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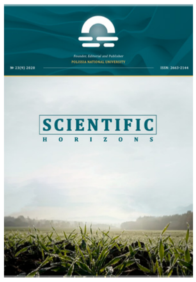

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Productivity of common flax varieties depending on fertiliser

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Abstract. Modern flax varieties have a high genetic potential for productivity, which can be realised by improving the elements of cultivation technology, in particular, the fertilisation system, which is why the study is relevant. The purpose of the study was

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to investigate the regularities of the development of productivity of common flax plants and determine changes in quality indicators depending on the application of improved agrotechnological techniques in the soil and climatic conditions of the Western Forest-Steppe. The following methods were used: field, laboratory (to determine qualitative indicators), and statistical (to assess the reliability of data). Field studies were conducted during 2021-2023 on grey forest surface-gleyed soils. The features of growth and development of common flax varieties Miandr, Oberih, Usivskyi and Ivanivskyi were studied using the following fertiliser rates: $N_{20}P_{40}K_{60}$; $N_{30}P_{60}K_{90}$; $N_{45}P_{90}K_{135}$. It was found that the productivity of common flax varied depending on the dose of mineral fertilisers and varietal characteristics. On average, in 2021-2023, the growing season of common flax lasted 91-94 days (depending on the variety and mineral nutrition of plants). The highest yield of flax straw (4.37 t/ha) was obtained on average for 2021-2023 in the Oberih variety, subject to the application of a dose of mineral fertilisers $N_{30}P_{60}K_{90}$. The increase over control was 0.52 t/ha (13.51%). The yield of straw in the Miandr variety varied from 3.59 t/ha (in the control) to 4.31 t/ha (with the application of $N_{45}P_{90}K_{135}$), for the Usivskyi variety – 3.97-4.17 t/ha, for the Ivanivskyi variety – 3.12-3.81 t/ha. In terms of seed yield, the highest indicators on average for 2021-2023 were obtained from the Miandr variety, provided that a dose of mineral fertilisers $N_{45}P_{90}K_{135}$ was used – 1.26 t/ha. The control yield was 0.88 t/ha. A similar trend was observed in the Oberih variety with seed yield indicators of 0.93 t/ha and 0.58 t/ha in the control. The seed yield of the Miandr variety exceeded the indicator of the Oberih variety by 0.33 t/ha against the background of fertiliser $N_{45}P_{90}K_{135}$. Against this background, fertilisation resulted in the highest seed yields in the varieties Usivskyi (0.99 t/ha) and Ivanivskyi (0.91 t/ha), which was 0.17 t/ha (20.73%) and 0.07 t/ha (8.33%) higher than the control variant, respectively. The results of these studies can be used to adjust the elements of the technology of growing common flax in production conditions to increase the yield and quality of fibre

Keywords: common flax; varieties; mineral fertilisers; productivity; cultivation technologies

INTRODUCTION

In modern conditions, the improvement of existing cultivation technologies and the selection of new adaptive varieties is relevant in the cultivation of flax. Since climate change is currently taking place, improving technologies and adapting varieties to appropriate conditions without losing the yield and quality of fibre and seeds is an important aspect of research. The average annual air temperature has increased by 2.0 degrees Celsius since the beginning of the 20th century, according to L. Wilson *et al.* (2021). O. Tarariko *et al.* (2022) note that recent climate changes are encouraging researchers to improve technologies for growing all crops.

Meteorological factors and their role in the development of flax productivity were investigated by Y. Trach (2020). The weather conditions and their changes were analysed during 2000-2020 in relation to long-term average indicators and the criterion of the coefficient of materiality of deviations of elements of agromeorological data. According to these observations and analyses, climate change is still occurring in the Western Forest-Steppe and Polissia, namely: an increase in the average daily air temperature, a change in the duration and onset of the growing season of flax, and an increase in the number and intensity of adverse weather events.

