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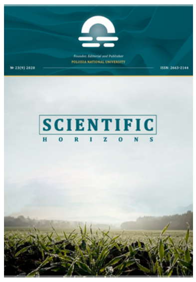

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Features of forming the productivity of modern hemp varieties using organic cultivation technology

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Abstract. Seed hemp can be used to produce products and restore soil fertility. The adaptive potential of cannabis varieties can be implemented by optimising their cultivation technologies. The purpose of this study was to substantiate the features of forming the productivity of cannabis varieties adapted to organic cultivation technologies. Field studies were conducted during 2019-2021 on leached chernozems. Research methods: field, laboratory, statistical and comparative calculation. The regularities of yield formation of hemp straws, fibre, and seeds depending on the

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genetic potential of varieties and cultivation technology were investigated. The suitability of five hemp varieties for organic cultivation was evaluated. It was established that the introduction of organic cultivation technology has a positive effect on crop productivity. With organic cultivation of Hliana and Hloba varieties, the increase in the yield of straw (0.07-0.11 t/ha) was statistically insignificant compared to inorganic technology. Cultivation of Zolotoniski 15 and Sula varieties using organic technologies increased the yield of hemp straw by 0.14 t/ha. The Lara variety showed an insignificant decrease in the straw yield. This confirmed the theory that the introduction of organic cultivation of hemp will not lead to a decrease in yields. Organic technologies for growing hemp contributed to an increase in their yield compared to the traditional one, provided that varieties were selected correctly. The best suitability for organic cultivation in terms of fibre yield was recorded in the Lara variety. The obtained results will be used to improve and introduce organic technologies for growing adapted hemp varieties, depending on the purpose of fibre or seeds

Keywords: seeds, straw; fibre; genetic potential; biodestructor; correlation

INTRODUCTION

Agribusiness around the world is interested in cannabis, as its cultivation and processing can significantly contribute to the European Union's bioeconomy strategy. Market interest in growing this niche crop encourages a gradual transition from the traditional use of stem fibres (textiles, cellulose or paper) to multi-purpose production. Hemp (*Cannabis sativa* L.) is a valuable high-yielding annual crop, because due to its unique consumer properties, all parts of the plant are used in different ways. Many types of products are made from the plant material of this crop. Due to the lack of investment in research over decades, restrictions have led to the need to develop sustainable hemp production systems.

Strategic areas for the development of the agricultural sector are the cultivation of highly profitable niche crops. The adaptive productivity potential of niche crop varieties can be implemented by optimising the elements of their cultivation technologies (Kyrylyuk *et al.,* 2019; Panchyshyn *et al.,* 2023). It is advisable to consider the scientific developments of researchers to improve the yield and quality of crop production.

In many European countries, cannabis varieties are grown that are suitable for multiple uses, including fibre and seed (Tang *et al.,* 2016). An important area of use of hemp in addition to food is energy – for the production of bioethanol, biogas, and biodiesel (Viswanathan *et al.*, 2021). C. Asquer *et al.* (2019) confirmed the possibility of using industrial hemp straw residues in the biogas sector for biogas production by anaerobic digestion. Research has shown that the essential oil obtained from industrial hemp can be used as biological insecticides, acaricides or repellents to protect plants from pests in organic production (Rossi *et al.,* 2020). According to G. Benelli *et al.* (2018), the strengths of growing cannabis for the production of bioinsecticides include the following: low costs for the production of raw materials and the availability of land for growing crops, increased demand for environmentally safe products, the possibility of using by-products in other industries, in particular cosmetics and pharmaceuticals.

It does not require the use of plant protection products or pesticides, and hemp itself suppresses weeds, repels pests, is resistant to pathogens and requires only minerals contained in the soil. This has a positive effect on the environment, as it contributes to the preservation of soil fertility (Adesina *et al.,* 2020). Hemp can be grown for several years in a monoculture without reducing the yield, it is a good precursor for the most important crop – wheat (Gorchs *et al.,* 2017). However, it has been established that growing hemp in a monoculture can lead to a deterioration in soil fertility. According to V.M. Kabanets and S.I. Berdin (2020) growing this crop in a monoculture without the use of fertilisers leads to a significant decrease in the content of humus and basic nutrients in the arable soil layer.

Studying the productivity of modern hemp varieties to determine their adaptability in specific environmental conditions is an important factor in harnessing their genetic potential and increasing profitability (Cherney & Small, 2016). Researchers in Serbia conducted studies to evaluate different varieties of cannabis by plant height, stem yield, fibre and seed yield (Habán *et al.,* 2022). It was found that dicotyledonous varieties were preferred for the conditions of Southern and South-Eastern Europe for the production of biomass (stems and fibres), and monoecious varieties were preferred for seed production. According to researchers, an important factor in successful cannabis cultivation is to consider the climatic conditions of the environment and adapt agricultural technologies to ensure optimal conditions for plant growth and development. The adaptive potential of modern cannabis varieties can be maximised by optimising agricultural technologies, in particular, the transition to organic production. In modern market conditions, the eco-brand is one of the main prerequisites for effective economic development of the country. Currently, the level of environmental safety of goods in the international market is one of the main factors determining their competitiveness (Berezovsky, 2020). The growing demand of consumers for innovative products made from safe plant raw materials may become a prerequisite for expanding the production of hemp.

