according to the background of nutrition (Factor B), the lowest cost of 1 ton of seeds of the studied crop at the level of 1.89 thousand UAH was recorded in the version with the introduction of the biologic Organic-Balance according to a single scheme. The increase in this indicator by 14.2% (up to 2.16 UAH thousands/ton) was in the version with double use of Melanoriz for feeding sunflower seeds.

In the conditions of a market economy, one of the main criteria for the economic efficiency of technological processes is the obtaining of conditional net profit and the level of profitability.

A comparison of indicators of conditional net profit shows that it was the lowest (10,000 hryvnias/ha) when growing the Yason variety with a one-time feeding with the biopreparation Melanoriz during the tillering phase

Table 2

Cost of 1 ton of winter barley grain, depending on the influence of the studied factors, (average for 2017-2019 yrs.) UAH thousands

Nutrition variant (factor B)	Varieties (factor A)				
	Dostoyny	Valkyrie	Oscar	Jason	Average for B
Control (water treatment)	1,99	1,87	1,80	2,02	1,92
Azotophit I	2,20	1,70	1,98	2,29	2,04
Azotophit I+II	2,21	1,74	1,72	2,23	1,98
Mycofriend I	2,06	1,92	1,90	2,16	2,01
Mycofriend I+II	2,14	1,97	1,91	2,22	2,06
Melanoriz I	2,19	2,05	1,96	2,25	2,11
Melanoriz I+II	2,27	2,07	2,04	2,27	2,16
Organic-Balance I	2,13	1,76	1,72	1,94	1,89
Organic-Balance I+II	2,16	1,78	1,79	1,99	1,93
Average for A	2,15	1,87	1,87	2,15	2,01

Note: foliar top dressing with growth-regulating biologics:

I – in the spring tillering phase;

I + II – in the tillering phase and at the beginning of stooling

Table 3

Conditional net profit for growing winter barley grain depending on the varietal composition and growth-regulating preparations, UAH thousands/ha (average for 2017-2019 yrs.)

Nutrition variant (factor B)	Varieties (factor A)				
	Dostoyny	Valkyrie	Oscar	Jason	Average for B
Control (water treatment)	10,8	12,1	13,0	10,5	11,6
Azotophit I	11,4	15,3	14,0	10,6	12,8
Azotophit I+II	12,0	15,7	15,8	11,7	13,8
Mycofriend I	11,9	13,5	13,8	10,9	12,5
Mycofriend I+II	11,8	13,8	14,6	11,0	12,8
Melanoriz I	10,6	12,0	13,0	10,0	11,4
Melanoriz I+II	10,5	12,6	12,9	10,5	11,6
Organic-Balance I	11,1	15,8	16,3	13,2	14,1
Organic-Balance I+II	11,6	16,4	16,3	13,5	14,4
Average for A	11,3	14,1	14,4	11,3	12,8

Note: foliar top dressing with growth-regulating biologics:

I – in the spring tillering phase;

I + II – in the tillering phase and at the beginning of stooling

(Table 3). A significant increase of this indicator to 16.4 thousand hryvnias/ha or by 64.0% was provided by the Valkyria variety after two-time treatment of crops with the biological preparation Organic-Balance.

The average factorial values proved the advantage of the Oscar variety, which provided an increase in conditional net profit to 14.4 UAH thousands / ha, which was 27.4% more than the lowest level for the worthy and Jason varieties as 11.3 UAH thousands / ha.

Regarding Factor B (nutrition background), the advantage of double treatment of crops with Organic-Balance was proved, which contributed to an increase in the studied indicator up to 14.4 UAH thousands / ha. The minimum level of conditional net profit (11.4 UAH thousands / ha) was obtained in the version with a single top dressing with the biologic Melanoriz. Fig. 2 is a clear confirmation of the advantages of the biological preparation Organic-Balance and, on the contrary, the lowest efficiency in ensuring the conditional net profit from Melanoriz.

An extremely important indicator of economic efficiency is the profitability of culture production.

The level of profitability of the elements of the winter barley grain cultivation technology, depending on the varietal composition and biopreparations, ranged from 105.4% in the version with the Yason variety with one-time treatment of sowing with the biopreparation Azotophyt. In the Valkyrie variety in the same variant, it increased to 177.1%, or the difference between these identical variants of feeding with Azotophyte in the phase of spring tillering was 68.0 relative percent (Table 4).

On average, in relation to the varietal composition, the investigated indicator reached the highest level of 152.0 and 152.2% for the cultivation of Oscar and Valkyrie varieties, respectively. The Dostoiny and Yason varieties have a significantly lower profitability level of 118.9; 119.2% or 27.5-28.0 percent less compared to Valkyrie and Oscar varieties.

