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YIELD AND SEED QUALITY INDICATORS OF SOFT WINTER WHEAT (*TRITICUM AESTIVUM* L.) FOR DIFFERENT PREVIOUS CROPS AND SOWING DATES

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Topicality. *Wheat yields are formed as a result of the genetic characteristics of a variety in interaction with soil and climatic conditions and cultivation technology. Yields depend on and vary depending on the previous crop, the level of mineral nutrition and the impact of weather conditions in the year of cultivation. Therefore, the study of the effect of previous crops and sowing dates on winter wheat grain remains an essential task.* ***Purpose.*** *Studying the effect of previous crops and sowing dates on the seed yield and quality of soft winter wheat.* ***Materials and Methods.*** *The research focused on five previous crops (soybean, sunflower, maize (in milk ripeness), green fallow (white mustard), mustard (for seed)), and three sowing dates (25 September, 5 and 15 October). Varieties of soft winter wheat were examined: Podolianka, MIP Fortuna, MIP Roksolana, MIP Yuvileina, MIP Feieriia, MIP Vidznaka, MIP Nika, MIP Darunok, and MIP Aelita. The seeding rate was 5 million seeds per 1 ha. Sowing, phenological observations and yield recording were performed in accordance with the standard methods used in wheat variety testing.* ***Results.*** *The average yield of winter wheat varieties in the experiment for 2021 and 2022 was 6.09 t/ha, with a maximum after the green fallow of 6.72 t/ha and a minimum after the sunflower of 5.50 t/ha. Shifting the sowing date from 25 September to 15 October reduced the average yield of the varieties. Only after the mustard, the highest yield of winter wheat (6.13 t/ha) was obtained when sown on 5 October. The seed germination energy of the varieties was highest after the green fallow and amounted to 96–97 %. Depending on the sowing date, the germination energy varied within 1–3 %. The laboratory germination rate of the varieties was 96–97 %.* ***Conclusions.*** *It was found that the highest yields were provided by green fallow and soybean as previous crops, and the optimal sowing date was in late September. A higher level of yield after all the previous crops was observed in the varieties MIP Aelita, MIP Vidznaka and MIP Feieriia. It was found that the studied varieties produced the maximum of 1000 grain weight and 1000 standard seeds weight, and hence the seed yield after such previous crops as green fallow (white mustard) and mustard for seeds. After maize, it was possible to achieve higher germination energy and laboratory germination rates. Shifting the sowing dates to later ones resulted in a decrease in the yield of standard seeds, while the rest of the indicators were almost independent of this factor.*

Key words: *variety, previous crops, yield level, sowing dates, sowing qualities of seeds*

Introduction. Grain economy is the main sector of agricultural production. Winter wheat, which is one of the most valuable grain crops and ranks first among other crops in terms of yield and harvest of food grain, is of great importance in enhancing grain production [1–2]. Soft wheat (*Triticum aestivum* L.) is the most widespread grain crop in the world (90–95 %) [3]. The crop has the widest cultivation area and adaptability in the world. Soft winter wheat is one of the most crucial crops and is the main source of carbohydrates and proteins for humans [4]. Wheat products are commonly used and play an important role in human diet [5, 6].

Wheat yield is the result of the realisation of the genetic varietal characteristics in interaction with soil and climatic conditions and cultivation technology [7].

The level of yield depends and varies depending on the previous crop, foliar feeding,

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and the level of mineral nutrition and, to a large extent, on the influence of weather conditions of the year of cultivation [8]. Therefore, studying the influence of the previous crop on the grain quality and yield of winter wheat remains an important challenge [8, 9]. The previous crops and weather conditions of a certain year significantly affect the sowing dates of wheat [10]. Determining the optimal sowing dates according to specific growing conditions is an important issue, as different varieties have different biological characteristics, and in this context, establishing optimal agronomic practices for each individual variety is relevant. Information on the optimal previous crops and sowing dates for each genotype is of practical importance and makes it possible to evaluate winter wheat genotypes in terms of yield and stability [12].