The solution to the problem of growing hemp is now becoming relevant and requires optimisation of cultivation technology. Therefore, the purpose of the study was to establish the features of forming the productivity of hemp crops depending on varietal characteristics and cultivation technology.

MATERIALS AND METHODS

The study was conducted during 2019-2021 on leached chernozems in forest-steppe conditions.

The experiment scheme includes factors: Factor A – conditions of years of research. Factor B – varieties: 1. Hliana (Standard); 2. Zolotoniski 15; 3. Lara; 4. Hloba; 5. Sula. Factor C – cultivation technology: 1. inorganic (control); 2. transitional; 3. organic; 4. organic + BioStimix-Niva, 1 l/ha (in the phase of 3 pairs of leaves).

The originator of the Sula, Hloba, Lara varieties is LLC "Institute of organic farming", and the Hliana and Zolotoniski 15 varieties – Institute of Bast Crops of NAAS,

The soil of the experimental plots at a 0-20 cm depth was characterised by the following agrochemical indicators: pH-salt – 6.6, humus content – 4.16%, easily hydrolysed nitrogen – 124.6 mg/kg of dry soil, mobile forms of phosphorus – 140.3 mg/kg of dry soil, exchange potassium – 87.7 mg/kg of dry soil. The depth of the humus horizon is 53-100 cm. The predecessor of hemp in the crop rotation was soybeans. Sowing of hemp was carried out with a Monosem seed drill. The seeding rate of hemp varieties for dual use (seeds and fibre) was 1.2 million pcs./ha of germinating seeds, and for green fibre – 4.0 million pcs./ha of germinating seeds. The total area of the experiment was 0.68 hectares. The accounting plot area – 25 m². The repetition rate in the experiment is fourfold. Inorganic cultivation technology provided only for the use of mineral fertilisers $N_{30}P_{30}K_{30}$ without the use of plant protection products. Mineral fertilisers were not used in the variants with transitional and organic technology. The microbiological preparation BioStimix-Niva was applied in the phase of three pairs of leaves with a consumption rate of 1 l/ha.

The analysis of the yield of the Lara variety using various cultivation technologies was carried out according to the scheme: 1. Hliana (control); 2. Lara (inorganic); 3. Lara (organic); 4. Lara (organic + BioStimix-Niva application, 1 l/ha).

The predecessor of hemp was soybeans. The soil of the experimental plots is leached chernosem, characterised by the following indicators in the 0-20 cm layer: pH – 6.4, humus content – 4.01%, easily hydrolysed nitrogen – 114.8 mg/kg dry soil, mobile forms of phosphorus – 138.3 mg/kg dry soil, exchange potassium – 89.8 mg/kg dry soil. Accounting of the yield of straw, fibres, and seeds was carried out according to conventional methods. The obtained research results were processed statistically using Excel and Statistica 10.0 software suites. A comparison of the significant difference between the average values was made using the criterion of the least significant difference. The significance level was set to P≤0.05.

RESULTS

The creation of new hemp varieties sets the task of finding ways to optimise cultivation technologies to ensure the realisation of their genetic potential. The yield of hemp fibre had the characteristics of its variation. The best indicator was observed in the Lara variety, which averaged 3.6 t/ha over the years of research (Fig. 1).

