

UDC 635.615; 631.87; 631.82

## EFFICIENCY OF ORGANIC AND INTENSIVE WATERMELON GROWING TECHNOLOGY

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<https://doi.org/1032717/0131-0062-2026-79-54-61>

**Purpose.** To determine the effectiveness of organic and intensive watermelon cultivation technologies under the conditions of the Steppe zone of Ukraine. **Methods.** The research was conducted at the “Shchedry Lan” farming enterprise located in the Kramatorsk district of Donetsk region. The experimental design included three treatments: control (watermelon cultivation without fertilizers and plant protection products), intensive cultivation technology, and organic cultivation technology. The watermelon hybrid Farao F<sub>1</sub> was grown by the seedling method with a planting scheme of 140 × 70 cm (10.2 thousand plants per hectare) using drip irrigation and soil mulching with plastic film. **Results.** The article presents the results of evaluating the effectiveness of organic and intensive watermelon cultivation technologies and their influence on plant productivity, fruit yield, biochemical composition, and economic performance. **Conclusions.** In terms of plant productivity, the organic cultivation approach was inferior to the intensive technology. Under organic cultivation, plants formed on average one fruit weighing 5.8 kg, whereas intensive technology ensured the formation of 2.8 fruits per plant with an average weight of 10 kg. Intensive cultivation technology provided the highest watermelon yield, reaching 83.3 t/ha, while under organic cultivation the yield amounted to 31.2 t/ha. Differences between cultivation technologies in fruit dry matter content (8.0–9.2%) and total sugar content (7.2–7.5%) were insignificant. However, the organic cultivation technology resulted in fruits with a significantly higher vitamin C content (9.8 mg/100 g) and a lower nitrate concentration (35.0 mg/kg) compared with the intensive technology (60.0 mg/kg). The higher watermelon yield obtained under intensive cultivation ensured the maximum profit level (UAH 780.0 thousand/ha), exceeding that of the organic technology (UAH 528.88 thousand/ha). At the same time, the lower production costs under organic cultivation (UAH 170.0 thousand/ha) resulted in a similar production cost level for both technologies (UAH 5.20–5.45/kg). When organic products were sold with a 40% price premium, the highest profitability level was recorded for the organic technology (311.0%), whereas under intensive cultivation this indicator reached 150.0%.

**Keywords:** watermelon, plant productivity, yield, biochemical composition of products, economic efficiency

**Introduction.** Watermelon (*Citrullus lanatus*) cultivation is an important component of vegetable production in Ukraine, particularly in the southern and eastern regions, where this crop demonstrates high yield potential and economic efficiency (Knysh V.I. et al., 2023). Watermelon remains in stable demand due to its nutritional and dietary value, which contributes to the continuous expansion of cultivation areas. Its fruits are widely consumed fresh, used in the processing industry, and may also serve as animal feed. Watermelon production plays a signifi-

cant role in the development of the agricultural sector, promotes employment, and enables the efficient use of arid lands (Sych Z.D. et al., 2018; Yarovy H.I., Romanov O.V., 2017, 2025; Vitanov O.D. et al., 2018, 2020).

At the same time, modern production systems for this crop are largely based on the intensive application of mineral fertilizers and chemical plant protection products, which leads to increased anthropogenic pressure on agroecosystems, deterioration of soil conditions, and accumulation of chemical residues in agricultural products.

Under current conditions of agricultural development in Ukraine, the implementation of biological cultivation technologies for agricultural crops, including watermelon, is becoming increasingly relevant. Such technologies involve the use of biopreparations based on beneficial microorganisms, biological plant protection products, organic fertilizers, and other environmentally safe components aimed at restoring soil fertility and creating sustainable agroecosystems (Limar V.A., Limar A.O., 2022). The application of biological approaches reduces dependence on synthetic chemicals, enhances soil biological activity, and contributes to the stability of agricultural production under climate change conditions (Knysh V.I., Pavlova S.L., 2012).

Biological technologies are of particular importance in the context of the development of organic farming, which is rapidly expanding both in Ukraine and worldwide. However, despite the considerable advantages of biological technologies, their effectiveness under specific soil and climatic conditions of Ukraine, particularly in the Steppe zone, still requires further scientific substantiation (Ninova H.V., Herasko T.V., 2020).

