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The peculiarities of the formation of yield and sowing qualities of soft winter wheat seeds depending on the preceding crop, sowing date and fertilisers

A. A. Siroshtan*, M. M. Lystukha

*The V. M. Remeslo Myronivka Institute of Wheat, NAAS of Ukraine, 68 Tsentralna St., Tsentralne village, Obukhiv district, Kyiv region, 08853, Ukraine, *e-mail: siroshtanandriy@gmail.com*

Purpose. To identify the features of the formation of yield and sowing qualities of soft winter wheat seeds depending on a pre-crop, sowing date and different doses of nitrogen fertilizer in the conditions of the central part of the Forest-Steppe of Ukraine. **Methods.** The study was conducted from 2021/22 to 2023/24 at the V. M. Remeslo Myronivka Institute of Wheat of the NAAS. The influence of different nitrogen fertilizer (UAN-32) norms [25, 50 and 75 kg/ha of active substance (a.s.)], sowing dates (5 and 15 October) and precrops (sunflower and soybean) on the yield and sowing qualities of three soft winter wheat varieties ('MIP Assol', 'Estafeta Myronivska' and 'MIP Dniprianka') was established. The sowing qualities of soft winter wheat seeds were determined according to generally accepted methods in different variants of the experiment. **Results.** It was determined that the conditions in a given year had a significant influence on yield, 1,000-seed weight, conditioned seed yield and sprouting activity. The indicators of germination energy and laboratory seed germination remained relatively stable under different growing conditions. In drier growing conditions in 2021/22, significantly lower values of yield (3.81 t/ha) and 1,000-seed weight (42.6 g), as well as significantly higher seed sprouting activity (87%), were observed compared to in 2022/23 and 2023/24. The highest conditioned seed yield (75.9%) was obtained in 2023/24. The highest average yield values (4.79–5.04 t/ha), 1,000-seed weight values (43.5–44.9 g) and conditioned seed yield values (72.9–75.2%) were obtained after sowing soybeans. Higher yields (4.07–5.38 t/ha) and 1,000-seed weights (43.9–45.8 g) were found when sowing on 5 October. No significant effect of sowing dates on the yield of conditioned seeds was found. It was determined that fertilising the plants with UAN-32 at an application rate of 75 kg/ha a.s. contributed to significantly higher yields and maximum 1,000-seed weights (43.1–47.4 g) and conditioned seed yields (74.5–81.6%) compared to other nutritional standards. No significant effects of sowing dates, precrops or different fertilising rates on sprouting activity, germination energy or laboratory seed germination were found. Over the years, stable direct relationships (r = 0.70–0.92) were found between yield and 1,000-seed weight, as well as between yield and conditioned seed yield. **Conclusions.** To obtain higher yields, it is worth sowing soft winter wheat varieties on 5 October after a soybean precrop with UAN-32 nutrition at a rate of 75 kg/ha a.s.

Keywords: *Triticum aestivum L.; yield; 1,000-seed weight; yield of conditioned seeds; sprouting activity; germination energy; laboratory germination.*

Introduction

Grain cultivation is a key factor in shaping the agricultural sector, which in turn determines the level of development of Ukraine's agrarian economy in modern conditions [1]. Winter wheat is the most important food crop among the most important grain crops in Ukraine [2]. Increasing wheat production in Ukraine remains a priority.

Research conducted by a number of scientists has found that the yield of winter wheat depends on soil and climatic conditions during certain periods of plant development [3, 4]. Each weather element has a specific effect on plant growth and development when combined with the agrotechnical measures used in winter crop cultivation [5]. The genetic potential of modern crop varieties, particularly winter wheat, can be realised by improving agricultural cultivation technologies [6, 7].

In areas with unstable moisture levels, the impact of weather conditions on winter wheat productivity is 30–40%. The most important factor is the use of various agricultural techniques, particularly mineral fertilisers [8]. Using mineral nutrients positively affects the productive stem density of winter wheat. Properly selected doses of mineral fertiliser contribute to balanced plant nutrition, significantly increasing crop productivity [9]. The greatest effect on

Andrii Siroshtan
https://orcid.org/0000-0003-3246-2907
Mykhailo Lystukha
https://orcid.org/0000-0002-6476-7521

grain yield is achieved through the use of nitrogen fertilisers [10].

Among the special measures to prevent the effects of adverse weather conditions, particularly drought, adhering to scientifically based crop rotation is important. The choice of preceding crop for winter wheat and its position in the crop rotation are the most important factors in increasing production of this important crop. These factors must be considered alongside soil and climatic conditions, as well as organisational, economic, and agrotechnical measures [11]. Only scientifically sound crop rotations can provide winter wheat with suitable pre-crops, prevent the mass spread of pests and diseases, and reduce the level of weed contamination in crops [12]. Therefore, when choosing pre-crops for winter wheat, many factors must be considered, primarily soil and climatic conditions, as well as the requirements of relevant scientifically based cultivation technologies [13].

