

EFFICIENCY OF SPRING WHEAT CULTIVATION IN SHORT-ROTATION ORGANIC CROP ROTATION UNDER LEFT-BANK FOREST-STEPPE CONDITIONS

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Aim. To determine the impact of predecessors and different types of organic fertilizer systems on the yield and quality of spring wheat grain in a short-rotation crop rotation and its economic efficiency of its cultivation. **Methods.** The technology for growing crops is generally accepted and recommended for the zone of research, permissible in organic farming. The experiment sows varieties and hybrids of crops listed in the State Register. **Results.** According to the research results, conducted in the stationary field experiment on the study of short-rotation organic crop rotations on typical chernozem with unstable moisture in the Left-Bank Forest-Steppe in 2022–2023, it was found that the yield of spring wheat grain grown in crop rotation soybean (*Glycine max* (L.) Merrill) – spring wheat (*Triticum aestivum* L.) – buckwheat (*Fagopyrum esculentum* Moench) depending on various types of organic fertilization ranged from 2.22 to 3.08 t/ha with a protein content of 13.53–14.14 %, gluten content of 29.00–32.17 %, and fat content of 1.78–2.02 %, respectively. **Conclusions.** The maximum conditional net profit of 6.89 thousand UAH/ha with a profitability level of 181 % was provided by the comprehensive application of organic fertilizers, which includes the incorporation of the by-products of the predecessor, green manure sowing, and bio fertilizers «Bio-Hel» at a dose of 3.0 l/ha.

Key words: crop, fertilizers, yield, grain quality, economic efficiency, profitability.

Introduction. The main goal of modern agricultural production is to ensure the population is provided with high-quality food products while preserving the environment. Therefore, it is essential to reduce the negative impact of agricultural production on the environment, which is associated with the depletion of natural resources and their pollution due to the use of foreign resources in the agricultural sector (pesticides, mineral fertilisers, and GMOs).

The intensification of the economic crisis against the backdrop of environmental problems requires agribusinesses to urgently and radically change the technologies for growing agricultural crops towards their ecological sustainability and resource conservation while ensuring profitable production.

Ensuring producers of organic products with scientifically grounded, competitive cultivation technologies adapted to regional conditions is a pressing issue in the current environment.

Analysis of recent research and publications. Agro ecological challenges drive scientists worldwide to seek alternative farming systems. Many renowned researchers believe that organic farming - which produces

environmentally safe agricultural products, represents an «alternative» approach to agriculture. This method avoids synthetic chemical fertilizers and pesticides, ensuring a closed production cycle that leads to natural and resource-saving effects [1–3].

Agriculture and crop production, which prioritize biological and agro technical methods, have recently been termed biological farming. This farming system is also referred to as alternative, ecological, organ-biological, or ANOG (the Association for the Cultivation of Organic Fruit, Vegetables and Field Crops) system in the literature. Despite the different terminologies, the core principle remains the same - producing environmentally clean products and preserving environmental purity [4].

Organic agricultural production is especially significant for dietary and children's nutrition, where crop rotations play a crucial role.

Spring wheat is one of the primary food crops used in the baking industry to produce high-quality bread and bakery products (soft varieties), and for making pasta, noodles, and semolina (hard varieties). Its grain contains 14–18 % protein and up to 40 % gluten [5; 6].

Spring wheat is widely used as an insurance crop in case of the need to reseed dead winter wheat [7; 8].

In 2013, before the onset of war and occupation of part of the country, the sown area of spring wheat was 160.2 thousand hectares, in 2021 – 192.1 thousand hectares, and in 2023, Ukrainian farmers sowed 285 thousand hectares [9].

The limited cultivation of spring wheat in Ukraine is due to its lower yield compared to winter wheat. However, recent years have seen the introduction of new spring wheat varieties that provide grain yields of up to 5.0–6.0 tons per hectare [5].

NAAS agrarian scientists recommend expanding the area under spring wheat to 1 million hectares [10; 11].

To increase the yield of spring wheat, especially in organic farming, the use of organic fertilizers (straw, green manure, etc.) and certified biofertilizers in cultivation technologies is becoming increasingly important [8].

Therefore, studying the impact of different types of organic fertilisers on the yield and quality of agricultural crops in short-rotation crop rotations, particularly spring wheat, in the conditions of the Left-Bank Forest-Steppe, is relevant and timely.