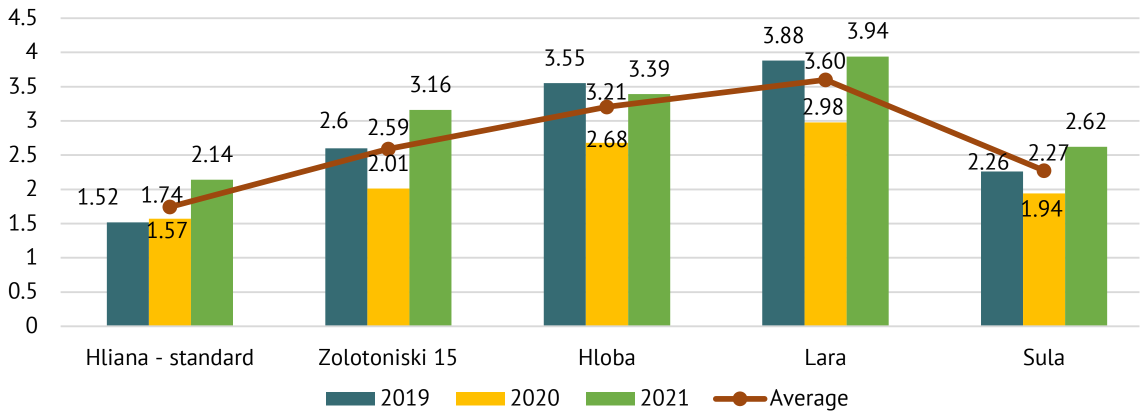

Figure 1. *Yield of hemp fibre in variety testing crops, 2019-2021*

The lowest yield of hemp fibre over the years of research was in the Hliana variety – 1.74 t/ha. The highest fibre yield (3.05 t/ha) on average for varieties was noted in 2021. The worst year for the formation of fibre yield was 2020. The average yield for varieties this year was 2.24 t/ha. In 2019, the highest fibre yield was found in the Lara variety (3.88 t/ha), which is 2.6 times higher than the yield of the Hliana variety (1.52 t/ha). In 2019, the yield of fibre of Lara was 0.33-1.62 t/ha higher than that of Sula, Zolotoniski 15 and Hloba varieties. Of all the varieties selected by the Institute of organic agriculture, the lowest fibre yield was demonstrated by the Sula variety (2.26 t/ha), which is 0.74 t/ha more compared to the Hliana variety (standard). The fibre yield of the Sula variety was 1.62 t/ha lower compared to the Lara variety. The highest yield of hemp fibre in 2021 was formed by the Lara variety – 3.94 t/ha, which is 1.84 t/ha more compared to the Hliana variety (standard). This year, the yield of hemp fibre in the Sula variety was 1.32 t/ha less than the Lara variety and 0.48 t/ha more than the Hliana variety. The yield of fibre of Zolotoniski 15 and Hloba varieties exceeded the Hliana variety (standard) by 1.8-1.25 t/ha. The least favourable year for the formation of the yield of hemp fibre was 2020. The yield of fibre of all varieties decreased. The most sensitive varieties to the conditions of the year were Sula and Hliana. The yield of these varieties was lower by 1.04 and 1.41 t/ha, respectively, compared to the Lara variety. Such variability in the yield of hemp fibre indicates the feasibility of growing several varieties at the same time. It is best to use the Hloba, Lara, and Sula varieties for this purpose.

Organic technology of growing hemp straws and fibres contributed to an increase in yield (Table 1).

Table 1. *Formation of yield straw and fibres depending on the conditions of years of research (factor A), variety, and cultivation technology (2019-2021)*

Variety (factor *B*)	Growing technology (factor *C*)	Yield, t/ha	
		straw	fibres
Hliana – standard	inorganic (control)	4.09	1.74
	transitional period	4.16	1.74
	organic	4.16	1.80
	organic + BioStimix-Niva, 1 l/ha	4.20	1.81
Zolotoniski 15	inorganic (control)	4.73	2.62
	transitional period	4.47	2.62
	organic	4.72	2.65
	organic + BioStimix-Niva, 1 l/ha	4.87	2.67
Lara	inorganic (control)	5.05	3.58
	transitional period	4.97	3.60
	organic	5.00	3.64
	organic + BioStimix-Niva, 1 l/ha	4.96	3.66
Hloba	inorganic (control)	5.11	3.19
	transitional period	5.00	3.21
	organic	5.13	3.24
	organic + BioStimix-Niva, 1 l/ha	5.21	3.25
Sula	inorganic (control)	5.19	2.73
	transitional period	5.28	2.72
	organic	5.18	2.75
	organic + BioStimix-Niva, 1 l/ha	5.33	2.77
	LSD_{05} *A*	-	0.01
	LSD_{05} *B*	0.06	0.01
	LSD_{05} *C*	0.05	0.01
	LSD_{05} *AB*	0.11	0.02
	LSD_{05} *BC*	0.12	-

Source: *compiled by the authors*

The yield of hemp straws of varieties Hliana and Hloba increased slightly in variants with organic cultivation. The increase in the yield of these varieties was 0.7-0.11 t/ha compared to the control, which is within a significant difference. This indicates an insignificant increase in the yield of straw using organic technology compared to the control (inorganic). Using organic cultivation technology, Zolotoniski 15 and Sula varieties increased the yield of straw by 0.14 t/ha compared to the control. Growing the Lara variety using organic technologies led to a certain decrease in yield, although the difference did not exceed the LSD criterion. Therefore, it cannot be said that the introduction of organic cultivation technology will inevitably lead to a decrease in yield.

The average yield of the straw of the varieties under study with inorganic cultivation technology was 4.83 t/ha, transitional – 4.78 t/ha, organic – 4.84 t/ha. Cultivation of hemp varieties using organic technology using the BioStimix-Niva destructor ensured the formation of an average yield of 4.91 t/ha. There is an average direct correlation between the yield of straw and hemp fibre (r=0.56), which significantly determines the influence of varietal properties (factor B) and cultivation technology (factor C) on this indicator. In general, there was a positive reaction of fibre yield to the use of organic technologies, which is especially important for obtaining a gross indicator. In the future, the authors will consider the system of relationships between seed yield, which also has correlations with indicators of vegetative mass.

The average fibre yield of Hliana variety was 1.77 t/ha, Zolotoniski 15 variety – 2.64 t/ha, Lara variety – 3.62 t/ha, Hloba variety – 3.22 t/ha, and Sula variety – 2.74 t/ha. According to this indicator, the best suitability for growing using organic technologies was observed in the Lara variety. The yield of fibre using inorganic and transitional cultivation technologies is at the same level and averages 2.77 and 2.78 t/ha, respectively. According to organic cultivation technologies, the fibre yield is 2.82-2.83 t/ha. Thus, the use of a biodestructor did not significantly affect this indicator. The highest fibre yield was obtained when growing the Lara variety (3.58-3.66 t/ha). The lowest yield of hemp fibre was recorded in the Hliana variety – 1.74-1.81 t/ha.