The yield of field crops, including winter wheat, is dependent on a complex of agrobiological conditions, namely the optimal state of the crops. High biological value of seeds, rapid and uniform seed germination are a prerequisite for the development of high-quality crops. Sowing seed qualities determine the plant resistance to unfavourable factors, the intensity of plant development and yield formation. Therefore, pre-sowing laboratory testing of crop seeds is a crucial part of agrotechnology. Only certified seed should be used for cultivating winter wheat [13].

Further research into the influence of previous crops and sowing dates on yields, seed quality and baking quality of grain is relevant and will help increase wheat production in Ukraine as new varieties and lines of winter wheat are developed.

The study aims at examining the influence of previous crops and sowing dates on the yield and seed quality of winter wheat varieties.

Materials and Methods. The average air temperature during the growing season from August 2020 to July 2021 was 9.8 °C, which is 1.6 °C higher than the long-term average (Table 1). From August to November 2020, the average monthly air temperature exceeded the long-term average by 1.6–5.0 °C. September and October 2020 were abnormally warm (exceeding long-term average monthly temperature was 4.0 and 5.0 °C, respectively). In the spring-summer period of the wheat growing season, the average monthly temperatures in June and July were 1.5 and 3.0 °C higher than the long-term average, respectively.

The average air temperature for the period

Table 1. Air temperature during the growing season of soft winter wheat, 2020–2022

Month	Air temperature, °C				
	long-term	2020/21		2021/22	
		actual	±*	actual	±*
August	19.5	21.1	1.6	20.5	1.0
September	14.5	18.5	4.0	13.2	-1.3
October	8.2	13.2	5.0	7.6	-0.6
November	2.2	3.8	1.6	4.8	2.6
December	-2.2	-0.3	1.9	-1.1	1.1
January	-4.6	-2.3	2.3	-1.2	3.4
February	-3.5	-4.7	-1.2	1.7	5.2
March	1.3	2.3	1.0	2.3	1.0
April	9.1	7.7	-1.4	8.3	-0.8
May	15.3	14.5	-0.8	14.7	-0.6
June	18.6	20.1	1.5	20.7	2.1
July	20.3	23.3	3.0	20.4	0.1
Total	8.2	9.8	1.6	9.3	1.1

*Note: * ± – difference to the long-term temperature*

August 2021 – July 2022 was 9.3 °C, which is 1.1 °C higher than the long-term average. In August and November 2021, the average monthly air temperatures were 1.0 and 2.6 °C above the long-term average, respectively, and in September and October they were 1.3 and 0.6 °C lower. The air temperature from August to October differed slightly from the long-term average. Therefore, despite the fact that the weather conditions in autumn were rather dry, the temperature regime contributed to the normal development of winter crops. In the spring-summer period of winter wheat growing season, the average monthly temperatures were close to

the long-term average, only in June they were 2.1 °C higher.

Between August 2020 and July 2021, 905 mm of precipitation fell that is 150 % of the long-term average (Table 2). Precipitation in late September and October contributed to uniform germination of wheat. During the spring-summer period of winter wheat growing season, there was a sufficient amount of moisture, and precipitation reached 200 and 182 % of the long-term average in May and June.

From August 2021 to July 2022, there was 663 mm of precipitation (110 % of the long-term average). In August, the precipitation of 109 mm (188 % of the long-term average) contributed to the even emergence of wheat seedlings. During the spring-summer period of the winter wheat growing season, there was a sufficient amount of moisture, although the precipitation amount was 6–29 mm below the long-term average, only in April there was 340 % of the long-term average amount of precipitation.