The application of mineral fertiliser doses was studied by A. Shuvar *et al.* (2021). According to these data, the combined application of organic and mineral fertilisers is an alternative to the use of moderate doses of mineral fertilisers. Fertilisation, as an agrotechnical method of regulating the potential capabilities of common flax varieties, was considered by O. Melnyk *et al.* (2022), O. Petrova (2020), I. Vereshchagin *et al.* (2022). The researchers highlighted the state of the problem and developments in the field of flax growing and the impact of fertilisers on product quality. Improvement of the technology of growing long-stemmed flax in the Western region of Ukraine was studied by V. Dumych (2020). His study highlights the systems of minimising tillage, which are used to increase the yield of straw and seeds. Another important aspect of flax research is the evaluation of breeding material for the main economic indicators, which was carried out by H. Dorota *et al.* (2020).

Yu. Berezovsky *et al.* (2021), S.V. Yahelyuk and V.F. Didukh (2020), A. Seleznyov and N. Danilova (2020), in their papers covering the development of the flax industry in Ukraine, analysed the current state and main trends in its development. V. Petrychenko and V. Lykhochvor (2020) substantiated the strategy for the development and improvement of the efficiency of this industry, proposals for its development. A. Limont and Z. Limont (2021) in their study on the development of productivity of common flax and stem, considering the density of plants before harvesting, note the influence of these factors on the change in the number of stalk bolls, the proportion of unproductive stems, and the coefficient of variation in the height and diameter of stems. According to data, the highest yield of seeds and straw was obtained at the maximum density values, namely: 2,500 pcs./m^2.

The study of the features of the elements of common flax technology under certain soil and climatic conditions with different fertiliser rates is an important aspect of obtaining a high-yield fibre and seed crop. The purpose of this study was to determine the influence of these factors on the development of yield indicators.

MATERIALS AND METHODS

The research was conducted on the experimental field of the Institute of Agriculture of the Carpathian Region of NAAS in 2021-2023 according to generally accepted methods. The soil of the experimental field was grey forest is superficially gleyed with the following agrochemical indicators (before the experiment) at a 0-20 cm layer: humus (by Tyurin) – 1.7-2.1%; pH (salt extract) – 5.1-5.4; easily hydrolysable nitrogen (by Cornfield) according to DSTU 7863:2015 (2015), – 85.4-88.2 mg/kg of soil; mobile forms of phosphorus – 67.4-99.0 mg/kg of soil and potassium (by Kirsanov) according to DSTU 4405:2005 (2005) – 84.4-86.2.0 mg/kg of soil. The predecessor of flax was winter cereals.

***Table 1**. Experiment scheme*

No.	Factor A (variety)	Factor B (fertiliser)
1	Miandr	Without fertilisers (control)
2		$N_{20}P_{40}K_{60}$
3		$N_{30}P_{60}K_{90}$
4		$N_{45}P_{90}K_{135}$
5	Oberih	Without fertilisers (control)
6		$N_{20}P_{40}K_{60}$
7		$N_{30}P_{60}K_{90}$
8		$N_{45}P_{90}K_{135}$
9	Usivskyi	Without fertilisers (control)
10		$N_{20}P_{40}K_{60}$
11		$N_{30}P_{60}K_{90}$
12		$N_{45}P_{90}K_{135}$
13	Ivanivskyi	Without fertilisers (control)
14		$N_{20}P_{40}K_{60}$
15		$N_{30}P_{60}K_{90}$
16		$N_{45}P_{90}K_{135}$

***Source:** developed by the authors*

Ploughing was carried out to a depth of 22-26 cm, followed by harrowing, application of mineral fertilisers, pre-sowing cultivation, and rolling. The crops were sown at the optimum time, at a soil temperature of 7-8°C at a depth of 10 cm, as soon as weather conditions allowed (second ten days of April) with a SL-16 seeder using a narrow-row method (7.5 cm) in a fourfold replication with a seeding rate of 22 million germinated seeds per hectare in accordance with the methodological recommendations. Plot area: sown area – 36 m^2; accounting area – 25 m^2. The repetition of the experiment was fourfold. The seeding rate was 22 million germinated seeds per 1 ha. The following mineral fertilisers were used: ammonium nitrate, granular superphosphate, potassium salt, or potassium magnesium. To control weeds in the phase of leaf development, a tank mixture of herbicides Grodil (0.1 l/ha) and Oreol maxi (1.25 l/ha) was introduced on all variants of the experiment. To control the flax flea beetle (*Aphthona euphorbiae Schrk*) in the presence of economic threshold of harmfulness (ETH) (pest population density exceeds 10 beetles per 1m^2) – the entire field is treated using Fury insecticide (0.10 l/ha) during the onset of the full germination phase.