The yield of straw and hemp fibres is characterised primarily by dependence on varietal properties (Fig. 2).

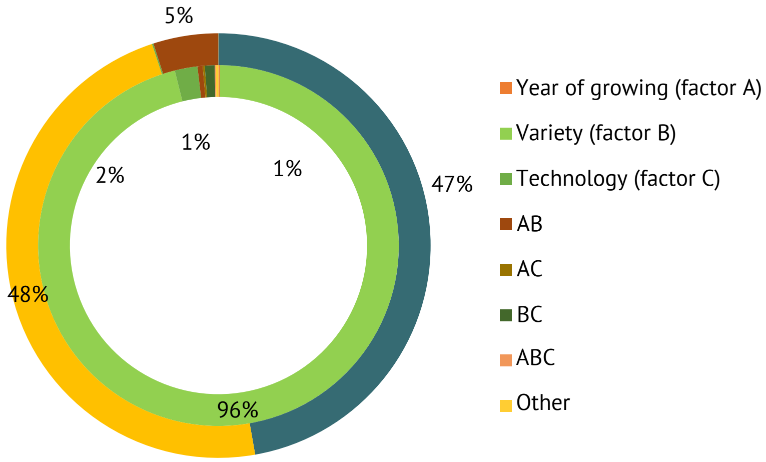

Figure 2. *Shares of influence of factors and their interactions on the yield of hemp straw (outer circle) and fibre (inner circle)*

However, there is a certain difference between these indicators – the yield of straw has an insignificant dependence on the conditions of the year, in contrast to the yield of fibre. The conditions of years of research had a more significant impact on the formation of fibre yield (47%). The genetic properties of the variety (factor B) had a dominant influence on the yield of the hemp straw, with a 96% share of influence. The influence of cultivation technology and the interaction of factors does not exceed 4%. The influence of the variety on the formation of fibre yield was 48%, that is, almost half.

Average yield indicators of straw, depending on the cultivation technology, also convincingly demonstrate that with organic hemp production, crops can exceed the usual yield, provided that the varieties are correctly selected. As a result of the study, it was found that the correct choice of hemp varieties can provide an increase in the yield of straw using organic technologies compared to traditional ones (Fig. 3).

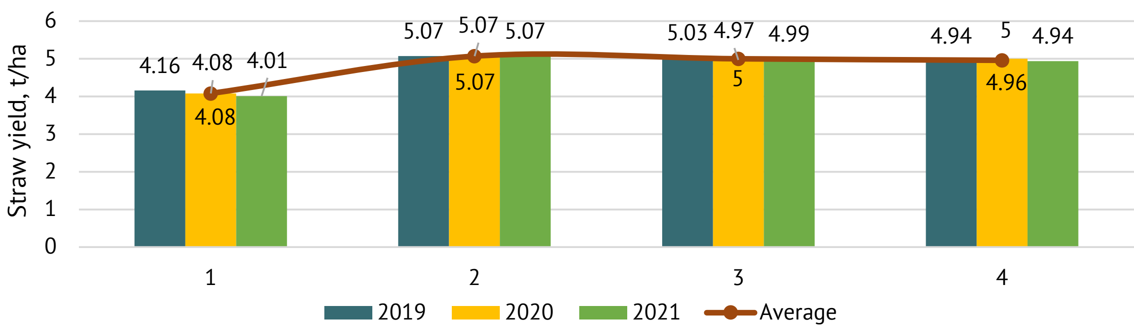

Figure 3. *Yield of straw depending on the varieties and cultivation technology (LSD$_{05}$ by technology factor – 0.10 t/ha)*
Note: *1 – Hliana (control); 2 – Lara (traditional); 3 – Lara (organic); 4 – Lara (organic + application of BioStimix-Niva, 1 l/ha)*

On average, over three years of research, the Hliana variety showed a stable yield of straw at the level of 4.08 t/ha, which is 0.99 t/ha less than the Lara variety. The yield of straw of the Lara variety over the years of research ranged from 4.94 to 5.07 t/ha, depending on the cultivation technology. Therefore, to obtain the maximum yield of hemp products, it is necessary to carefully select varieties according to the area of use. Growing hemp of the Lara variety using various organic technologies provides an average yield of 4.96 and 5.0 t/ha over the years of research, which is 0.07 and 0.11 t/ha less compared to the classical technology. Such a decrease in the yield of hemp straw of the Lara variety is insignificant.

Analysis of the seed yield of the varieties studied in the variety testing also showed that the highest indicators were formed in the Sula variety (Fig. 4).