#### **Analysis of recent research and publications.**

Organic cultivation systems for watermelon involve the implementation of a set of agronomic practices that differ significantly from intensive cultivation technologies. One of the key components of such systems is the use of biopreparations aimed at improving plant nutrition, stimulating growth processes, and protecting plants against pests and diseases (Song X. et al., 2022; Arias R.M. et al., 2023). It has been proven that different groups of microorganisms are capable of influencing nutrient cycling in soil, including atmospheric nitrogen fixation, increasing phosphorus and potassium availability, and synthesizing phytohormones (indole-3-acetic acid) and siderophores (Ali A.M. et al., 2021; Park S. et al., 2021; Mushtaq Z. et al., 2022). The use of such microbial preparations improves nutrient uptake by plants and creates favorable conditions for root system development.

In this context, an important task of agricultural microbiology is the selection of highly effective strains and the development of multifunctional microbial consortia adapted to different environmental conditions. It has been established that certain microorganisms can combine several beneficial functions simultaneously (Wang C. et al., 2021). In particular, Walia et al. (2014) reported that the strain *Bacillus subtilis* CKT1 possesses the ability to solubilize phosphates, synthesize auxin-like substances, produce siderophores, and generate HCN.

At the same time, excessive and unjustified application of mineral fertilizers and pesticides has been shown to negatively affect watermelon fruit quality and contribute to environmental problems (Abbou M. et al., 2023). Therefore, the use of biofertilizers containing complexes of microorganisms with different functional activities is considered an effective approach for increasing crop productivity and product quality while supporting sustainable production systems (Wang Z. et al., 2020). Although beneficial microorganisms are naturally widespread, their activity under production conditions is often limited by competition with other microflora and adverse environmental factors associated with human agricultural activity (Zubair M. et al., 2019).

It should also be noted that watermelon cultivation is complicated by the impact of numerous diseases and pests, including powdery mildew, downy mildew, aphids, and mites, resulting in increased chemical pressure on agroecosystems. In this regard, biological protection becomes an important component of environmentally safe cultivation technologies based on the use of natural agents such as microorganisms, entomophages, and biological products. The application of preparations based on bacteria (*Bacillus* spp.), fungi (*Trichoderma* spp., *Beauveria bassiana*), and plant extracts makes it possible to effectively suppress harmful organisms while reducing pesticide pressure on the agroecosystem. In addition, such products may activate the natural resistance mechanisms of plants (Horuz S., Aysan Y., 2018; Michelson A.E. et al., 2021). However, the effectiveness of biological control agents is not always consistently high, since under severe pest infestation or intensive disease development their efficiency may be lower compared with synthetic pesticides.

Therefore, the **purpose** of the conducted research was to determine the effectiveness of organic and intensive watermelon cultivation technologies under the conditions of the Steppe zone of Ukraine.

**Materials and Methods.** The research was carried out during 2023–2025 at the «Shchedryi Lan» farming enterprise located in the Kramatorsk district of Donetsk region, Ukraine.

The soil cover of the experimental site was represented by ordinary low-humus shallow heavy loam chernozem formed on loess parent material. The arable soil layer was characterized by the following agrochemical properties: humus content – 3.70%, pH of water extract – 7.1, available phosphorus – 90 mg/kg of soil, exchangeable potassium – 133 mg/kg, magnesium – 362 mg/kg, sulfur – 6 mg/kg, iron – 176

mg/kg, boron – 3.86 mg/kg, manganese – 96 mg/kg, copper – 4.0 mg/kg, zinc – 3.5 mg/kg, and molybdenum – 0.02 mg/kg.

The experimental design included three treatments (Table 1):

control – watermelon cultivation without the application of fertilizers and plant protection products; intensive cultivation technology; organic watermelon cultivation technology.

**Table 1. Intensive and organic watermelon cultivation technologies used in the experiments**

Elements of technology	Intensive cultivation technology	Organic growing technology
Tillage and sideration	Disking at 10-12 cm with leveling; plowing at 23-25 cm; cultivation at 6-8 cm	Disking at 10-12 cm with leveling; sowing of green manure (mixture of peas, barley, oats, rapeseed, flax); disk-ing of green manure at 10-12 cm in 2 tracks; plowing at 23-25 cm
Fertilization system	N <sub>24</sub> P <sub>72</sub> K <sub>72</sub> (for cultivation) + N <sub>24</sub> P <sub>72</sub> K <sub>72</sub> (in fertigation)	Granulated chicken manure 10 t/ha (for plowing) + 10 t/ha (for cultivation)
	Foliar fertilization (spraying)	
	Avangard vegetable (tent phase) 2 l/ha + Avangard boron (beginning of flowering) 1.5 l/ha	HelpRost vegetable (tent phase) 2 l/ha + HelpRost boron (beginning of flowering) 1.5 l/ha
Disease protection	Uniform (azoxystrobin + metalaxyl-M) 0.9 l/ha	Mikohelp 2 l/ha
Pest protection	Uniform (azoxystrobin + metalaxyl-M) 0.9 l/ha	Actoverm 1.8%, 3 l/ha