The aim of the research is to determine the influence of predecessors, different types of organic fertiliser on the yield and quality of spring wheat grain in a short rotation crop rotation and its economic efficiency of its cultivation.

Materials and methods. The research on the influence of precursors and organic fertilisation systems on the yield and quality of spring wheat in short-rotation crop rotation (soybean – spring wheat – buckwheat) was conducted in the subzone of unstable moisture of the Left-Bank Forest-Steppe at the Panfil Research Station of the NSC «IA NAAS» in a field stationary experiment during 2022–2023. The soil cover of the experimental plots is typical low-humus heavy loam, chernozem. The humus content

in the 0–20 cm soil layer varies from 3.46 to 3.72%, and in the 20–40 cm layer - from 3.09 to 3.46%.

The experiment was conducted in triplicate, with a plot area of 81 m² and a recorded area of 60 m². The arrangement of plots was systematic. The Agricultural technology in the experiment were generally accepted and recommended for the research area.

The varieties and hybrids of agricultural crops, listed in the State Register, were sown in the experiment.

Results and discussion. According to the results of the short-rotation crop rotation research, it was found that the yield of the studied crops depended on the crop rotation factor and the use of different types of organic fertiliser, namely by-products of predecessors, green manure, biofertilizers, and their combination, which had a positive effect on the yield and quality of spring wheat grain.

The yield of spring wheat in the studied short rotation crop rotation depended on fertilisation systems with the highest value for the combination of different types of organic fertilisers and was 3.08 t/ha, which is 0.68 t/ha or 39% more than when applying only the by-products of the predecessor (control). The introduction of green manure with green manure and liquid organic fertiliser «Bio-Hel» under the crop ensured the yield of spring wheat at the level of 2.69 and 2.84 t/ha, respectively, which is 0.47 and 0.62 t/ha or 21 and 28% more compared to the control, where the yield of the crop was 2.22 t/ha (Table 1).

Under the comprehensive application of biofertilizers (by-products of the predecessor crop, green manure, and «Bio-Hel»), the protein content in the spring wheat grain was at the level of 14.14%, gluten content was 32.17%, and fat content was 2.02%, which is 0.61% more protein, 3.17% more gluten, and 0.24% more fat than in the control. The application of the predecessor crop by-products with green manure and with liquid organic fertiliser «Bio-Hel» ensured a protein content in spring

Table 1. Yield and quality of spring wheat grain depending on the organic fertilisation system, average for 2022–2023

Fertilizer system	Yield, t/ha	Content in seeds, %.		
		proteins	gluten	fats
P.p.* (control)	2,22	13,53	29,00	1,78
P.p. + green manure	2,69	13,63	28,23	1,84
P.p. + «Bio-Hel»	2,84	13,85	28,98	1,90
P.p. + green manure + «Bio-Hel»	3,08	14,14	32,17	2,02
LSD _{0.5}	0,28–0,29			

*Note. P.p. – by-products of predecessors.

Table 2. Indicators of economic efficiency of spring wheat cultivation, with different types of organic fertilization, average for 2022–2023

Predecessor	Fertilization system	Cost of crop growth, thousand UAH	Costs of bio fertilizers, soil cultivation, thousand UAH	Net income, thousand UAH/ha	Profitability, %
Soybean	P.p.* (control)	0	0	0	0
	P.p. + green manure	5,82	2,0	3,82	191
	P.p. + «Bio-Hel»	7,69	1,7	5,99	352
	P.p. + green manure + «Bio-Hel»	10,69	3,8	6,89	181

*Note. P.p. - by-products of predecessors.

wheat grain at the level of 13.63 % and 13.85 %, and gluten content at 28.23 % and 28.98 % level, respectively (Table 1).

The economic efficiency indicators of the studied short-rotation organic crop rotation were directly dependent on different types of biological fertilization. Thus, the comprehensive application of organic fertilizers, which includes ploughing in the by-products of the predecessor crop, green manure, and applying liquid bio fertilizer «Bio-Hel», ensured the highest conditional net profit from the spring wheat production at the level of 6.89 thousand UAH/ha, with a profitability of 181 % (Table 2).

The application of predecessor crop by-products with green manure ensured a conditional net profit at the level of 3.82 thousand UAH/ha, with a profitability level of 191 %.

The highest profitability of cultivation of spring wheat in a short organic crop rotation, was achieved by applying the by-products of the predecessor crop with the use of

liquid bio fertilizer «Bio-Hel» at a dose of 3.0 l/ha, where this indicator was within 352 % (Table 2).