Table 2. Precipitation during the growing season of soft winter wheat, 2020–2022

Month	Sum of precipitation, mm				
	long-term	2020/21		2021/22	
		actual	±*	actual	±*
August	58	11	19	109	188
September	58	34	59	27	47
October	40	67	168	26	65
November	41	40	98	41	100
December	42	50	119	94	224
January	35	84	240	33	94
February	31	74	239	10	32
March	37	39	105	13	35
April	42	59	140	143	340
May	59	118	200	42	71
June	87	158	182	58	67
July	74	172	232	68	92
Total	603	905	150	663	110

*Note: * ± – difference to the long-term temperature*

The pre-sowing tillage included chopping of plant residues, ploughing to a depth of 18–22 cm, levelling the soil surface, and pre-sowing cultivation (5–6 cm). Seeds of wheat were treated with Vincit Forte SC (1.2 l/t). The seeding rate was 5 million seeds per 1 ha. The sowing was carried out with SN-10 Ts selective seeder. The sown area of the plot was 10.5 m^2; the registration area was 8.106 m^2. The repeatability of the experiment was 4 times. In spring, ammonium nitrate was applied at the rate of N_{35} a.i./ha, and in the heading stage, wheat crops were treated with a tank mixture of herbicides Grenadier Maxi, WG (35 g/ha) i Klainer, WG (25 g/ha), fungicide Greenfort Super, EC (0.5 l/ha) and sticking agent FainLyp (0.2 l/ha). Sowing, phenological observations and recording of yield are commonly used for wheat variety testing [14–16]. The Podolianka variety was used as a standard.

The experiment was three-factor: *factor A* – previous crops: soybean, sunflower, maize for silage, green fallow (white mustard), mustard for seeds; *factor B* – sowing dates: 25 September, 5 and 15 October; *factor C* – winter wheat varieties: Podolianka, MIP Fortuna, MIP Roksolana, MIP Yuvileina, MIP Feieriia, MIP Vidznaka, MIP Nika, MIP Darunok, MIP Aelita.

Results and Discussion. The yield of winter wheat varieties averaged 6.09 t/ha in 2021 and 2022, with a maximum yield of 6.72 t/ha after sowing on green fallow and a minimum yield of 5.50 t/ha after sunflower (Fig. 1). Shifting the sowing date from 25 September to 15 October resulted in a decrease in the average yield of the soft winter wheat varieties. The highest yield (6.13 t/ha) was obtained only after sowing on 5 October, after mustard for seeds.

The yields of most varieties exceeded the standard variety Podolianka, only MIP Nika, MIP Roksolana and MIP Feieriia were inferior after green fallow, mustard for seeds and maize for silage (Table 3). After the sunflower as a

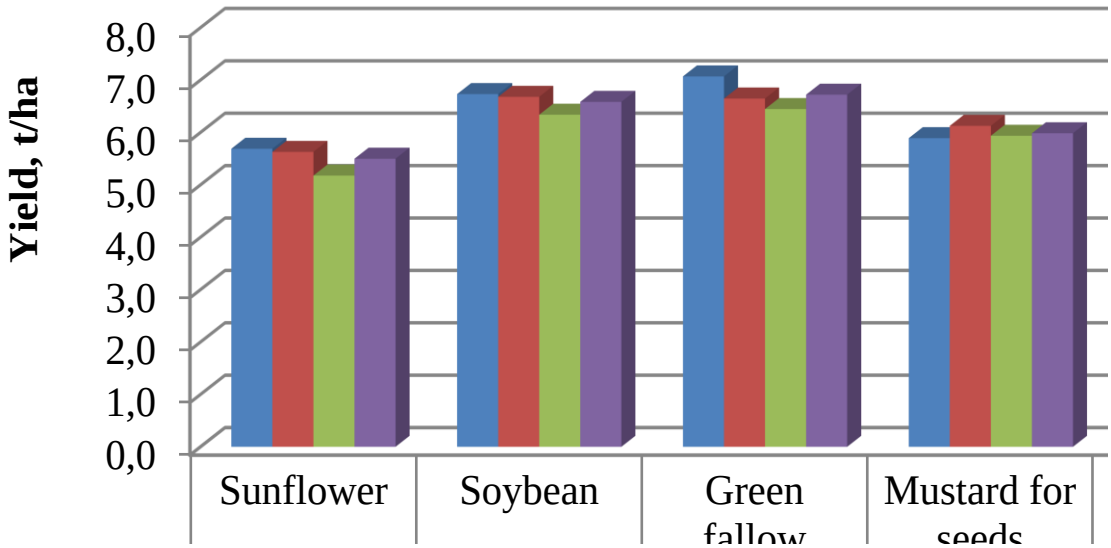

Fig. 1. Winter wheat yield depending on previous crops and sowing dates, 2021–2022.