According to power options, the lowest level of profitability is determined an average of 118.1% for a two-time

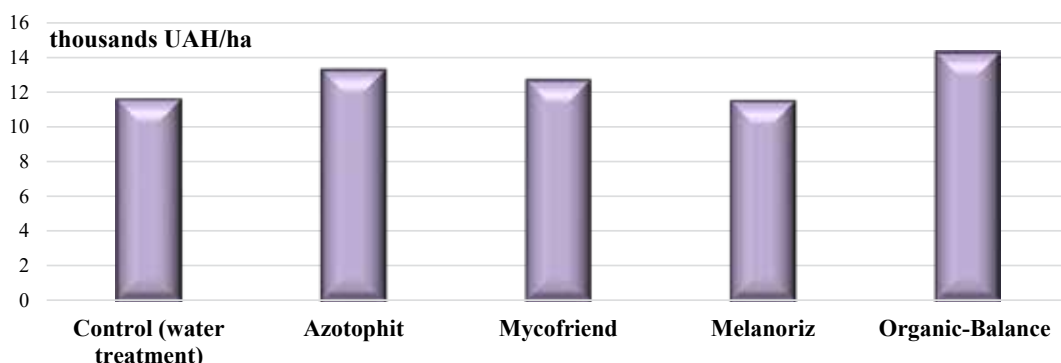


Fig. 2. Conditional net profit depending on the biological preparation (average by varieties for 2017-2019), thousand UAH/ha

Table 4

The level of profitability of the winter barley grain cultivation technology depending on the varietal composition and biological preparations (average for 2017-2019), %

Nutrition variant (factor B)	Varieties (factor A)				
	Dostoyny	Valkyrie	Oscar	Jason	Average for B
Control (water treatment)	136,2	150,9	160,5	133,2	145,2
Azotophit I	113,4	177,1	136,8	105,4	133,2
Azotophit I+II	113,0	170,7	172,7	110,3	141,7
Mycofriend I	128,2	144,2	147,4	118,0	134,5
Mycofriend I+II	119,4	138,8	146,0	111,9	129,0
Melanoriz I	114,8	129,6	139,2	108,7	123,1
Melanoriz I+II	107,1	127,6	130,6	107,1	118,1
Organic-Balance I	120,4	167,6	172,5	142,0	150,6
Organic-Balance I+II	117,6	163,3	162,1	136,2	144,8
Average for A	118,9	152,2	152,0	119,2	135,6

Note: foliar top dressing with growth-regulating biologics:

I – in the spring tillering phase;

I + II – in the tillering phase and at the beginning of stooling

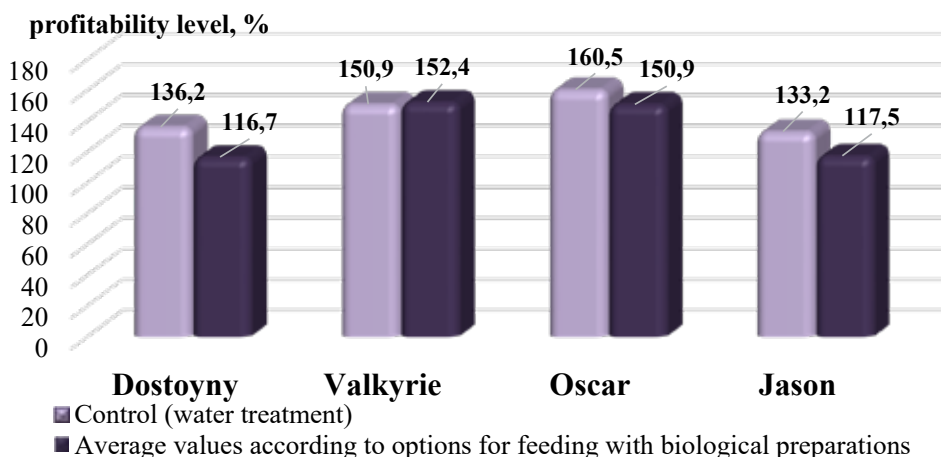


Fig. 3. The level of profitability of growing winter barley depending on foliar fertilizing with biological preparations (average for 2016-2019), %

application for feeding the drug Melanoriz. This indicator exceeded 150% for a one-time feeding with the biological preparation Organic-Balance. This testifies to the high eco-

nomical efficiency of foliar fertilizing of plants of winter barley varieties with the biological preparation Organic-Balance, and the use in both phases is 144.8%.

It should also be noted that the use of Organic-Balance for top dressing, and especially in the spring tillering phase, increased the profitability of growing all studied winter barley varieties, with the exception of the Dostoiny variety, the cultivation of which reached the highest profitability in the control variant for the treatment of sowing plants with water without the use of biological preparations. The reaction of winter barley varieties to foliar fertilization is presented in Fig. 3.

**Conclusions.** Conducting research with varieties of winter barley and further determining the economic efficiency regarding the use of modern biological preparations for foliar feeding of plants of this culture, it was established that it is most appropriate to grow Valkyria and Oscar varieties. Among biological preparations, the highest indicators of the cost of grown products, conditional net profit, level of profitability and the lowest production costs per product unit are provided by Organic-Balance, followed by Azotophyt.