CONCLUSIONS

It has been established that in the subzone of unstable moisture of the Left-Bank Forest-Steppe of Ukraine, spring wheat grown in a short-rotation organic crop rotation after soybean as a predecessor provided high grain quality and economic efficiency.

The average grain yield of spring wheat in 2022–2023 ranged from 2.22 to 3.08 t/ha. The highest yield (3.08 t/ha) was obtained with the integrated use of the predecessor's by-products, green manure and Bio-Hel bio fertilizer at a dose of 3.0 l/ha, with protein, gluten and fat content of 14.14 %, 32.17 % and 2.02 %, respectively.

The highest notional net profit of 6.89 thousand UAH/ha with a profitability level of 181 % was provided by spring wheat cultivation in a 3-leaf organic crop rotation (soybeans – spring wheat – buckwheat) with complex application of biological fertilisers.

REFERENCES

1. Pyndus V., Hutsalenko O., Omelchuk S. ta in. (2022). *Osnovy orhanichnoho roslynnytstva [Basics of organic crop production]*. Naukovo-metodychnyi tsentr VFPO [in Ukrainian].
2. Tsymbal Ya.S. (2022). Ekoloho-biolohichno zbalansovani sivozmyny v orhanichnomu zemlerobstvi. *Naukovo-metodychni rekomendatsii «Vyrobnnytstvo orhanichnoi silskohospodarskoi produktsii v umovakh voiennoho stanu» [Scientific and methodological recommendations «Production of organic agricultural products under martial law»]* / za red. Ya.M. Hadzala. Vinnytsia: TOV «TVORY». P. 36–41 [in Ukrainian].
3. Martyniuk I.V., Tsymbal Ya.S., Zadubynna Ye.V. (2021). Istoriia rozvytku ta vprovadzhennia orhanichnoho vyrobnytstva silskohospodarskoi produktsii [History of development and introduction of organic production of agricultural products]. *Zemlerobstvo ta roslynnytstvo: teoriia i praktyka – Agriculture and crop production: theory and practice*, 2, 40–46 [in Ukrainian].
4. *Ekolohichni entsyklopedychnyi slovnyk [Ecological encyclopedic dictionary]*. (1999). Vydavnychiy dim Noosfera [in Ukrainian].
5. Zinchenko O.I. (2016). *Roslynnytstvo [Plant growing]*. Uman: Vydavets «Sochinskyi M.M.» [in Ukrainian].

6. Rozhkov A.O. (2010). *Yara pshenytsia u Skhidnomu Lisostepu Ukrainy [Spring wheat in the Eastern Forest Steppe of Ukraine]* Kharkiv: «Maidan» [in Ukrainian].
7. Demydov O.A., Kavunets V.P., Siroshstan A.A. ta in. (2017). Pshenytsia miaka yara potrebuie uvahy [Spring wheat needs attention]. *Propozytsiia – Offer*, 1, 76–80 [in Ukrainian].
8. Melnyk S.I., Sytnyk V.P., Lazar T.I. ta in. (2006). *Rekomendatsii po vyroshchuvanniu yaroї pshenytsi v Lisostepu Ukrainy [Recommendations for growing spring wheat in the forest-steppe of Ukraine]*. Kharkiv [in Ukrainian].
9. Sait Derzhavnoi sluzhby statystyky Ukrainy. URL: www.ukrstat.gov.ua.
10. Usov O.S., Manko K.M. (2015). Osoblyvosti formuvannia vrozhaїnosti pshenytsi tverdoi yaroї zalezho vid poperednyka ta osnovnoho obrobтку gruntu [Peculiarities of forming the yield of durum spring wheat depending on the predecessor and the main tillage]. *Naukovi pratsi Instytutu bioenerhetychnykh kultur i tsukrovyykh buriakiv – Scientific works of the Institute of Bioenergy Crops and Sugar Beet*, 23, 70–75 [in Ukrainian].
11. Shuvar I.A., Bunchak O.M., Sendetskyi V. . ta in. (2015). *Vyrobnytstvo ta vykorystannia orhanichnykh dobryv [Production and use of organic fertilizers]* Ivano-Frankivsk: «Symfoniia forte» [in Ukrainian].
12. Shuvar I.A., Hudz V.P., Pecheniuk V.I. ta in. (2011). *Obrobitek gruntu v adaptivno-landshaftnykh systemakh zemlerobstva [Tillage in adaptive landscape farming systems]*. Lviv: Ministerstvo aharnoї polityky ta prodovolstva Ukrainy, Lvivskyi Natsionalnyi ahraryni universytet. NVF «Ukrainski tekhnolohii» [in Ukrainian].