The optimal sowing dates for winter crops are a controversial topic. Sowing dates affect the degree of plant development, winter hardiness and productivity [14]. To obtain high, stable yields, winter cereals should be sown at the optimal time, depending on previous crops, the weather in a given year, soil conditions, moisture content, and other factors [15]. Sowing dates also vary depending on the variety's biological characteristics. Depending on the sowing date, plants encounter different growth and development conditions and accumulate reserve substances in their leaves and tillering nodes at different rates. This affects their resistance to low and high temperatures, diseases and pests, and accordingly their yield potential. Therefore, in the context of climate change and warming temperatures, it is crucial to determine changes in the optimal sowing dates for winter wheat, as this is one of the most important aspects of agricultural technology and a key factor in sustainable food grain production [16].

Therefore, in the current economic conditions, the most effective way to increase winter wheat yields is to introduce high-yielding varieties and improve scientifically based cultivation technologies in Ukraine's natural and climatic conditions [17, 18]. It has also been established that grain crop yield increases by 20–25% thanks to the use of high-quality new variety seeds [19]. When producing seeds, their quality is typically evaluated based on varietal and sowing qualities [20].

The aim of the research is to identify the characteristics of soft winter wheat varieties in terms of yield formation and sowing qualities, depending on the preceding crop, sowing date, and different doses of nitrogen fertiliser, in the central part of the Forest-Steppe zone of Ukraine.

Materials and research methods

The research was conducted at the V. M. Remeslo Myronivka Institute of Wheat of the National Academy of Agrarian Sciences (MIW) during 2021/22–2023/24. The influence of different nitrogen fertiliser application rates [UAN-32 at 25, 50 and 75 kg/ha of active substance (a.s.)], sowing dates (1 October and 15 October) and crop rotations (sunflower and soybean) on the yield and sowing qualities of three soft winter wheat varieties ('MIP Assol', 'Estafeta Myronivska' and 'MIP Dniprianka') was investigated. The sowing qualities of soft winter wheat seeds were determined for different experimental variants in accordance with generally accepted methods [21, 22].

The soil cover of the MIW fields is deep black soil (38–42 cm), low in humus and slightly alkaline. The humus content in the 20 cm soil layer is 3.6–4.0%, readily available nitrogen – 0.006%, phosphorus – 0.025% and exchangeable potassium – 0.011–0.018%, pH – 5.3–6.4, total absorbed bases – 0.23–0.29 mg-eq per 1 kg of soil, degree of base saturation – 86.2–94.4%.

Soft winter wheat was cultivated using the standard method for the forest-steppe region of Ukraine [23]. Sowing was carried out using the SN-10 C seeder at a depth of 4–5 cm with a rate of 5 million viable seeds per hectare. The area of the experimental plots recorded was 10 m^2. There were four replications. The grain from the experimental plots was harvested using a Sampo-130 combine harvester.

The experimental data obtained was analysed using descriptive statistical methods [24]. To interpret the Pearson correlation coefficients (r), Chaddock's scale [25] was used:

– $0 < r < 0.09$: no correlation
– $0.10 < r < 0.29$: weak correlation
– $0.30 < r < 0.49$: moderate correlation
– $0.50 < r < 0.69$: significant correlation
– $0.70 < r < 0.89$: strong correlation
– $0.90 < r < 0.99$: very strong correlation
– $r = 1.00$: functional correlation

Research results

The years of the study showed contrasting air temperatures, with significant monthly variations in precipitation and uneven distribution throughout the year (see Table 1). The average annual air temperature was 9.3 °C in 2021/22, 9.7 °C in 2022/23 and 11.6 °C in 2023/24, compared to a long-term average of 8.3 °C. Thus, during the research period, an increase in the average annual air temperature of 1.0–3.3 °C above the long-term average (LTA) was observed. A significant increase in the average monthly air temperature of 0.8–6.5 °C from the LTA was observed every year in November, December, January, February, March, June and July. The months of September, October, April and July in the 2023/24 period were also abnormally warm, with average temperatures exceeding the normal range by 3.6–4.2 °C. A significant decrease in air temperature of 1.3–1.6 °C below the LTA was observed in September 2021/22 and 2022/23. In terms of precipitation, the 2021/22 growing season was characterised by dry conditions (469 mm, or 80% of the LTA). In contrast, conditions in 2022/23 were characterised by excessive moisture (773 mm, 132% of the LTA). In 2023/24, 544 mm of precipitation fell, which was 93% of the LTA. Critically low precipitation (less than 50% of the long-term average) was recorded in September and February 2021/22, January and May 2022/23, and August, September, May and July 2023/24. An abnormally high amount of precipitation (≥ 150% of the LTA) was recorded in April and August 2021/22, and in April, July, August, September and November 2022/23 and March, April, October and November 2023/24.