The Farao F<sub>1</sub> hybrid was used in the experiment. Winter wheat served as the preceding crop. Watermelon was cultivated by the seedling method with a planting scheme of 140 × 70 cm (10.2 thousand plants per hectare) using drip irrigation and plastic film mulching.

The research was conducted in accordance with the methodology of experimental studies in vegetable production (Bondarenko H.L., Yakovenko K.I., 2001). Phenological and biometric parameters of watermelon plant growth, as well as yield indicators, were recorded during the experiment. Statistical analysis of the obtained results was performed using analysis of variance (ANOVA) according to the method described by Rozhkov A.O. et al. (2016).

**Results.** Comparative analysis of the two watermelon cultivation technologies demonstrated that the intensive production system outperformed the organic technology in terms of the main economically valuable traits (Table 2). Under organic cultivation conditions, plants formed on average one fruit weighing 5.8 kg, whereas under intensive technology plants produced 2.8 fruits with an average weight of 10 kg each. As a result, plant productivity under the intensive cultivation system reached 29 kg per plant, while under the organic technology it

amounted to only 5.8 kg per plant. This indicates that the systems of nutrient optimization and plant growth stimulation under organic cultivation approaches were not sufficiently effective.

Plant productivity directly determined the overall yield level (Table 3). Without the application of fertilizers and plant protection products, watermelon yield was obtained only in 2023, whereas in 2024 and 2025 the plants died before forming a complete fruit yield. The highest watermelon productivity was achieved under the intensive cultivation technology, where the average yield over the years of research reached 83.3 t/ha, including 70.0 t/ha obtained during the first harvest and 13.3 t/ha during the second fruit harvest.

Under the organic cultivation technology, the yield level was significantly lower and averaged 31.2 t/ha over the study period. However, despite the lower productivity under organic cultivation, it should be noted that the majority of the watermelon yield (up to 96%) was harvested during the first picking, compared with the intensive technology, where approximately 88% of fruits were collected during the first harvest.

**Table 3. Watermelon yield depending on the cultivation system (2023–2025)**

Experiment options		Yield, t/ha			
		2023	2024	2025	Average over the years
Control	first harvest	10.0	0	0	3.3
	second harvest	0	0	0	0
	total	10.0	0	0	3.3
Organic growing technology	first harvest	30.0	30.0	30.0	30.0
	second harvest	0	5.0	0	1.7
	total	30.0	35.0	30.0	31.2
Intensive cultivation technology	first harvest	70.0	60.0	80.0	70.0
	second harvest	10.0	10.0	20.0	13.3
	total	80.0	70.0	100.0	83.3
<i>LSD<sub>0,95</sub></i>	<i>total</i>	8.5	7.5	8.7	-

The cultivation technologies also influenced the quality characteristics of watermelon fruits (Table 4). Differences between the technologies in terms of dry matter and total sugar content were insignificant. Dry matter content ranged from 8.0 to 8.2%, while total sugar content varied between 7.2 and 7.5%. Under the organic cultivation technology, a significantly higher vitamin C content was observed

in the fruits (9.8 mg/100 g compared with 8.5 mg/100 g under the intensive technology). In addition, watermelon fruits produced under organic cultivation accumulated substantially lower nitrate concentrations (35.0 mg/kg) than fruits obtained under intensive cultivation involving mineral fertilizer application (60.0 mg/kg).

