

ECONOMIC EFFICIENCY OF GROWING WINTER BARLEY (*HORDEUM VULGARE* L.) DEPENDING ON SOWING DATES AND SEEDING RATES

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Topicality. Nowadays, profitable agricultural production requires a comprehensive analysis of the feasibility of each agrotechnical technique of cultivation of field crops, including winter barley (*Hordeum vulgare* L.). In market conditions, the main criterion for choosing a technology for growing a particular crop is economic efficiency. Therefore, a competitive technology is the one that provides the highest profitability and profit. **Purpose.** Investigation of the influence of agrotechnical practices on the level of economic efficiency of growing winter barley. **Methods.** The field experiments were laid out and carried out in accordance with the generally accepted methodology of research. In the experiments, the winter barley of Deviatyval variety was sown, followed by sunflower as a predecessor. Sowing was carried out in four dates: 20, 30 September and 10, 20 October with seeding rates of 4.5, 5.0, 5.5, 6.0 million germinable seeds/ha. **Results.** On average, over the years of research (2017–2019), the best economic output was obtained by sowing winter barley on 30 September. As a result, the highest grain yield was 5.28–5.52 t/ha with a profitability level of 71.6–82.6 %. Sowing on 20 October in all variants of the experiment resulted in the lowest cost recovery when growing winter barley on a non-fallow predecessor, and the profitability level ranged from 16.1–21.7 % depending on the seeding rate. Sowing on 30 September resulted in the highest profit of 9321–10562 UAH/ha, which is 7375–7958 UAH/ha more compared to the variants with sowing dates at the end of the second ten days of October. **Conclusions.** We found that the economic indicators during the years of research were influenced by the grain yield of winter barley depending on the technological practices of its cultivation in the Northern Steppe of Ukraine. The research aimed at determining the economic efficiency of growing winter barley after sunflower, depending on the sowing dates and seeding rates, found that the variant with sowing on 30 September, where the highest grain yield was obtained, was more profitable. The sowing date with a seeding rate of 5.0 million seeds/ha provided the highest profitability (82.6%), and the net income reached 10562 UAH/ha.

Key words: winter barley, sowing dates, seeding rates, yield, economic efficiency

Introduction. Today, the grain industry plays an important role in the agricultural sector of Ukraine, providing raw materials for the food and livestock industries, and is one of the most effective strategic areas of the national economy. Grain and products of its processing are a solid foundation for both food and national security of the country [1–3].

In view of this, the investigation of the economic efficiency of grain production at agricultural enterprises and the search for ways of improving it is particularly relevant [4–6]. The development and implementation of modern highly efficient technologies for growing winter barley is relevant due to fluctuations in prices for material resources in the agricultural

sector of the economy. These technologies should meet such requirements as a significant increase in grain productivity, lower costs and higher profitability of grain production in order to be optimally adapted to the conditions of the modern agricultural market.

Evaluation of economic efficiency provides a clear description of all factors and techniques involved in the crop cultivation technology.

This indicator considers all quantitative and cost components and allows us to establish the feasibility or impracticability of implementing a certain technological element of crop cultivation [7, 8].

At the current stage of development of the Ukrainian agricultural sector, the cultivation of

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crops, in particular winter barley, after sunflower is quite common in the Steppe region of Ukraine, which is an extremely undesirable phenomenon [9, 10].

During the 1990s and the first decade of the new millennium, a sharp redistribution of sown areas took place in the Ukrainian agricultural sector in favour of oilseeds, especially sunflower as the most profitable and highly liquid crop. Before 1990, sunflower areas totalled about 1.6 million hectares, and in recent years they have increased significantly to 6.0 million hectares [11].

After this predecessor, the technological aspects of producing high-quality grain are quite energy-intensive, requiring a whole range of additional operations. One of the ways to reduce material and labour costs and maximise net profit is increasing the crop yield. The development of new and improvement of existing technological methods of winter barley cultivation allow us to obtain high quality grain.

In recent years, the cost of winter barley grain has been steadily rising due to a sharp increase in prices for fuel, agricultural machinery, fertilisers and pesticides. Given the shortage of funds on agricultural farms, the most efficient ways to make a profit from growing winter barley at minimal cost need to be identified.

Improvement in production profitability depends on the cost and price of products, and the price depends on the quality of the product. Higher quality leads to higher sales prices, higher profits and profitability, and therefore higher efficiency of production.