Table 3. Seed quality indicators of winter wheat varieties depending on previous crops and sowing dates (average on varieties), 2021–2022

Indicator	Previous crop						Sowing date		
	soybean	sunflower	maize on silage	green fallow (white mustard)	mustard on seeds	**Average on previous crops**	25 September	5 October	15 October
1000 grain weight, g	34.4	36.0	34.7	36.9	37.0	35.8	35.8	36.0	35.7
1000 seed weight, g	40.4	41.0	39.2	42.5	41.6	40.9	40.7	41.3	40.9
Seed yield, %	67.0	75.2	73.3	77.8	78.6	74.4	75.8	74.4	72.8
Germination energy, %	95.1	94.5	96.2	95.2	95.8	95.4	95.8	95.0	95.5
Laboratory germination, %	96.3	96.4	96.8	96.5	96.7	96.5	96.7	96.4	96.5

previous crop, the highest yield (6.03 t/ha) was recorded for MIP Aelita, and for the standard variety Podolianka – 5.16 t/ha. Shifting the sowing date to a later one resulted in lower yields of the varieties, except for MIP Feieriia and MIP Fortuna, which yields were higher after sowing on 5 October.

The highest average yield (7.33 t/ha) was obtained in the MIP Vidznaka variety after the previous crop soybean. The yield of the Podolianka variety was 6.03 t/ha. The first sowing date on 25 September contributed to the highest yields of the above-mentioned varieties. Sowing on 5 October contributed to higher yields (6.49–7.35 t/ha) for MIP Aelita, MIP Darunok, MIP Feieriia and MIP Fortuna varieties. After the green fallow, the Podolianka variety had a yield of 6.52 t/ha, while the highest yields were obtained from the MIP Aelita (7.14 t/ha) and MIP Vidznaka (7.60 t/ha) varieties. In most varieties, yields were higher than those sown on 25 September. After mustard for seeds, the highest yields (6.32–6.51 t/ha) were obtained in MIP Aelita and MIP Vidznaka varieties, with 5.88 t/ha in the Podolianka variety. All varieties formed a higher yield when they were sown on 5 October, with the exception of MIP Aelita (25 September) and MIP Nika (15 October). After the previous crop – maize for silage, depending on the sowing date, the Podolianka variety had an average yield (5.48 t/ha), the varieties MIP Darunok, MIP Vidznaka, MIP Aelita and MIP Feie-

riia had the highest yields (5.78–6.16 t/ha). In the Podolianka and MIP Darunok varieties, the highest yields were obtained at sowing in October, while in the other varieties, with a shift in the sowing date to a later date, the yield decreased.

Sowing of high-quality seeds is essential for obtaining a high yield of winter wheat. Therefore, we studied the effect of previous crops and sowing dates on the sowing quality of seeds of different winter wheat varieties.

It should be noted the significant influence of previous crops and sowing dates of winter wheat on seed quality. The maximum average 1000 grain weight (36.9–37.0 g) and the 1000 seed weight after cleaning (41.6–42.5 g) were obtained after green fallow and mustard on seeds as previous crops. Higher seed yield (78.6 %) was obtained after the mustard on seeds, and the best germination energy and laboratory germination were after maize (Table 3). Shifting the sowing date from 25 September to 15 October resulted in a decrease in seed yield, while other indicators were almost independent of this factor.

The highest germination energy of seeds, on average for the varieties, was after the green fallow and amounted to 96–97 % (Table 4). Germination energy varied within 1–3 %, depending on the sowing date. Seeds of most varieties had higher germination energy (95–98 %) after green fallow, but MIP Vidznaka and Podolianka varieties had high values (96–99 %) after the previous crop – mustard on seeds.