Only Organic-Balance and Azotophyt provide an increase in the value of the crop and obtaining a conditionally net profit for carrying out two-time feeding in the phase of tillering and at the beginning of the emergence of plants in the tube.

Mycofriend and Melanoriz, when used for feeding, provide significantly lower indicators of economic efficiency in the cultivation of all varieties of winter barley.

Thus, it is expedient to recommend the production to grow Valkyrie and Oscar winter barley varieties, and to use Organic-Balance and Azotophyt from biological preparations.

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Гамаюнова В.В., Кувшинова А.О., Бакланова Т.В.  
**Значення біопрепаратів у підвищенні рентабельності вирощування ячменю озимого в умовах Південного Степу України**

**Мета.** Визначити основні показники економічної ефективності вирощування ячменю озимого, встановити вплив на її складові сортових особливостей та ресурсощадного живлення з використанням сучасних біопрепаратів для позакоренових підживлень посіву рослин у основні періоди вегетації. **Методи.** Дослідження з чотирма сортами ячменю озимого проводили в навчально науково практичному центрі Миколаївського національного аграрного університету на чорноземі південному. Дослід двофакторний, фактор А- сорт: 1. Достойний (стандарт); 2. Валькірія; 3. Оскар; 4. Ясон. Фактор В – позакореневі підживлення: 1. Контроль (обробка водою); 2. Азотофіт; 3. Мікофренд; 4. Меланоріз; 5. Органік баланс. Агротехніка вирощування ячменю озимого була загальноприйнятою, окрім факторів, що взято на вивчення. Усі елементи технології та визначення проводили відповідно методичних зональних рекомендацій та ДСТУ. **Результати.** Проаналізовано вплив добору сорту й проведення позакоренових підживлень взятими на дослідження біопрепаратами на складові чинники економічної ефективності. Встановлено, що вартість вирощеного зерна ячменю озимого істотно змінювалася і коливалася залежно від сорту, біопрепарату, фази його використання та кількості підживлень. Аналогічно за впливу зазначених заходів змінювалися й показники умовно чистого прибутку, рівня рентабельності та собівартості. Проте із залученням для підживлення біопрепаратів перші два чинники економічної ефективності збільшувалися, а собівартість вирощування одиниці продукції, навпаки, знижувалася. Найсприятливіші економічні показники забезпечувало вирощування сортів Валькірія та Оскар, а із біопрепаратів – використання Органік балансу і Азотофіту. **Висновки.** Встановлено, що ресурсощадна оптимізація живлення ячменю озимого позитивно позначалася на всіх чинниках, які характеризують економічну ефективність і рентабельність вирощування цієї культури. Вони залежали і змінювалися за впливу сорту, дібраного для позакоренової обробки біопрепарату та кількості підживлень.

**Ключові слова:** ячмінь озимий, сорт, біопрепарати, позакореневе підживлення, економічна ефективність, умовно чистий прибуток, рівень рентабельності, вартість урожаю, собівартість вирощування.

Gamayunova V.V., Kuvshinova A.O., Baklanova T.V.  
**The importance of biological preparations in increasing the profitability of growing winter barley in the conditions of the Southern Steppe of Ukraine**

**Goal.** To determine the main indicators of the economic efficiency of growing winter barley based, to establish the influence on its components of varietal characteristics and resource-saving nutrition using modern biological preparations for foliar feeding of plants in the main growing seasons. **Methods.** Research with four varieties of winter barley was carried out in the educational, scientific and practical center of the Mykolaiv National Agrarian University on the southern chernozem. The test is two-factor, factor A – grade: 1. Decent (standard); 2. Valkyrie; 3. Oscar; 4. Jason. Factor B – foliar feeding: 1. Control (water treatment); 2. Azotophyte; 3. Mycofriend; 4. Melanosis; 5. Organic-Balance. The agricultural technique of growing winter barley was generally accepted, except for the factors taken into consideration. All elements of technology and definitions were carried out in accordance with methodical zonal recommendations and DSTU. **The results.** The impact of variety selection and foliar fertilizing with biological preparations taken for research on the components of economic efficiency was analyzed. It was established that the cost of grown winter barley grain significantly changed and fluctuated depending on the variety, biological preparation, the phase of its use and the number of feedings. Similarly, under the influence of the mentioned measures, indicators of conditional net profit, level of profitability and cost price also changed. However, with the involvement of biological preparations for feeding, the first two factors of economic efficiency increased, and the cost of growing a unit of production, on the contrary, decreased. The most favorable economic indicators were provided by the cultivation of Valkyrie and Oscar varieties, and from biological preparations – the use of Organic-Balance and Azotofit. **Conclusions.** It was established that the resource-saving optimization of winter barley nutrition had a positive effect on all factors that characterize the economic efficiency and profitability of growing this crop. They depended and changed under the influence of the variety selected for foliar treatment of the biological preparation and the number of feedings.

**Key words:** winter barley, variety, biological preparations, foliar fertilization, economic efficiency, conditional net profit, level of profitability, cost of harvest, cost of cultivation.