Table 1

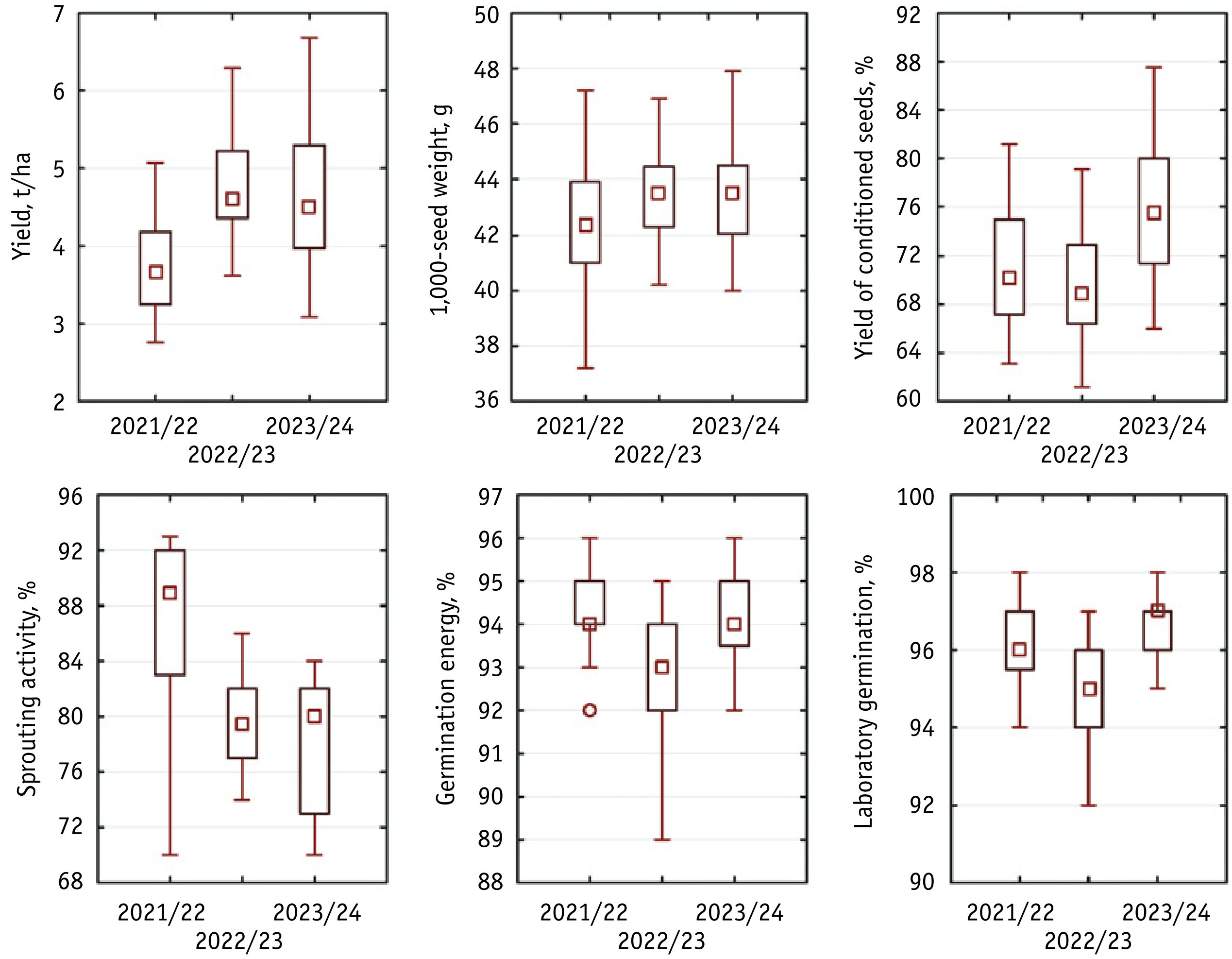
Average daily air temperature and precipitation by month during the study period

Vegetation year	Month												Per year
	VIII	IX	X	XI	XII	I	II	III	IV	V	VI	VII	
Air temperature, °C													
2021/22	20.5	13.2	7.6	4.8	−1.1	−1.2	1.7	2.3	8.4	14.6	20.7	20.4	9.3
2022/23	21.6	12.9	8.2	3.8	0.2	−0.1	−0.5	5.2	9.3	15.5	19.7	20.9	9.7
2023/24	22.8	18.4	12	4.5	0.9	−1.9	3.3	4.4	13.1	15.9	21.4	24.5	11.6
R	2.3	5.5	4.4	1.0	2.0	1.8	3.8	2.9	4.7	1.3	1.7	4.1	2.3
LTA	19.6	14.5	8.3	2.3	−2.2	−4.4	−3.4	1.5	9.1	15.3	18.7	20.2	8.3
Precipitation, mm													
2021/22	88	19	18	26	63	23	9	11	86	29	42	55	469
2022/23	88	118	30	81	43	11	28	45	85	21	39	184	773
2023/24	5	8	51	79	60	23	44	86	72	6	103	7	544
R	83	110	33	55	20	12	35	75	14	23	64	177	304
LTA	59	51	34	40	43	36	31	34	44	52	79	81	583

Note. R – range of variation, LTA – long-term average value.