Collection and accounting of seeds and straw was carried out separately. The weight of 1,000 seeds, its germination rate, and germination energy were determined. Fibre quality was determined by the following indicators of technological analysis: fibre content in straw, in flax stock, fibre yield, its strength and flexibility. Sampling for structural and technological analysis was carried out in the yellow ripeness phase of flax plants. Morphophysiological studies in dynamics by stages of organogenesis of common flax was determined according to procedures (Molotskyi *et al.,* 2006). Statistical processing of the results was carried out using the programmes Statistica 6.0 and Excel 2003.

Experimental studies of plants (both cultivated and wild), including the collection of plant material, were in accordance with institutional, national or international guidelines. The authors adhered to the standards of the Convention on Biological Diversity (1992) and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (1979).

RESULTS AND DISCUSSION

The effectiveness of the fertiliser application was primarily assessed based on the yields of flax straw and flax seeds. It is from them that conclusions can be drawn about the influence of growing conditions on the processes of plant growth and development. The choice of variety and the application of appropriate fertiliser affects the course of plant vegetation and productivity.

The results of the study showed that the use of fertiliser significantly affected the productivity of common flax (Table 2). The yield of straw in 2021 of the Miandr variety ranged from 5.8 t/ha (in the control) to 6.11 t/ha (with the application of $N_{30}P_{60}K_{90}$). A similar pattern of straw yield formation under the influence of fertiliser was recorded in the Oberih variety from 6.0 t/ha (in the control), up to 6.21 t/ha (for applying a dose of mineral fertilisers $N_{30}P_{60}K_{90}$). On average, the increase in flax straw yield was 0.20-0.31 t/ha (3.45-5.34%) for the Miandr variety, 0.12-0.21 t/ha (2.00-3.50%) for the Oberih variety, and for the Usivskyi variety, the average increase in flax straw yield was 0.21-0.42 t/ha (3.32-6.65%), for the Ivanivskyi variety – 0.19-0.47 t/ha (3.37-8.33%). The highest yield of flax straw (6.74 t/ha) was obtained from the new variety Usivskyi, subject to the application of $N_{30}P_{60}K_{90}$. The increase over control was 0.42 t/ha (6.65%). The yield of straw in 2022 of the Miandr variety ranged from 1.58 t/ha (in the control) to 2.20 t/ha (with the application of $N_{45}P_{90}K_{135}$). A similar pattern of straw yield generation under the influence of fertiliser was recorded in the Oberih variety from 1.17 t/ha (in the control) to 2.13 t/ha (when applying a dose of mineral fertilisers $N_{45}P_{90}K_{135}$).

***Table 2**. Productivity of flax straw of common flax varieties depending on the elements of cultivation technology in 2021-2023, (t/ha)*