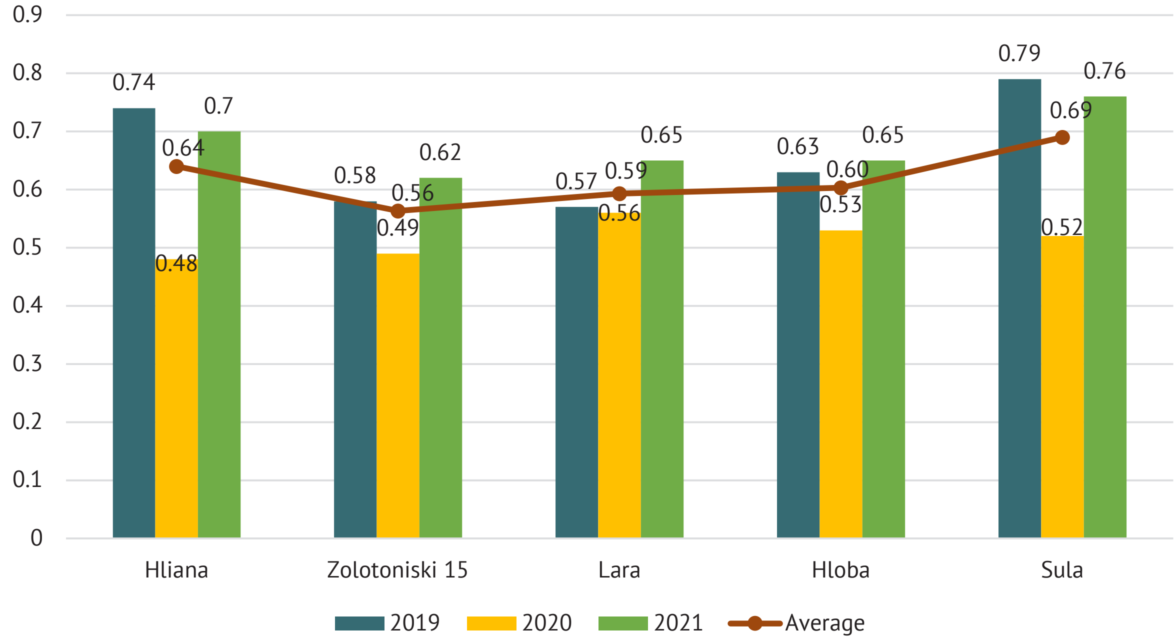

Figure 4. *Yield of hemp seeds in variety testing, 2019-2021*

The highest yield of hemp seeds was obtained in 2019 and 2021. In 2020, the seed yield was slightly lower. The yield of the Hliana variety was 0.4-0.6 t/ha lower compared to the Sula variety. In the Zolotoniski 15, Lara, and Hloba varieties, the average seed yield was 0.04-0.08 t/ha lower compared to the Hliana variety. The dependence of the yield on varietal characteristics and conditions of the research year confirms the feasibility of growing 3-4 hemp varieties on the farm annually to obtain stable yields.

The yield of hemp seeds had a slight variation in the variants of experiments. This allowed identifying the main factors influencing the formation of seed yield and proving the effectiveness of organic cultivation technologies.

Despite the fact that the average seed yield over the years of research had insignificant intervals of variation (0.56-0.58 t/ha), the conditions of the years have a significant impact on it (Fig. 5).

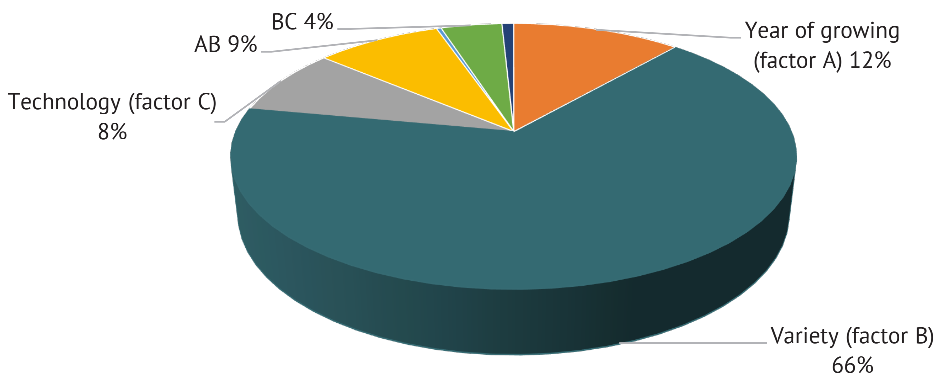

Figure 5. *Shares of influence of growing factors on the yield of hemp seeds*

The share of influence of cultivation technologies (factor C) was less significant on the formation of the yield of hemp seeds (8%). This indicates the prospect of using organic technologies for growing hemp. At the same time, there are opportunities to improve organic cultivation technologies to obtain a high level of yield. According to the results of research, it was found that varietal properties have the greatest influence on yield (66%). It is the variety that plays a crucial role in the formation of crop yield indicators. The influence of cultivation technologies also plays an important role in the complex of factors and interactions that affect seed yield (Table 2).