The unstable price situation in the market of material and technical resources requires attention to the optimal implementation of basic agrotechnological works in compliance with the recommendations of scientists, which is the key to cost savings [13].

The sowing dates and seeding rates of winter barley are important factors contributing to the grain yield and quality of the crop. Moreover, these techniques are not associated with additional costs. Determining the optimal sowing dates and seeding rates for winter barley after sunflower allows agricultural producers to partially solve the tasks aimed at increasing gross output with minimal labour and material resources.

This research was aimed at determining

the influence of sowing dates and seeding rates on the economic efficiency of winter barley cultivation after sunflower in the Northern Steppe zone of Ukraine.

Materials and Methods. The Laboratory of Agrobiological Resources of Winter Cereals conducted the field trials on the areas of the State Enterprise Research Farm "Dnipro" at the SE Institute of Grain Crops of NAAS in 2016–2019. The soil of the experimental plots is represented by ordinary low-humus medium loamy chernozem on loess with a humus content of 3.3–3.5 % in the topsoil, a total nitrogen content of 0.18–0.20 %, mobile phosphorus of 90–120 mg/kg and exchangeable potassium of 70–120 mg/kg of absolutely dry soil (according to the Chirikov criterion). The climate of the zone is temperate continental with insufficient and unstable humidity.

The research was conducted in a two-factor field experiment. Factor A (sowing dates) was studied on plots of the first order, sowing was carried out in four terms with a gradation of 10 days: 20 and 30 September, 10 and 20 October. Factor B (seeding rates) was studied on plots of the second order. Four seeding rates were sown with a gradation of 0.5 million germinating seeds per hectare: 4.5; 5.0; 5.5; 6.0 mln seeds/ha. The experiment was laid out with using the sequential design, in a systematic method. The registration plot area was 40 m², experiments were repeated three times.

In the experiments, the Deviatyi val variety of winter barley zoned for the Steppe zone was studied, which belongs to the varieties of alternate wheat.

The technology of crop cultivation is generally accepted for the northern part of the Steppe of Ukraine, except for the problems posed for study.

After harvesting the sunflower, the crop residues were qualitatively chopped and partially incorporated into the soil with disc harrows or heavy disc harrows BDT-7. Subsequently, shallow tillage was carried out with KPE-3.8 cultivators to a depth of 10–12 cm. In the pre-sowing cultivation, background fertilizer was applied at a rate of N₆₀P₆₀K₃₀ kg a.i./ha. Feeding of winter barley plants was carried out with nitrogen fertilizers in rate of N₃₀ kg a.i./ha (ammonium nitrate with N of 34.4 %) on freeze-thawed soil. Harrowing was used to reduce the

number of weed plants, destroy the soil crust and levelling the soil after weed germination and falling precipitation

Pre-sowing treatment of winter barley seeds with Vitavax 200 FF fungicide at the dose of 2.5 l/t of seeds was carried out. The seeds were sown with a mounted laboratory seeder SN-16 in combination with a T-25 tractor, without a time gap after pre-sowing cultivation. The sowing was performed in a continuous row method, with 15 cm row spacing and depth of seed placement of 5–6 cm. In order to improve the germination conditions, the soil was compacted with ZKSh-6A sprocket packers. The crop was harvested with a Sampo-500 combine harvester in the full ripeness stage.

During the research, we used the methodology of B. A. Dospekhov [14] and the methodological recommendations of the All-Union Research Institute of Maize for conducting field experiments with cereals, grain legumes and fodder crops [15]. The economic evaluation of the research results was carried out according to generally accepted methods [16, 17].

The cost of production was calculated using the purchase price of winter barley grain as of September 2019. The purchase price of one tonne of winter barley grain was UAH 4,230.

The economic analysis of the efficiency of winter barley cultivation after sunflower included mandatory consideration of the costs of purchasing and transporting seed material, plant protection products, general production costs and costs of harvesting and post-harvest grain processing according to the average weighted prices of the 2019 marketing year for the production conditions of the Steppe zone.

Results and Discussion. On average, over 2017–2019, the best economic results in winter barley cultivation were obtained in variants with a sowing date of 30 September. At this sowing date, the highest grain yield of 5.28–5.52 t/ha was formed at a profitability level of 71.6–82.6 %.

The lowest cost recovery for winter barley cultivation on the non-fallow predecessor was obtained in all experimental variants for a sowing date of 20 October. The level of profitability of grain production at this sowing date was minimal and ranged from 16.1–21.7 % depending on the seeding rates (Table 1).