The test results revealed the variable impact of years with different hydrothermal regimes on the yield and sowing qualities of soft winter wheat seeds (see Fig. 1). In the drier year of 2021/22 compared to 2022/23 and 2023/24, significantly lower average yield values (3.81 t/ha, $LSD_{0.05}$ = 0.36 t/ha) and 1,000-seed weight (42.6 g, $LSD_{0.05}$ = 1.2 g) were obtained, but significantly higher average seed sprouting activity (87%, $LSD_{0.05}$ = 4.0%) was observed. In 2022/23 and 2023/24, the average yield and 1,000-seed weight were higher than in 2021/22. However, no significant difference was found between these two years. A significantly higher yield of conditioned seeds (75.9%, $LSD_{0.05}$ = 3.9%) was noted in 2023/24. There was no significant influence of growing conditions on average germination energy (92–94%, $LSD_{0.05}$ = 3%) or laboratory seed germination (95–97%, $LSD_{0.05}$ = 3%), indicating a weak dependence on weather conditions. The greatest variation in yield, condition seed yield, 1,000-seed weight, and seed germination activity was obtained in 2023/24; the greatest variation in germination energy and laboratory seed germination was obtained in 2022/23.

On average, from 2021/22 to 2023/24, the yield of soft winter wheat varieties ranged from 3.18 to 5.99 t/ha, depending on the pre-crop, sowing date and nutritional requirements (see Fig. 2). The soft winter wheat varieties in the study produced a higher yield of 0.04–1.05 t/ha when sown on 5 October compared to 15 October, for all fertiliser application options and after both pre-crops. Higher yields of 0.46–1.27 t/ha were also observed after soybean compared to sunflower in terms of other factors. When nitrogen fertiliser was applied, an increase in yield of 0.08–1.45 t/ha was observed compared to the control variant. Only an insignificant increase in yield was observed in the 'MIP Dniprianka' (0.08 t/ha) and 'Estafeta Myronivska' (0.20 t/ha) varieties when sown on 15 October after sunflowers, with the application of 25 kg/ha a.s. of UAN-32. Fertilising plants with UAN-32 at a rate of 75 kg/ha a.s. of active ingredient resulted in a significantly higher yield of the studied soft winter wheat varieties than the control and lower fertiliser rates, when taking into account the sowing dates and pre-crops. The lowest yields were obtained for the varieties 'MIP Assol' (3.40 t/ha), 'Estafeta Myronivska' (3.18 t/ha) and 'MIP Dniprianka' (3.43 t/ha) when sown on



Notes. □ – average; ▯ – 25–75%; I – range of variation; ○ – outliers (values that differ significantly from other values in the sample).

Fig. 1. Variation in yield and sowing qualities of soft winter wheat seeds during the study years

15 October after sunflowers in the control variant (no fertiliser application), while the highest values (5.87, 5.90 and 5.99 t/ha, respectively) were obtained when sown on 5 October after soybeans with UAN-32 fertiliser at a rate of 75 kg/ha a.s. On average, across years, pre-crops, sowing dates and fertiliser rates, the 'MIP Dniprianka' variety had a higher yield (4.61 t/ha) than the other varieties studied.

Significant variations in 1,000-seed weight (39.9–47.7 g) and the yield of conditioned seeds (63.9–81.6%) were observed in soft winter wheat varieties, depending on the influencing factors (see Table 2). The 1,000-seed weight was found to be 0.6–2.1 g higher when sown on 5 October compared to 15 October. A significant increase in this trait was observed when sown on 5 October in the varieties 'Estafeta Myronivska' and 'MIP Dniprianka' after both pre-crops and in variety 'MIP Assol' after sunflower only. No significant effect of sowing dates on the yield of conditioned seeds was found. However, higher values of this trait were noted by 1.0–2.8% when sowing on 5 October in the varieties 'Estafeta Myronivska' and 'MIP Dniprianka', compared to the second sowing date. This was taken into account alongside the pre-crops and nutrition options. On average for the nutrition options, a higher weight of 1,000 seeds by 0.5–1.8 g and a higher yield of conditioned seeds by 2.5–3.5% were obtained after soybeans as a pre-crop compared to sunflowers. The soft winter wheat variety showed maximum values of 1,000-seed weight (43.1–47.4 g) and yield of conditioned seeds (74.5–81.6%) when fertilised with UAN-32 at a rate of 75 kg/ha a.s. On average across all variants of the experiment, the 'MIP Dniprianka' variety had a higher 1000-seed weight (44.1 g) and yield of conditioned seeds (73.7%).