Table 2. *Yield of hemp seeds depending on varietal characteristics, cultivation technology, and year of research (factor A)*

Varieties (factor *B*)	Technology (factor C)	Yield, t/ha			
		2019	2020	2021	Average
Hliana – standard	inorganic (control)	0.62	0.55	0.54	0.57
	transitional period	0.62	0.52	0.53	0.56
	organic	0.60	0.55	0.52	0.56
	organic + BioStimix-Niva, 1 l/ha	0.62	0.60	0.56	0.59
Zolotoniski 15	inorganic (control)	0.54	0.53	0.54	0.54
	transitional period	0.54	0.55	0.53	0.54
	organic	0.54	0.54	0.53	0.54
	organic + BioStimix-Niva, 1 l/ha	0.53	0.54	0.54	0.54
Lara	inorganic (control)	0.55	0.56	0.55	0.55
	transitional period	0.56	0.55	0.55	0.55
	organic	0.54	0.54	0.54	0.54
	organic + BioStimix-Niva, 1 l/ha	0.56	0.56	0.56	0.56
Hloba	inorganic (control)	0.55	0.55	0.56	0.55
	transitional period	0.56	0.55	0.56	0.56
	organic	0.60	0.55	0.60	0.58
	organic + BioStimix-Niva, 1 l/ha	0.63	0.60	0.60	0.61
Sula	inorganic (control)	0.60	0.60	0.60	0.60
	transitional period	0.64	0.62	0.62	0.63
	organic	0.62	0.62	0.61	0.62
	organic + BioStimix-Niva, 1 l/ha	0.61	0.61	0.61	0.61
	LSD_{05} (factor *A*)				0.01
	LSD_{05} (factor *B*)				0.01
	LSD_{05} (factor *C*)				0.01
	LSD_{05} (*AB*)				0.02
	LSD_{05} (*BC*)				0.02

Source: *compiled by the authors*

In 2019, the highest yield indicator was recorded in the Sula variety using transitional cultivation technology. Slightly lower seed yields were obtained using organic cultivation technologies, although this deviation was within the statistical error range. Zolotoniski 15 and Lara varieties had the lowest seed yields, which did not exceed 0.54 and 0.56 t/ha, respectively. This year, the greatest variation in yield was observed – 0.53-0.64 t/ha. In subsequent years, the yield of hemp seeds in all variants of the experiment varied from 0.52 to 0.62 t/ha. The best response to the use of organic technology was the Hloba variety, where the yield increase is up to 10%. It is noteworthy that the use of a biodestructor led to a certain increase in yield, which was noticeable in the Hliana variety – 3.5%, and in the Hloba variety – 9.8% compared to the control variants.

The results of the analysis of the yield of hemp seeds of the Lara variety depending on the cultivation technology are shown in Figure 6.

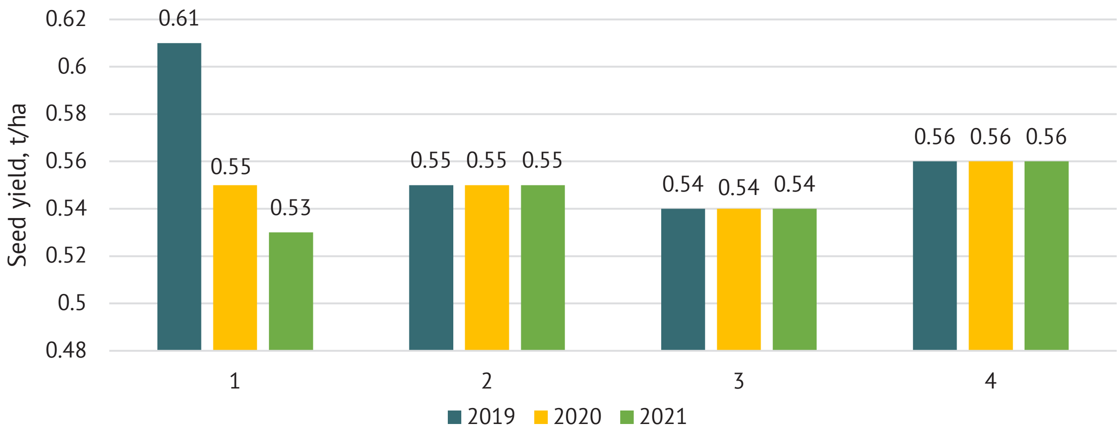

Figure 6. *Yield of hemp seeds depending on the cultivation technology, 2019-2021*
Note: *1 – Hliana (control); 2 – Lara (traditional); 3 – Lara (organic); 4 – Lara (organic + application of BioStimix-Niva, 1 l/ha)*

The highest yield of hemp seeds of the Hliana variety was observed using inorganic cultivation technology in 2019. On average, over the years of research, deviations in the yield of the Lara variety were insignificant. As a result, the study of experimental data by multivariate analysis of variance did not establish the influence of the studied factors. A detailed correlation analysis of economically valuable traits confirmed the hypothesis that the number of correlations may be different for each variety (Table 3).