**Table 4. The influence of various growing technologies on the quality indicators of watermelon fruits (average for 2023-2025)**

Indicators	Organic growing technology	Intensive cultivation technology	<i>LSD<sub>0,95</sub></i>
Dry matter content, %	8.0	8.2	0.85
Total sugar content, %	7.2	7.5	0.69
Vitamin C content, mg/100 g	9.8	8.5	0.82
Nitrate content, mg/kg	35.0	60.0	4.56

To calculate the economic efficiency of watermelon cultivation, the 2025 selling price was used, taking into account a 40% organic price premium. Due to the higher crop productivity under intensive cultivation approaches, the maximum profit level was obtained under the intensive technology (UAH 780.0 thousand/ha), which exceeded the corresponding indicator for the organic cultivation technology (Table 5). In fact, in order for organic watermelon production to achieve a profit level comparable to that of the intensive technology, the selling price of organic products should be 70–100% higher. However, under current conditions this is

unlikely, owing to the low purchasing power of the population caused by relatively low incomes resulting from the armed aggression of the Russian Federation against Ukraine. This situation is also indirectly influenced by the insufficient promotion of organic products through mass media and the limited awareness of potential consumers regarding the benefits of organic products compared with those produced under intensive cultivation systems. Unfortunately, at present, lower product prices remain more attractive both for end consumers and retail chains.

It should also be noted that the implementation costs of the organic cultivation technology were significantly lower (UAH 170.0 thousand/ha) compared with the intensive technology (UAH 520.0 thousand/ha). Under such conditions, the production cost per unit of output remained almost identical for both cultivation systems.

Since the selling price of organic products was 40% higher and the studies recorded relatively low production costs, the organic cultivation technology ensured a higher profitability level (311.0%),

whereas under intensive cultivation approaches this indicator amounted to 150.0%. Therefore, despite the lower yield level compared with the intensive technology, the implementation of organic watermelon cultivation approaches can be considered economically feasible. However, to increase crop productivity, further improvement of fertilizer systems and microbial preparation applications aimed at optimizing plant nutrition and stimulating plant growth processes is required.

**Table 5. Economic efficiency of different watermelon cultivation technologies (average for 2023–2025)**

Indicators	Organic growing technology	Intensive cultivation technology
Yield, t/ha	31.2	81.3
Sales price per 1 t, thousand UAH	22.4	16.0
Sales revenue, thousand UAH/ha	698.88	1300.8
Total production costs, thousand UAH/ha	170.0	520.0
Profit, thousand UAH/ha	528.88	780.8
Cost, thousand UAH/t	5.45	5.2
Profitability, %	311	150

**Discussion.** A comparison of organic and intensive watermelon cultivation technologies indicates substantial differences not only in crop productivity but also in the environmental and economic aspects of production. Numerous studies have demonstrated that intensive technologies based on the application of mineral fertilizers, drip irrigation systems, and fertigation ensure the highest yield formation. In particular, the application of optimal mineral nutrition rates (100% of the recommended fertilizer dose) combined with regulated irrigation contributed to watermelon yields exceeding 90 t/ha, which significantly surpassed the performance of alternative cultivation systems (Nisha S.K. *et al.*, 2020).

At the same time, organic cultivation technologies are characterized by a more complex system of plant nutrition management and protection against harmful organisms, which often limits the realization of the crop productivity potential. According to research findings, the average yield level in organic vegetable production may be 20–30% lower compared with conventional intensive systems due to the limited use of readily available nutrient forms. Similar trends have also been reported for cucurbit crops, including watermelon, where plant nutrient supply is considered one of the key factors determining yield formation (Kopczyńska K. *et al.*, 2020).

However, results from several studies indicate that the optimal combination of organic fertilizers

(manure, composts, poultry manure) with humic substances can significantly increase watermelon productivity. In particular, the use of integrated organic nutrition systems ensured a significant increase in such indicators as fruit number, fruit weight, and total yield, confirming the effectiveness of organic approaches under appropriate technological support. These findings suggest that organic technologies may become competitive provided that nutrient management systems and agronomic practices are properly optimized (Tillman J. *et al.*, 2015).

In addition, organic technologies possess several important advantages that are not always reflected solely by yield indicators. Organic products have been shown to exhibit improved quality characteristics, including reduced nitrate content, absence of pesticide residues, and increased levels of biologically active compounds. Furthermore, organic systems contribute to improved soil structure, enhanced biological activity, and reduced negative environmental impact (Kopczyńska K. *et al.*, 2020).

The economic efficiency of organic watermelon cultivation also has specific features. Despite potentially lower yields, organic products may achieve a higher market value, which partially compensates for yield losses. At the same time, some practical studies indicate that under insufficient technological support, organic production may be inferior to intensive systems both in terms of productivity and economic performance.