Variety	Fertilisation background	Flax straw yield, t/ha			Deviation from control, t/ha		
		2021	2022	2023	2021	2022	2023
Miandr	Control	5.80	1.58	3.38	–	–	–
	$N_{20}P_{40}K_{60}$	6.00	1.95	3.59	0.20	0.37	0.21
	$N_{30}P_{60}K_{90}$	6.11	2.07	4.33	0.31	0.49	0.95
	$N_{45}P_{90}K_{135}$	6.09	2.20	4.65	0.29	0.62	1.27
Oberih	Control	6.00	1.17	4.38	–	–	–
	$N_{20}P_{40}K_{60}$	6.10	1.30	4.74	0.10	0.13	0.36
	$N_{30}P_{60}K_{90}$	6.21	1.92	4.97	0.21	0.75	0.59
	$N_{45}P_{90}K_{135}$	6.13	2.13	4.76	0.13	0.96	0.38
Usivskyi	Control	6.32	1.13	2.64	–	–	–
	$N_{20}P_{40}K_{60}$	6.53	1.18	3.01	0.21	0.05	0.37
	$N_{30}P_{60}K_{90}$	6.74	1.38	3.33	0.42	0.25	0.69
	$N_{45}P_{90}K_{135}$	6.67	1.40	4.43	0.35	0.27	1.79
Ivanivskyi	Control	5.64	1.45	2.29	–	–	–
	$N_{20}P_{40}K_{60}$	5.83	1.90	2.79	0.19	0.45	0.50
	$N_{30}P_{60}K_{90}$	6.11	2.05	3.12	0.47	0.6	0.83
	$N_{45}P_{90}K_{135}$	5.95	2.18	3.31	0.31	0.73	1.02

***Source:** compiled by the authors*

The increase in the yield of flax straw in 2022 was 0.37-0.62 t/ha for the Miandr variety (23.42-39.24%), for the Oberih variety – 0.13-0.96 t/ha (11.11-82.05%), for the Usivskyi variety, the average increase in the yield of flax straw was 0.05-0.27 t/ha (4.42-23.89%), for the Ivanivskyi variety – 0.45-0.73 t/ha (31.03-50.34%). The highest yield of flax straw in 2022 (2.20 t/ha) was obtained in the Miandr variety, subject to the application of $N_{45}P_{90}K_{135}$, the increase over the control was 0.62 t/ha (39.24%), and the Ivanivskyi variety (2.18 t/ha), subject to the application of a dose of $N_{45}P_{90}K_{135}$, the increase over the control was 0.73 t/ha (50.34%).

The yield of flax straw in 2023 mainly depended on the varietal characteristics and fertilisation background, namely: Miander – 3.38-4.65 t/ha; Oberih – 4.38-4.97 t/ha; Usivskyi – 2.64-4.63 t/ha; and Ivanivskyi – 2.29-3.31 t/ha. The increase over control (without fertilisers): Miandr – 0.21-1.27 t/ha (6.21-37.57%); Oberih – 0.36-0.59 t/ha (8.22-13.47%); Usivskyi – 0.37-1.79 t/ha (14.01-67.80%) and Ivanivskyi – 0.50-1.02 t/ha (21.83-44.54%). The highest straw yield in 2023 was in the Oberih variety with the applicatoin of $N_{45}P_{90}K_{135}$ – 4.97 t/ha. Other varieties were also characterised by high indicators – Miandr – 4.65 t/ha, Usivskyi – 4.63 t/ha. Slightly lower straw yield indicators were obtained with the Ivanivskyi variety – 3.31 t/ha.

Regarding the seed yield indicator in 2021 (Table 3), it was obtained from the Miandr variety under the condition of using a dose of mineral fertilisers $N_{45}P_{90}K_{135}$ – 0.99 t/ha. With this, the yield of the control was 0.91 t/ha. A similar trend was observed in the Oberih variety with seed yield indicators of 0.90 t/ha and

0.83 t/ha in the control. The seed yield of the Miandr variety exceeded the indicator of the Oberih variety by 0.09 t/ha against the background of $N_{45}P_{90}K_{135}$ application. Against this background, fertilisation resulted in the highest seed yields in the varieties Usivskyi (1.02 t/ha) and Ivanivskyi (1.05 t/ha), which is 0.08 t/ha (8.51%) and 0.06 t/ha (6.06%) higher than the control variant, respectively.