Table 3. *Correlation coefficients r between economically valuable characteristics of hemp varieties*

Indicators	Varieties				
	Hliana	Zolotoniski 15	Lara	Hloba	Sula
Height of plants during biological ripeness, cm	***0.52***	0.11	0.02	***0.41***	-0.06
Duration to biological ripeness, days	-0.01	0.18	0.11	***0.42***	-0.14
Height of plants during harvesting on straw, cm	***0.60***	0.01	0.06	0.13	-0.04
Yield of straw, t/ha	***0.38***	-0.15	-0.14	***0.43***	-0.05
Seed yield, c/ha	1.00	1.00	1.00	1.00	1.00
Oil content, %	***-0.61***	0.11	0.05	***-0.46***	-0.16
Fibre yield, t/ha	***-0.45***	-0.08	0.01	***0.32***	-0.04
Fibre content in stems, %	***-0.73***	-0.07	0.02	0.18	0.08

Source: *compiled by the authors*

The Hliana variety had correlations between seed yield and plant height during the period of biological ripeness, the period of harvesting, and the yield of straw. In this variety, inverse correlations with oil content, fibre yield, and fibre content were also tracked. Of all the correlations, only one was strong – with the fibre content in the stems. Therefore, it is more appropriate to use the Hliana variety for growing fibre, rather than for seed production or dual-use. Although in the conducted studies, the varieties selected by LLC "Institute of organic farming" showed significantly better results compared to the varieties Hliana and Zolotoniski 15.

DISCUSSION

Many researchers have investigated the effectiveness of implementing crop cultivation technologies for the production of organic goods (Gerasko *et al.,* 2022; Kolomiyets *et al.,* 2022). According to Gerasko *et al.* (2022), an important task of organic production is to increase the volume of safe crops and maintain the stability of agroecosystems. B.N. Nasiyev *et al.* (2022) highlighted the relevance of a biological technology for growing crops such as barley and safflower for effective management of the agricultural landscape in organic farming. Cannabis, due to its unique properties, is a versatile and sustainable crop. In the course of research, it was found that its cultivation can minimise the use of synthetic fertilisers, since it requires minimal use of them. Growing hemp also helps minimise the environmental impact of carbon (Nath, 2022). The beneficial environmental impact of cannabis on the environment can reduce the cost of its protection measures to some extent. As indicated by Żuk-Gołaszewska *et al.* (2018), one hectare of cannabis is capable of absorbing about 2.5 tonnes of carbon dioxide. According to J. Viskovic (2023), cannabis is characterised by the potential of a sustainable and environmentally safe crop. E. Campiglia *et al.* (2020) evaluated the impact of various methods of growing hemp on the environment. The main factors of influence are the correct selection of varieties for cultivation, the density of sowing, and the timing of harvesting (Strzelczyk *et al.,* 2023). Results have been achieved in the case of biofertilisers and humic substances, but the decisive factor is the presence of moisture and high temperatures (Hammami *et al.,* 2022). However, cannabis can also have quite high productivity under water stress. From an economic standpoint, hemp is a crop that can produce yields on the so-called marginal lands (Blandinières *et al.,* 2022). This confirms the possibility of using hemp in organic farming.

The development of new varieties of crops requires clarification of ways to optimise their cultivation in order to realise their genetic potential. According to V.L. Dimitriev *et al.* (2021), increased yields and improved quality of hemp products are influenced by seeding rates. Thus, sowing hemp with a seed rate of 3.2 million pcs./ha, provides 3.32 t/ha of fibre (straw) with high quality indicators.

The paper by O. Horash *et al.* (2022) highlights the dependence of the yield of commercial seeds of hemp on the seeding rates and varietal characteristics. The maximum adaptive potential of the studied varieties USO 31, Hliana, and Hlesia (1,271, 1,506 and 1,737 t/ha, respectively) was noted for cultivation with a seeding rate of 0.6 million pcs./ha. The data obtained confirm the conclusions of other researchers regarding the dependence of hemp productivity on varietal characteristics. M. Baldini *et al.* (2020) determined that the yield of hemp seeds of the Bialobrzeskie variety is 0.61-0.65 t/ha and the Fedora variety – 0.92-1.0 t/ha. In the conditions of Serbia, M. Habán *et al.* (2022) found that the highest fibre yield was provided by the Bialobrzeskia variety (3.3±0.64 t/ha), and the highest seed yield was provided by the monoecious Novosadska variety (778.67±6.59 kg/ha). The productivity assessment (in terms of fibre and seeds) of six monoecious cannabis varieties was carried out in northern Greece (Tsaliki *et al.,* 2021). The highest fibre yield was observed in Futura 75 and Bialobrzeskie varieties (4.57 and 4.27 t/ha, respectively). Santhica 27, Tygra, and Bialobrzeskie varieties provided the highest seed yields – 2.7, 2.9, and 2.6 t/ha, respectively. The Bialobrzeskie variety under study recorded high fibre and seed yields.

The obtained experimental data are consistent with the conclusions of other researchers regarding the choice of hemp varieties depending on the area of use (for fibre or seeds). The fibre yield formation model is similar to the seed yield formation model (Baldini *et al.,* 2020), which is also confirmed in the presented studies and is important for the use of dual-use varieties. Such varieties have advantages over fibre-only varieties in terms of potential gross profit per hectare (Das *et al.,* 2020). It is important to select varieties for cultivation that may differ in the efficiency of water consumption in dry and hot conditions (Herppich *et al.,* 2020). This feature must be considered for the placement of agrocenoses in the conditions of unstable moisture, in which the experiments were conducted. According to M. Habán *et al.* (2022), the interaction of two factors, environmental conditions and genotype, plays a significant role in hemp production. The scope of use of hemp is constantly expanding, and accordingly, the territorial zone of cultivation of this crop is becoming wider. Now it is important to use cannabis not only for fibre, but also for seeds.