### Conclusions.

In terms of plant productivity, organic watermelon cultivation approaches were inferior to the intensive technology. Under organic cultivation, plants formed on average one fruit weighing 5.8 kg, whereas under intensive technology 2.8 fruits per plant were formed with an average weight of 10 kg.

The intensive cultivation technology ensured the highest watermelon yield, reaching 83.3 t/ha, while under organic cultivation approaches the yield amounted to 31.2 t/ha.

Differences between cultivation technologies in terms of dry matter content (8.0–9.2%) and total sugar content (7.2–7.5%) were insignificant. However, the use of the organic cultivation technology resulted in fruits with significantly higher vitamin C content (9.8 mg/100 g) and lower nitrate accumulation (35.0 mg/kg) compared with the intensive cultivation technology (60.0 mg/kg).

The higher watermelon yield obtained under intensive cultivation approaches resulted in the maximum profit level (UAH 780.0 thousand/ha), which exceeded the corresponding indicator under the organic cultivation technology (UAH 528.88 thousand/ha). However, the relatively lower production costs under the organic technology (UAH 170.0 thousand/ha) resulted in a similar production cost level for both cultivation systems (UAH 5.20–5.45/kg). When organic products were sold with a 40% price premium, the studies recorded a higher profitability level for the organic technology (311.0%), whereas under intensive cultivation approaches this indicator amounted to 150.0%.

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УДК: 635.615; 631.87; 631.82

## ЕФЕКТИВНІСТЬ ОРГАНІЧНОЇ ТА ІНТЕНСИВНОЇ ТЕХНОЛОГІЇ ВИРОЩУВАННЯ КАВУНА

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<https://doi.org/1032717/0131-0062-2026-79-54-61>

**Мета.** Встановлення ефективності органічної та інтенсивної технологій вирощування кавуна в умовах Степу України. **Методи.** Дослідження проведено на базі фермерського господарства «Щедрий лан», розташованого в Краматорському районі Донецької області. Схема досліду включала три варіанти: контроль (вирощування кавуна без застосування добрив і засобів захисту рослин); інтенсивна та органічна технології вирощування. Гібрид кавуна Фарао F<sub>1</sub> вирощували розсадним способом за схемою висадки рослин 140×70 см (10,2 тис. шт./на га) з використанням крапельного зрошування та мульчування ґрунту плівкою. **Результати.** У статті представлено результати визначення ефективності органічної та інтенсивної технологій вирощування кавуна з впливом на показники продуктивності рослин, урожайністю плодів та їх біохімічним складом, економічними параметрами вирощування. **Висновки.** За рівнем продуктивності рослин органічні підходи вирощування кавуна поступаються інтенсивній технології. При цьому на рослині формується в середньому один плід х масою 5,8 кг, тоді як за інтенсивної технології формується 2,8 плоди/рослину з середньою масою 10 кг. Інтенсивна технологія вирощування забезпечує максимальну урожайність кавуна на рівні 83,3 т/га, тоді як за органічних підходів урожайність становила 31,2 т/га. За вмістом в плодах сухої речовини (8,0-9,2 %) та загального цукру (7,2-7,5 %) між технологіями вирощування відмінність незначна. Використанням органічної технології вирощування зумовлює формування плодів з істотно вищим вмістом вітаміну С (9,8 мг/100 г) та нижчою кількістю нітратів (35,0 мг/кг), відносно інтенсивної технології вирощування (60,0 мг/кг). Більш високий рівень урожайності кавуна за інтенсивних підходів вирощування зумовлює отримання максимального рівня прибутку (780,0 тис. грн./га), що перевищує показник за органічної технології вирощування (528,88 тис. грн./га). Але відносно нижчий рівень витрат на вирощування за органічної технології (170,0 тис. грн./га) зумовлює рівень собівартості продукції за обох технологічних підходів на одному рівні (5,20-5,45 грн./кг). За умови продажу органічної продукції з націнкою 40% в дослідженнях зафіксовано більш високий рівень рентабельності виробництва за органічної технології (311,0 %), тоді як за інтенсивних підходів вирощування даний показник становив 150,0 %.

**Ключові слова:** кавун, продуктивність рослин, урожайність, біохімічний склад продукції, економічна ефективність

Received 17.04.2026

Peer-reviewed 28.04.2026

Assepted 15.05.2026