***Table 3**. Productivity of seeds of common flax varieties depending on the elements of cultivation technology in 2021-2023, (t/ha)*

Variety	Fertilisation background	Seed yield, t/ha			Deviation from control, t/ha		
		2021	2022	2023	2021	2022	2023
Miandr	Control	0.91	0.77	0.97	–	–	–
	$N_{20}P_{40}K_{60}$	0.94	0.86	1.00	0.03	0.09	0.03
	$N_{30}P_{60}K_{90}$	0.96	0.98	1.23	0.05	0.21	0.26
	$N_{45}P_{90}K_{135}$	0.99	1.43	1.37	0.08	0.66	0.40
Oberih	Control	0.83	0.45	0.47	–	–	–
	$N_{20}P_{40}K_{60}$	0.86	0.65	0.69	0.03	0.2	0.22
	$N_{30}P_{60}K_{90}$	0.89	0.87	0.90	0.06	0.42	0.43
	$N_{45}P_{90}K_{135}$	0.90	0.98	0.92	0.07	0.53	0.45
Usivskyi	Control	0.94	0.55	0.97	–	–	–
	$N_{20}P_{40}K_{60}$	0.98	0.68	1.01	0.04	0.13	0.04
	$N_{30}P_{60}K_{90}$	1.01	0.77	1.07	0.07	0.22	0.10
	$N_{45}P_{90}K_{135}$	1.02	0.8	1.16	0.08	0.25	0.19
Ivanivskyi	Control	0.99	0.55	0.97	–	–	–
	$N_{20}P_{40}K_{60}$	1.02	0.57	1.00	0.03	0.02	0.03
	$N_{30}P_{60}K_{90}$	1.03	0.58	1.03	0.04	0.03	0.06
	$N_{45}P_{90}K_{135}$	1.05	0.58	1.09	0.06	0.03	0.12

***Source:** compiled by the authors*

The use of a dose of mineral fertiliser $N_{45}P_{90}K_{135}$ for the new variety Ivanivskyi in 2021 resulted in an increase in seed yield of 0.06 t/ha (6.06%) compared to the control variant (without fertiliser), with the highest seed yield of 1.05 t/ha. The highest seed yield in 2022 was obtained from the Miandr variety – 1.43 t/ha. The yield of the control was 0.77 t/ha. A similar trend was observed in the Oberih variety with seed yield indicators of 0.98 t/ha and 0.45 t/ha in the control.

The seed yield of the Miandr variety exceeded the indicator of the Oberih variety by 0.45 t/ha against the background of $N_{45}P_{90}K_{135}$ application. Against the same background, fertilisation provided the highest seed yields in the Usivskyi (0.80 t/ha) and Ivanivskyi (0.58 t/ha) varieties, which were 0.25 t/ha (45.45%) and 0.03 t/ha (5.45%), respectively. The use of a dose of mineral fertiliser $N_{45}P_{90}K_{135}$ for the Miandr variety in 2022 resulted in an increase in seed yield of 0.66 t/ha (85.71%) compared to the control variant (without fertiliser), Oberih variety – 0.53 t/ha (117.78%) compared to the control variant (without fertiliser), respectively, with the highest seed yield of 1.43 t/ha.

Analysing the yield indicators of flax seeds that were received in 2023, it is worth noting that the Miandr variety had the highest result, namely 1.37 t/ha against the background of $N_{45}P_{90}K_{135}$ application, an increase over the control (without fertilisers) – 0.40 t/ha (41.23%). The second in terms of yield was the Usivskyi variety, with a yield in the range of 0.97-1.16 t/ha, an increase over control (without fertilisers) – 0.04-0.19 t/ha (4.12-19.59%). Slightly lower indicators of seed yield were noted in the Ivanivskyi varieties – 0.97-1.09 t/ha, an increase of 0.03-0.12 t/ha (3.09-12.37%) and Oberih – 0.47-0.92 t/ha, an increase of 0.22-0.45 t/ha (46.81-95.74%). According to the data presented in Table 2, it can be concluded that the yield of flax seeds during 2021-2023 depended on varietal characteristics and the level of mineral nutrition, and hydrothermal conditions that accompanied the plant during the growing season.