ЛІТЕРАТУРА

1. Пиндус В., Гуцаленко О., Омельчук С. та ін. Основи органічного рослинництва. Науково-методичний центр ВФПО, 2022. 327 с.
2. Екологічно та біологічно збалансовані сівозміни в органічному землеробстві: наук.-метод. реком. «Виробництво органічної сільськогосподарської продукції в умовах воєнного стану» / за ред. Ю.М. Гадзала. Вінниця: ТОВ «ТВОРИ», 2022. С. 36–41.
3. Мартинюк І.В., Цимбал Я.В. С., Задубинна Є. В. Історія розвитку та впровадження органічного сільськогосподарського виробництва. *Землеробство та рослинництво: теорія і практика*. 2021. Вип. 2. С. 40–46.
4. Екологічний енциклопедичний словник. Видавництво «Ноосфера», 1999. 930 с.
5. Зінченко О.І. Рослинництво. Умань: Вид-во «Соцінський М.М.», 2016. 612 с.
6. Рожков А.О. Яра пшениця у Східному Лісостепу України: моногр. / за ред. М.А. Бобро / Харків: «Майдан», 2010. 232 с.
7. Демидов О.А., Кавунець В.П., Сіроштан А.А. та ін. Потребує уваги яра м'яка пшениця. *Пропозиція*. 2017. №1. С. 76–80.
8. Мельник С.І., Ситник В.П., Лазар Т.І. та ін. Рекомендації щодо вирощування ярої пшениці в умовах Лісостепу України. Харків, 2006. 23 с.
9. Сайт Державної служби статистики України. URL: www.ukrstat.gov.ua.
10. Усов О.С., Манько К.М. Особливості формування врожаю ярої твердої пшениці залежно від попередника та основного обробітку ґрунту. *Наукові праці Інституту біоенергетичних культур і цукрових буряків*. 2015. Вип. 23. С. 70–75.
11. Шувар І.А., Бунчак О.М., Сендецький В.М. та ін. Виробництво та використання органічних добрив: моногр. Івано-Франківськ: Симфонія Форте, 2015. 596 с.
12. Шувар І.А., Гудзь В.П., Печенюк В.І. та ін. Обробіток ґрунту в системах адаптивного ландшафтного землеробства. Львів: Міністерство аграрної політики та продовольства України, Львівський національний аграрний університет. НВФ «Українські технології», 2011. 384 с.

Савченко С.Д.

Ефективність вирощування пшениці ярої в короткоротаційній органічній сівозміні в умовах Лівобережного Лісостепу

Мета. Встановити вплив попередників, різних видів органічного удобрення на урожайність і якість зерна пшениці ярої в короткоротаційній сівозміні та економічній ефективності її вирощування. **Методи.** Технологія вирощування сільськогосподарських культур загальноприйнята і рекомендована для зони проведення досліджень, дозволених у органічному землеробстві. У досліді висіваються занесені до Державного

реєстру сорти і гібриди сільськогосподарських культур. **Результати.** За результатами досліджень, проведених у стаціонарному польовому досліді з вивчення короткоротаційних органічних сівозмін на типових чорноземах нестійкого зволоження Лівобережного Лісостепу в 2022–2023 рр., встановлено, що врожайність зерна пшениці ярої, вирощеної в сівозміні (соя (*Glycine max* (L.) Merrill) – пшениця яра (*Triticum aestivum* L.) – гречка (*Fagopyrum esculentum* Moench)), залежно від різних видів органічного удобрення була в межах від 2,22 до 3,08 т/га, з умістом білка – 13,53–14,14 %, клейковини – 29,00–32,17 % та жиру – 1,78–2,02 % відповідно. **Висновки.** Максимальний умовно чистий прибуток 6,89 тис. грн/га за рівня рентабельності 181 % забезпечувало комплексне застосування органічних добрив, яке передбачає внесення побічної продукції попередника, сидерального посіву та біодобрив «Біо-Гель» в дозі 3,0 л/га.

Ключові слова: культура, добрива, урожайність, якість зерна, економічна ефективність, рентабельність.

ВІДОМОСТІ ПРО АВТОРІВ

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