On average, for 2021/22–2023/24, taking into account varieties, pre-crops, sowing dates and nutrition options, the activity of soft winter wheat seed sprouting varied from 72 to 86%, seed germination energy – from 92 to 96%, and laboratory seed germination was 94–97% (Table 3).

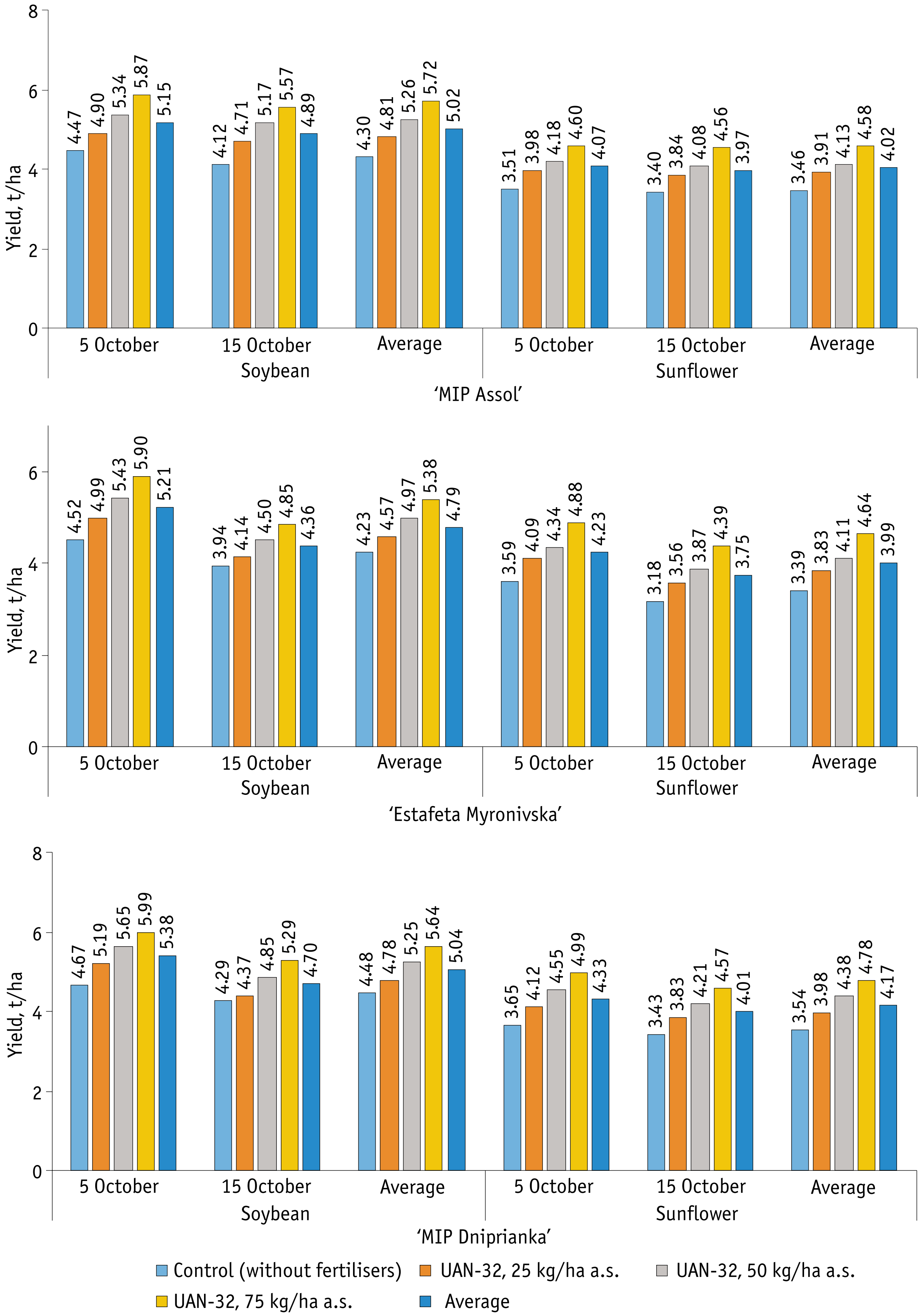


Fig. 2. Yield of soft winter wheat varieties depending on pre-crops, sowing dates and fertilisers (average for 2021/22–2023/24)

Table 2

Weight of 1,000 seeds and yield of conditioned seeds of soft winter wheat varieties depending on pre-crops, sowing dates and fertilisers (average for 2021/22–2023/24)