The analysis of the productivity of common flax varieties on average for 2021-2023 is shown in Table 3. The highest yield of flax straw (4.37 t/ha) was obtained on average for 2021-2023 (Table 4) in the Oberih variety, subject to the application of a dose of $N_{30}P_{60}K_{90}$. The increase over control was 0.52 t/ha (13.51%). The average straw yield for 2021-2023 in the Miandr variety ranged from 3.59 t/ha (in the control) to 4.31 t/ha (with the application of $N_{45}P_{90}K_{135}$), in the Usivskyi variety – 3.97-4.17 t/ha, in the Ivanivskyi variety – 3.12-3.81 t/ha.

Table 4. *Productivity of common flax varieties depending on the elements of cultivation technology, on average for 2021-2023 (t/ha)*

No.	Fertilisation background	Flax straw yield, t/ha	Deviation from control, t/ha	Deviation to control, %	Seed yield, t/ha	Deviation from control, t/ha	Deviation to control, %
				Miandr			
1	Control	3.59	–	–	0.88	–	–
2	$N_{20}P_{40}K_{60}$	3.85	0.26	7.24	0.93	0.05	5.68
3	$N_{30}P_{60}K_{90}$	4.17	0.58	16.16	1.06	0.18	20.45
4	$N_{45}P_{90}K_{135}$	4.31	0.72	20.01	1.26	0.38	43.18
				Oberih			
5	Control	3.85	–	–	0.58	–	–
6	$N_{20}P_{40}K_{60}$	4.05	0.20	5.19	0.73	0.15	25.86
7	$N_{30}P_{60}K_{90}$	4.37	0.52	13.51	0.89	0.31	53.45
8	$N_{45}P_{90}K_{135}$	4.34	0.49	12.73	0.93	0.35	60.31
				Usivskyi			
9	Control	3.36	–	–	0.82	–	–
10	$N_{20}P_{40}K_{60}$	3.57	0.21	6.25	0.89	0.07	8.54
11	$N_{30}P_{60}K_{90}$	3.82	0.46	13.69	0.95	0.13	15.85
12	$N_{45}P_{90}K_{135}$	4.17	0.81	24.11	0.99	0.17	20.73
				Ivanivskyi			
13	Control	3.12	–	–	0.84	–	–
14	$N_{20}P_{40}K_{60}$	3.17	0.05	1.60	0.86	0.02	2.38
15	$N_{30}P_{60}K_{90}$	3.76	0.64	20.51	0.88	0.04	4.76
16	$N_{45}P_{90}K_{135}$	3.81	0.69	22.11	0.91	0.07	8.33

Note: *$LSD_{0.05}$, t/ha: flax straw yield A (varieties) – 0.5; B (fertilisers) – 0.11; AB (interaction) 0.010; $LSD_{0.05}$, t/ha: seed yield A (varieties) –0.47; B (fertilisers) –0.03; AB (interaction) –0.09*
Source: *compiled by the authors*

On average, the increase in flax straw yield was 0.26-0.72 t/ha (7.24-20.01%) for the Miandr variety; 0.20-0.52 t/ha (5.19-13.51%) for the Oberih variety; 0.21-0.81 t/ha (6.25-24.11%) for the Ivanivskyi variety; 0.05-0.69 t/ha (1.6-22.11 %) depending on the fertiliser. The average seed yield for 2021-2023 was 1.26 t/ha in the Miandr variety, subject to the application of $N_{45}P_{90}K_{135}$. The control yield was 0.88 t/ha. A similar trend was observed in the Oberih variety with seed yield indicators of 0.93 t/ha (against the application of $N_{45}P_{90}K_{135}$) and 0.58 t/ha (in control). The yield of seeds of the Miandr variety exceeded the indicator of the Oberih variety by 0.33 t/ha against the application of $N_{45}R_{90}K_{135}$. Against this background, fertilisation resulted in the highest seed yields in the varieties Usivskyi (0.99 t/ha) and Ivanivskyi (0.91 t/ha), which was 0.17 t/ha (20.73%) and 0.07 t/ha (8.33%) higher than the control variant, respectively.