The profit for this sowing date was 1946–2604 UAH/ha, which is 3198–3367 UAH/ha less compared to the variants that were sown in the late September. Instead, the value of this indicator for sowing date of 30 September was

Table 1. Economic efficiency of winter barley cultivation depending on sowing dates and seeding rates (average for 2017–2019)

Sowing date	Seeding rate, mln seeds/ha	Yield, t/ha	Costs per 1 ha, UAH	Cost price 1 ton of grain, UAH	Net income per 1 ha, UAH	Profitability level, %
20 September	4.5	4.06	11937	2940	5237	43.9
	5.0	4.30	12218	2841	5971	48.9
	5.5	4.20	12340	2938	5426	44.0
	6.0	4.17	12495	2996	5144	41.2
30 September	4.5	5.24	12488	2383	9677	77.5
	5.0	5.52	12787	2317	10562	82.6
	5.5	5.40	12900	2389	9942	77.1
	6.0	5.28	13013	2465	9321	71.6
10 October	4.5	4.28	12040	2813	6065	50.4
	5.0	4.46	12293	2756	6573	53.5
	5.5	4.55	12503	2748	6743	53.9
	6.0	4.33	12569	2903	5746	45.7
20 October	4.5	3.20	11535	3605	2001	17.3
	5.0	3.27	11737	3589	2095	17.9
	5.5	3.45	11990	3475	2604	21.7
	6.0	3.32	12098	3644	1946	16.1

the highest and varied between 9321–10562 UAH/ha, depending on the seeding rates.

The cost of winter barley at the late sowing date (20 October) in the variants where sowing was carried out at a rate of 5.0 million seeds per hectare exceeded this figure in the same variant at the optimal sowing date (30 September) by UAH 1272. The difference in the profitability level in the above variants was 64.7 p.p. Sowing winter barley at both early and late sowing dates led to a significant decrease in economic efficiency.

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Актуальність. У сучасних умовах прибуткове ведення сільськогосподарського виробництва не можливе без всебічного аналізу доцільності кожного агротехнічного заходу технологій вирощування польових культур, у тому числі й ячменю озимого (*Hordeum vulgare* L.). У ринкових умовах основним критерієм вибору технології вирощування тієї чи іншої культури є економічна ефективність. Тому конкурентоспроможною буде та технологія, яка забезпечить найбільшу рентабельність та прибуток. **Мета роботи.** Виявлення впливу агротехнічних заходів на рівень економічної ефективності вирощування ячменю озимого. **Матеріали та методи.** Закладку і проведення польових дослідів здійснювали у відповідності до загальноприйнятої методики дослідної справи. В дослідях висівали сорт ячменю озимого – Дев'ятий вал (*Dev'iatyi val*), по попереднику – соняшник. Сівбу проводили в 4 строки: 20, 30 вересня та 10, 20 жовтня з нормами висіву 4,5; 5,0; 5,5; 6,0 млн шт. схожих насінин/га. **Результати.** У середньому за роки проведення досліджень (2017–2019 рр.), найкращі економічні результати при вирощуванні ячменю озимого були отримані за сівби 30 вересня з найвищою врожайністю зерна 5,28–5,52 т/га, з рівнем рентабельності – 71,6–82,6 %. За сівби 20 жовтня по всіх варіантах дослідів отримали найнижчу окупність витрат при вирощуванні ячменю озимого після соняшника, і рівень рентабельності змінювався в межах 16,1–21,7 % залежно від норми висіву насіння. Максимальний прибуток (9321–10562 грн/га) одержали за сівби 30 вересня, що на 7375–7958 грн/га більше порівняно з варіантами за сівби 20 жовтня. **Висновки.** Встановлено, що економічні показники, в роки досліджень, визначалися урожайністю зерна ячменю озимого залежно від технологічних заходів його вирощування в умовах Північного Степу України. За результатами досліджень з визначення економічної ефективності вирощування ячменю озимого після соняшника залежно від строків сівби та норм висіву насіння було встановлено, що більш рентабельним був варіант дослідів, де одержували максимальний рівень зернової продуктивності культури – сівба 30 вересня. Сівба за цього строку з нормою висіву 5,0 млн. шт/га. забезпечувала максимальний рівень рентабельності (82,6 %), а чистий дохід становив –10562 грн/га.

Ключові слова: ячмінь озимий, строки сівби, норми висіву, урожайність, економічна ефективність