Pre-crop	Sowing date	Control (without fertilisers)	UAN-32, 25 kg/ha a.s.	UAN-32, 50 kg/ha a.s.	UAN-32, 75 kg/ha a.s.	Average	Control (without fertilisers)	UAN-32, 25 kg/ha a.s.	UAN-32, 50 kg/ha a.s.	UAN-32, 75 kg/ha a.s.	Average	Control (without fertilisers)	UAN-32, 25 kg/ha a.s.	UAN-32, 50 kg/ha a.s.	UAN-32, 75 kg/ha a.s.	Average
		'MIP Assol'					'Estafeta Myronivska'					'MIP Dniprianka'				
1,000-seed weight, g																
Soybean	05.10.	41.9	43.3	44.4	45.8	43.9	42.3	43.9	45.0	45.5	44.2	43.8	45.4	46.5	47.4	45.8
	15.10.	41.3	42.7	43.5	45.2	43.2	41.3	42.6	43.9	44.6	43.1	42.1	43.7	44.4	45.7	44.0
	Average	41.6	43.0	44.0	45.5	43.5	41.8	43.3	44.5	45.1	43.7	43.0	44.6	45.5	46.6	44.9
Sunflower	05.10.	41.4	43.2	43.8	45.3	43.4	41.6	43.3	44.0	44.6	43.4	42.0	43.5	44.7	45.8	44.0
	15.10.	39.9	41.5	42.5	43.6	41.9	40.1	41.4	42.4	43.1	41.8	40.6	42.1	43.0	44.0	42.4
	Average	40.7	42.4	43.2	44.5	42.7	40.9	42.4	43.2	43.9	42.6	41.3	42.8	43.9	44.9	43.2
Average		41.1	42.7	43.6	45.0	43.1	41.3	42.8	43.8	44.5	43.1	42.1	43.7	44.7	45.7	44.1
$LSD_{0.05}$		0.9					1.1					1.4				
Conditioned seed yield, %																
Soybean	05.10.	67.4	71.1	74.6	78.8	73.0	67.8	71.7	76.4	80.4	74.1	70.1	74.4	79.2	81.6	76,3
	15.10.	66.6	70.8	75.7	79.0	73.0	65.7	69.5	73.6	78.1	71.7	68.2	71.9	76.0	79.5	73.9
	Average	67.0	71.0	75.2	78.9	73.0	66.8	70.6	75.0	79.3	72.9	69.2	73.2	77.6	80.6	75.2
Sunflower	05.10.	65.4	68.7	70.7	76.3	70.3	64.9	69.1	72.1	76.4	70.6	67.5	71.1	74.8	79.4	73.2
	15.10.	65.3	68.4	70.8	76.0	70.1	63.9	66.5	69.3	74.5	68.6	65.9	69.0	73.3	77.2	71.4
	Average	65.4	68.6	70.8	76.2	70.3	64.4	67.8	70.7	75.5	69.6	66.7	70.1	74.1	78.3	72.3
Average		66.2	69.8	73.0	77.5	71.6	65.6	69.2	72.9	77.4	71.3	67.9	71.6	75.8	79.4	73.7
$LSD_{0.05}$		3.5					4.2					3.7				

No significant effect of sowing dates, pre-crops, and nutrition options on the formation of sowing qualities of soft winter wheat varieties was found. On average, across all experimental variants, a significantly lower seed sprouting activity was observed for the 'MIP Assol' variety (76%), while the 'Estafeta Myronivska' and 'MIP Dniprianka' varieties were distinguished by high values of this trait (85 and 84%, respectively). The studied soft winter wheat varieties did not differ in terms of germination energy (94%) and laboratory germination (96%) of seeds.

It should be noted that nitrogen fertilisation, particularly the application of UAN-32 at a rate of 75 kg/ha a.s., creates optimal conditions for protein biosynthesis, assimilation, accumulation and active enzyme formation. This ensures the high biological completeness of winter wheat seeds. This explains the increase in the 1,000 seeds weight, yield per unit area, and sowing quality stability at different sowing dates and with different crop rotations. Thus, nitrogen fertilisation with UAN-32 at a rate of 75 kg/ha a.s. significantly impacts production processes (e.g. yield formation, weight of 1,000 seeds and conditioned seed yield) by activating photosynthesis and nitrogen metabolism, as well as the transport of assimilates. Meanwhile, the sowing qualities of the seeds (sprouting activity, germination energy and laboratory germination) remain stable, as they are physiologically and genetically protected indicators that do not respond to increased nitrogen rates under optimal nutrition.