The results of current studies indicate that the productivity and growing conditions of common flax directly depend on the varietal characteristics and mineral nutrition of plants. Analysing the significance of the research factor, fertilisers had a greater impact on productivity than varieties. When applying different fertiliser rates, the productivity of straw and flax seeds of all the varieties under study increases. These findings were consistent with the data of other scientists. H. Dorota and O. Voloshchuk (2023) investigated that the highest straw yield was developed by applying mineral fertilisers $N_{30}P_{60}K_{90}$. When increasing the rates of mineral nutrition from $N_{20}P_{40}K_{60}$ to $N_{45}P_{90}K_{135}$, the straw yield increased. According to the findings, the influence on straw yield was established. The highest results in the Western Forest-Steppe were obtained with $N_{45}P_{90}K_{135}$ in the Miandr variety, while the yield of flax straw was 4.15 t/ha and seeds – 1.21 t/ha. The increase in relation to the non-fertilised version (control) was 0.46 and 0.37 t/ha, respectively.

Ye. Zaika *et al.* (2021) found that in seed crops of common flax varieties, the highest yield was obtained with the aplication of $N_{48}P_{48}K_{48}$, namely: 0.69 t/ha (Rushnichok variety) and 0.66 t/ha (Vruchyi variety). The researchers recommend using the results of these studies to accelerate the introduction of new varieties of common flax in various parts of seed production in the Forest-Steppe zone and note that it is characterised by a good reaction to the use of fertilisers, and low sensitivity to condensed crops. Comparing these studies, the application of fertiliser also had a positive effect on these indicators, the increase in relation to non-fertilised variants (control) was: 0.05-0.38 t/ha (Miandr variety), 0.15-0.35 t/ha (Oberih variety), 0.07-0.17 t/ha (Usivskyi variety) and 0.02-0.07 t/ha (Ivanivskyi variety).

One of the main measures to increase the productivity of common flax and improve the quality of fibre is the use of mineral fertilisers. Indicators of its quality may vary depending on the doses and ratio of micro- and macro- elements, the timing and methods of their introduction. According to current research, the amount and quality of fibre also improved with the movement of fertiliser application. The highest flexibility indicators were observed in the Oberih variety – 56.3-63.7 mm; Miandr – 55.0-62.7 mm, Usivskyi – 52.0-52.4 mm, Ivanivskyi – 53.7-57.6 mm. Improvement of cultivation technology should be carried out depending on zonal features, using new achievements in agrochemistry and ecology. The solution of this problem involves the use of microelements and biologics that are important for growth and development on flax, depending on the availability of mobile forms of elements in soils. This information is consistent with the data set out by O. Rudik and R. Vozhegova (2018), A. Chuhlib (2020).

Summing up the above data, it can be noted that given the changes in the environment, it is important to revise some elements of the technology of growing common flax depending on the zone and varietal characteristics.

CONCLUSIONS

The results of three years of research show that in the soil and climatic conditions of the Western Forest-Steppe, the maximum yield of flax straw was ensured by the rates of mineral fertilisers $N_{30}P_{60}K_{90}$ and $N_{45}P_{90}K_{135}$. According to these fertilisation rates, the varieties under study formed an average yield of 4.17-4.31 t/ha (Miandr), 4.37-4.34 t/ha (Oberih), 3.82-4.17 t/ha (Usivskyi) and 3.76-3.81 t/ha (Ivanivskyi). A decrease in the fertilisation rate and non-fertiliser options resulted in lower coenosis yields. The deviation of these indicators in relation to the control (without fertilisation) was: in the Miandr variety – 0.58-0.72 t/ha; Oberih – 0.52-0.49 t/ha; Usivskyi – 0.46-0.81 t/ha; Ivanivskyi – 0.64-0.69 t/ha.