The increase in crop productivity under the influence of the use of microbiological preparations to activate the microbiological activity of the soil is widely covered in studies (Vlasyuk &Tymoshchuk, 2018; Panfilova, 2021). Y. Ulko (2019) highlights the increasing economic and environmental impact of the use of biologics in the cultivation of agricultural crops in organic farming. The high efficiency of using biodestructors for accelerated decomposition of plant residues is highlighted by Ye. Yurkevich and N. Valentiuk (2021).

Studies have confirmed that the cultivation of such agricultural crops as hemp using organic technologies has a positive effect on its productivity. The results of the analysis of scientific publications and trends in the development of hemp production indicate a lack of scientific developments on this topic, which increases the need for further research.

CONCLUSIONS

The most important factor for the effective cultivation of hemp using organic technologies are varietal characteristics. As a result of the assessment of five varieties of hemp, it was found that the yield of straw on average over the years of research ranged from 1.75-3.6 t/ha. The highest yield of hemp fibre was recorded in the Lara variety, and the lowest – in the Hliana variety. The fibre yield of hemp varieties depended on years of research. The most favourable year for the formation of crop productivity was 2021, and the least – 2020. The yield of straw and hemp fibres of the varieties under study was 4.09-5.33 and 1.74-3.58 t/ha, respectively, depending on the cultivation technology. It is confirmed that the cultivation of hemp using organic technologies does not cause a significant decrease in the yield of straw and fibres. There is an average direct correlation between the yield of straw and fibre (r=0.56), which indicates the influence of the variety and cultivation technology on this indicator. The use of a biodestructor contributed to an increase in the fibre yield of Hliana (3.5%) and Hloba (10.9%) varieties compared to the control. The yield of straw does not significantly depend on the conditions of the year, in contrast to the yield of fibre (47%). However, it strongly depends on the variety (96%). The influence of cultivation technology and the interaction of factors does not exceed 4%. The influence of the variety on the formation of fibre yield was 48%. Organic technologies for growing Lara varieties ensure the formation of straw yields at the level of 4.96 and 5.0 t/ha, which does not significantly differ from the control.

The highest yield of hemp seeds on average for 2019-2020 was observed in the Sula variety (0.69 t/ha), which is 0.4-0.6 t/ha more compared to the standard. The average yield of seeds of the Zolotoniski 15, Lara, and Hloba varieties was 0.56-0.6 t/ha. Varietal characteristics showed the maximum impact on the yield of hemp seeds (66%). The yield of Lara seeds for organic cultivation did not significantly deviate from the conventional technology. Based on the conducted studies, it was found that Hloba, Zolotoniski 15, Lara, and Sula varieties are suitable for double cultivation for seeds and fibre. It is advisable to use the Hliana variety only for growing fibre. Further research may focus on studying the physical parameters of fibre and seed quality using organic cultivation technologies.

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CONFLICT OF INTERESTS

None.

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Особливості формування продуктивності сучасних сортів конопель посівних за органічної технології вирощування

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Анотація. Коноплі посівні можуть використовуватися для отримання продукції і відтворення родючості ґрунтів. Адаптивний потенціал сортів конопель можна реалізувати завдяки оптимізації технологій їх вирощування. Метою досліджень було обґрунтування особливостей формування продуктивності сортів конопель посівних адаптованих до органічних технологій вирощування. Польові дослідження проведені протягом 2019-2021 рр. на вилужених чорноземах. Методи досліджень: польовий, лабораторний, статистичний і порівняльно-розрахунковий. Досліджено закономірності формування врожайності трести, волокна і насіння конопель посівних залежно від генетичного потенціалу сортів і технології вирощування. Оцінено придатність п'яти сортів конопель посівних для органічного вирощування. Встановлено, що впровадження органічної технології вирощування позитивно впливає на продуктивність культури. За органічного вирощування сортів Гляна і Глоба підвищення урожайності трести (0,07-0,11 т/га) було статистично неістотним порівняно з неорганічною технологією. Вирощування сортів Золотоніські 15 і Сула за органічних технологій збільшує на 0,14 т/га урожайність трести. У сорту Лара відмічено несуттєве зниження врожайності трести. Це підтверджує версію, що впровадження органічного вирощування конопель посівних не призведе до зниження рівня врожайності. Органічні технології вирощування конопель посівних сприяли підвищенню їх урожайності порівняно із класичними за умови правильного підбору сортів. Найкращу придатність для органічного вирощування за урожайністю волокна зафіксовано у сорту Лара. Отримані результати досліджень будуть використані для удосконалення і впровадження органічних технологій вирощування адаптованих сортів конопель посівних залежно від призначення на волокно чи насіння

Ключові слова: насіння; треста; волокно; генетичний потенціал; біодеструктор; кореляція