Correlations between the yield and sowing qualities of soft winter wheat seeds can be established to identify the traits that have the greatest impact on yield formation. Pearson's correlation coefficients (r) were calculated to determine the strength and direction of the relationships between the studied traits. After taking into account varieties, pre-crops, sowing dates and different fertiliser doses, strong and very strong direct correlations were obtained between yield and 1,000-seed weight (r = 0.70–0.83) and yield of conditioned seeds (r = 0.74–0.92). These correlations were stable over the years of testing (see Table 4). Significant, stable and strong

Table 3

Sowing qualities of soft winter wheat seeds depending on pre-crops, sowing dates and fertilisers (average for 2021/22–2023/24)

Pre-crop	Sowing date	Options for applying different fertilizer rates	'MIP Assol'			'Estafeta Myronivska'			'MIP Dniprianka'		
			Sprouting activity, %	Germination energy, %	Laboratory germination, %	Sprouting activity, %	Germination energy, %	Laboratory germination, %	Sprouting activity, %	Germination energy, %	Laboratory germination, %
Soybean	05.10.	Control (without fertilisers)	76	93	95	86	94	96	85	93	94
		UAN-32, 25 kg/ha a.s.	77	95	96	86	96	97	86	94	96
		UAN-32, 50 kg/ha a.s.	79	95	97	86	95	97	85	94	96
		UAN-32, 75 kg/ha a.s.	79	94	97	86	95	97	85	94	96
	Average		78	94	96	86	95	97	85	94	96
	15.10.	Control (without fertilisers)	74	93	95	83	93	95	81	93	95
		UAN-32, 25 kg/ha a.s.	76	94	96	83	94	96	82	94	96
		UAN-32, 50 kg/ha a.s.	76	94	97	83	94	96	81	94	96
		UAN-32, 75 kg/ha a.s.	72	94	95	85	94	97	81	93	96
	Average		75	94	96	84	94	96	81	94	96
Sunflower	05.10.	Control (without fertilisers)	76	93	94	85	94	96	85	95	96
		UAN-32, 25 kg/ha a.s.	76	93	95	86	95	97	85	95	96
		UAN-32, 50 kg/ha a.s.	75	92	95	85	94	96	84	94	96
		UAN-32, 75 kg/ha a.s.	76	92	95	84	93	96	83	93	95
	Average		76	93	95	85	94	96	84	94	96
	15.10.	Control (without fertilisers)	77	93	95	84	92	95	84	94	96
		UAN-32, 25 kg/ha a.s.	78	94	96	85	94	96	83	94	95
		UAN-32, 50 kg/ha a.s.	78	93	96	84	94	96	84	94	96
		UAN-32, 75 kg/ha a.s.	77	94	96	86	94	97	85	93	96
	Average		78	94	96	85	94	96	84	94	96
Average			76	94	96	85	94	96	84	94	96
$LSD_{0.05}$			4	3	3	4	3	3	5	3	3

Table 4

Correlation between yield and sowing qualities of soft winter wheat seeds

	Characteristic	1	2	3	4	5	6
2021/22							
1	Yield	1.00	0.70	0.80	–0.13	–0.15	–0.02
2	1,000 seed weight		1.00	0.62	0.47	–0.36	–0.25
3	Yield of conditioned seeds			1.00	–0.02	–0.29	–0.03
4	Sprouting activity				1.00	–0.21	–0.20
5	Germination energy					1.00	0.70
6	Laboratory germination						1.00
2022/23							
1	Yield	1.00	0.83	0.92	0.03	0.12	0.24
2	1,000 seed weight		1.00	0.89	–0.20	–0.02	0.06
3	Yield of conditioned seeds			1.00	–0.04	0.12	0.24
4	Sprouting activity				1.00	0.54	0.59
5	Germination energy					1.00	0.91
6	Laboratory germination						1.00
2023/24							
1	Yield	1.00	0.76	0.74	0.07	0.49	0.26
2	1,000 seed weight		1.00	0.88	0.02	0.38	0.32
3	Yield of conditioned seeds			1.00	0.26	0.50	0.48
4	Sprouting activity				1.00	0.39	0.38
5	Germination energy					1.00	0.83
6	Laboratory germination						1.00

correlations were established over the years between 1,000-seed weight and the yield of conditioned seeds (r = 0.62–0.89).

However, no stable correlations were found between yield, sprouting activity, germination energy and laboratory seed germination over three years, in terms of either strength or direction. Specifically, weak inverse correlations were observed between yield and seed sprouting activity (r = –0.13) and seed germination energy (r = −0.15) in 2021/22. In 2022/23 and 2023/24, weak and moderate direct correlations were observed between yield and seed germination energy (r = 0.12–0.49) and laboratory germination (r = 0.24–0.26). Additionally, no stable relationships in terms of strength and direction were established between the weight of 1,000 seeds and conditioned seed yield with regard to seed sprouting activity, germination energy and laboratory germination during the years of testing. Therefore, changing growing conditions affect not only the magnitude of traits, but also the relationships between them.

Conclusions

A significant influence of growing conditions on yield, 1000-seed weight, conditioned seed yield, and sprouting activity was established. Meanwhile, germination energy and laboratory germination remained relatively stable. In 2021/22, a significantly lower yield (3.81 t/ha) and 1000-seed weight (42.6 g) were observed, alongside significantly higher seed sprouting activity (87%). In contrast, the highest conditioned seed yield (75.9%) was obtained in 2023/24.