Application of mineral fertilisers at the rate of $N_{20}P_{40}K_{60}$, $N_{30}P_{60}K_{90}$, $N_{45}P_{90}K_{135}$ contributed to an increase in the yield of flax seeds of all the varieties under study. Depending on the variety and mineral nutrition, the increase ranged from 0.02 to 0.38 t/ha. Based on the results of the research, the influence of the studied factors on the yield and fibre content in straw was established. The highest indicators were obtained in the Oberih variety – 1.24 t/ha and 28.3% with the application of $N_{30}P_{60}K_{90}$. Slightly lower indicators of fibre yield and its content in straw against the same background were found in the Miandr variety – 1.04 t/ha and 25.1%; Usivskyi – 0.97 t/ha and 25.1%; Ivanivskyi – 1.02 t/ha and 24.1%, respectively. The increase over control ranged from 0.08 to 0.22 t/ha, depending on the variety and mineral nutrition.

Prospects for further research will be related to the study of seeding rates of common flax in the Carpathian region in order to prevent lodging of plants, increase productivity and fibre quality. It is crucial to investigate the impact of biological methods on the effectiveness of growing common flax.

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CONFLICT OF INTEREST

None.

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Продуктивність сортів льону-довгунця залежно від удобрення

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Анотація. Сучасні сорти льону-довгунця мають високий генетичний потенціал продуктивності, реалізувати його можна за допомогою удосконалення елементів технології вирощування, зокрема, системи удобрення, що й зумовлює актуальність дослідження. Метою роботи було дослідити закономірності формування продуктивності рослин льону-довгунця та визначити зміни якісних показників залежно від застосування удосконалених агротехнологічних прийомів в ґрунтово-кліматичних умовах Лісостепу Західного. У процесі виконання роботи використовували наступні методи: польовий, лабораторний (для визначення якісних показників), та статистичний (для оцінки достовірності даних). Польові дослідження проводили впродовж 2021-2023 рр. на сірих лісових поверхнево оглеєних ґрунтах. Досліджували особливості росту і розвитку сортів льону-довгунцю Міандр, Оберіг, Усівський та Іванівський із застосуванням таких норм удобрення, як $N_{20}P_{40}K_{60}$, $N_{30}P_{60}K_{90}$, $N_{45}P_{90}K_{135}$. Встановлено, що продуктивність льону-довгунця змінювалися залежно від дози мінеральних добрив та сортових особливостей. В середньому за 2021-2023 рр. вегетаційний період у льону-довгунця тривав 91-94 доби (залежно від сорту та мінерального живлення рослин). Найвищу врожайність льоносоломи (4,37 т/га) отримано в середньому за 2021-2023 рр. у сорту Оберіг за умови внесення дози мінеральних добрив $N_{30}P_{60}K_{90}$. Приріст до контролю становив – 0,52 т/га (13,51 %). Врожайність соломи у сорту Міандр, варіювала від 3,59 т/га (на контрольному варіанті) до 4,31 т/га (за внесення дози мінеральних добрив $N_{45}P_{90}K_{135}$), у сорту Усівський –3,97-4,17 т/га, у сорту Іванівський – 3,12-3,81 т/га. Щодо врожайності насіння, то найвищі показники в середньому за 2021-2023 рр. отримано у сорту Міандр за умови використання дози мінеральних добрив $N_{45}P_{90}K_{135}$ – 1,26 т/га. При цьому врожайність на контролі становила 0,88 т/га. Аналогічну тенденцію спостерігали у сорту Оберіг з показниками врожайності насіння – 0,93 т/га та 0,58 т/га на контролі. Врожайність насіння у сорту Міандр перевищувала показник сорту Оберіг на 0,33 т/га при фоні удобрення $N_{45}P_{90}K_{135}$. На цьому ж фоні удобрення отримали найвищі показники врожайності насіння у сортів Усівський (0,99 т/га) та Іванівський (0,91 т/га), що вище контрольного варіанту на 0,17 т/га (20,73 %), та 0,07 т/га (8,33 %) відповідно. Результати цих досліджень можуть бути використані для корегування елементів технології вирощування льону-довгунця у виробничих умовах для підвищення врожайності та якості волокна

Ключові слова: льон-довгунець; сорти; мінеральні добрива; продуктивність; технології вирощування