Higher average values were obtained for yield (4.79–5.04 t/ha), 1,000-seed weight (43.5–44.9 g) and yield of conditioned seeds (72.9–75.2%) after the soybean pre-crop. Higher yields (4.07–5.38 t/ha) and 1,000-seed weight (43.9–45.8 g) were found when sowing took place on 5 October. No significant effect of sowing dates on the yield of conditioned seeds was observed. Fertilising plants with UAN-32 at a rate of 75 kg/ha a.s. of active ingredient was found to contribute to significantly higher yields, as well as maximum 1,000-seed weights (43.1–47.4 g) and conditioned seed yields (74.5–81.6%). No significant effects of sowing dates, pre-crops, or different feeding rates on sprouting activity, germination energy, or laboratory seed germination were found. Therefore, to obtain higher yields and higher-quality soft winter wheat seeds, it is advisable to sow on 5 October after a soybean pre-crop with UAN-32 fertiliser at a rate of 75 kg/ha a.s.

Direct and inverse correlations of varying strength ($-0{,}36 \le r \le 0{,}92$) were found between the yield and sowing qualities of soft winter wheat seeds. Over the years, stable direct relationships (r = 0.70–0.92) were established between yield and 1,000-seed weight, as well as between yield and the yield of conditioned seeds, indicating their close interdependence.

The 'MIP Dniprianka' variety was selected due to its higher average yield (4.61 t/ha), higher 1,000-seed weight values (44.1 g) and higher conditioned seed yield (73.7%), indicating its superior productivity potential.

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Сіроштан А. А.*, Листуха М. М. Особливості формування врожайності та посівних якостей насіння пшениці м’якої озимої залежно від попередника, строку сівби та добрив. *Plant Varieties Studying and Protection*. 2025. Т. 21, № 4. С. 215–223. https://doi.org/10.21498/2518-1017.21.4.2025.346239

*Миронівський інститут пшениці імені В. М. Ремесла НААН, вул. Центральна, 68, с. Центральне, Обухівський р-н, Київська обл., 08853, Україна, *e-mail: siroshtanandriy@gmail.com*

Мета. Виявити особливості формування врожайності та посівних якостей насіння сортів пшениці м’якої озимої залежно від попередника, строку сівби та різних доз азотного добрива в умовах центральної частини Лісостепу України. **Методи.** Дослідження проводили впродовж 2021/22–2023/24 рр. в умовах Миронівського інституту пшениці імені В. М. Ремесла НААН. Встановлювали вплив різних норм (25, 50 і 75 кг/га діючої речовини) азотного добрива (КАС-32), строків сівби (5 і 15 жовтня), попередників (соняшнику, сої) на врожайність та посівні якості насіння трьох сортів пшениці м’якої озимої (‘МІП Ассоль’, ‘Естафета миронівська’, ‘МІП Дніпрянка’). Посівні якості насіння визначали за різних варіантів досліду відповідно до загальноприйнятих методів. **Результати.** Встановлено, що умови року достовірно впливали на формування врожайності, маси 1000 насінин, виходу кондиційного насіння та активності наклюьовування. Показники енергії проростання й лабораторної схожості були відносно стабільними за різних умов вирощування. У більш посушливих (2021/22 р.) відмічено достовірно нижчі значення врожайності (3,81 т/га) та маси 1000 насінин (42,6 г) і суттєво більшу активність наклюьовування насіння (87%), як порівняти з 2022/23 та 2023/24 рр. Найвищий вихід кондиційного насіння (75,9%) отримано у 2023/24 рр. Більші середні значення врожайності (4,79–5,04 т/га), маси 1000 насінин (43,5–44,9 г), виходу кондиційного насіння (72,9–75,2%) зафіксовано після такого попередника, як соя. Виявлено вищу врожайність (4,07–5,38 т/га) та масу 1000 насінин (43,9–45,8 г) за проведення сівби 5 жовтня. Не встановлено суттєвого впливу строків сівби на вихід кондиційного насіння. Визначено, що підживлення рослин КАС-32 у нормі 75 кг/га д. р., порівнюючи з іншими нормами, сприяло формуванню достовірно вищої врожайності та максимальних значень маси 1000 насінин (43,1–47,4 г) і виходу кондиційного насіння (74,5–81,6%). Не виявлено значного впливу строків сівби, попередників і різних норм живлення на активність наклюьовування, енергію проростання та лабораторну схожість насіння. Встановлено стабільні за роками прямі зв’язки (r = 0,70–0,92) врожайності з масою 1000 насінин і виходом кондиційного насіння. **Висновки.** Для отримання вищої врожайності варто висівати сорти пшениці м’якої озимої 5 жовтня, після такого попередника, як соя, за живлення КАС-32 у нормі 75 кг/га д. р.

Ключові слова: *Triticum aestivum L.; урожайність; маса 1000 насінин; вихід кондиційного насіння; активність наклюьовування; енергія проростання; лабораторна схожість.*

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