Table 4. Seed germination energy of winter wheat depending on previous crops and sowing dates, 2021–2022

Previous crop	Sowing date	MIP Aelita	MIP Vidznaka	MIP Darunok	MIP Nika	MIP Roksolana	MIP Feieriia	MIP Fortuna	MIP Yuvileina	Podolianka	Average
Sunflower	25.09	93	95	97	95	95	95	97	90	97	95
	05.10	94	96	96	94	96	96	95	96	94	95
	15.10	94	97	97	96	96	97	97	92	96	96
Soybean	25.09	95	96	96	98	96	96	96	96	96	96
	05.10	96	95	98	96	95	96	72	97	95	93
	15.10	95	94	97	94	95	93	94	98	93	95
Green fallow (white mustard)	25.09	97	96	99	97	96	97	97	97	97	97
	05.10	95	96	97	98	96	95	97	97	98	97
	15.10	93	95	97	96	98	98	95	95	96	96
Mustard on seeds	25.09	93	96	97	97	93	94	96	94	97	95
	05.10	93	99	97	95	88	92	96	96	98	95
	15.10	93	99	95	97	96	96	92	98	97	96
Maize on silage	25.09	96	95	94	98	96	97	97	97	97	96
	05.10	96	96	91	97	96	95	97	96	97	96
	15.10	95	95	93	97	98	96	96	95	97	96

Laboratory germination, on average for the varieties, was 96–98 % (Table 5). Seed germination energy of the MIP Aelita variety was 96–98 % after soybean as previous crop; this indicator was 96–99 % in the MIP Vidznaka variety and 98–99 % in the MIP Yuvileina variety after mustard on seeds; MIP Darunok (98–99 %), MIP Nika (96–99 %) and MIP Feieriia (95–98 %) – after green fallow; МІП Roksolana (96–98 %) and MIP Fortuna (95–97 %) – after green fallow and maize on silage. The Podolianka variety showed laboratory germination from 96 to 98 %; this indicator did not depend on changes in previous crops and sowing dates.

Conclusions. According our studies, it was found that the highest yield of winter wheat is obtained after such previous crops as green fallow (white mustard) and soybean; the optimalsowing date is 25 September. The highest yield on background of all previous crops was observed in the varieties MIP Aelita, MIP Vidznaka and MIP Feieriia. In addition, it was

Table 5. Laboratory seed germination of winter wheat depending on previous crops and sowing dates, 2021–2022

Previous crop	Sowing date	MIP Aelita	MIP Vidznaka	MIP Darunok	MIP Nika	MIP Roksolana	MIP Feieriia	MIP Fortuna	MIP Yuvileina	Podolianka	Average
Sunflower	25.09	94	95	98	96	96	95	97	93	97	96
	05.10	95	96	97	97	97	97	97	96	97	97
	15.10	97	98	97	98	96	98	98	94	98	97
Soybean	25.09	96	97	96	98	97	97	96	96	97	97
	05.10	98	97	98	96	95	99	93	98	96	97
	15.10	97	96	98	96	97	94	95	98	96	96
Green fallow (white mustard)	25.09	97	96	99	98	96	98	98	98	98	98
	05.10	96	97	98	99	98	96	97	97	98	97
	15.10	94	96	98	96	98	98	95	96	96	96
Mustard on seeds	25.09	95	96	98	97	98	98	97	98	97	97
	05.10	94	99	98	95	95	92	96	98	98	96
	15.10	94	99	96	97	96	97	94	99	97	97
Maize on silage	25.09	97	97	95	98	97	98	97	98	98	97
	05.10	96	97	96	96	96	96	97	97	97	96
	15.10	96	97	96	97	98	96	97	96	97	97

found that the maximum 1000 grain weight and 1000 seed weight, and thus seed yield, were produced by all varieties after the green fallow (white mustard) and mustard for seeds. The maize on silage contributed to high values of germination energy and laboratory germination. Shifting the sowing dates to later resulted in a decrease in the yield of high-quality seeds, while the other indicators were almost independent of this factor.

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Актуальність. Урожайність пшениці формується внаслідок реалізації генетичних особливостей сорту у взаємодії з ґрунтово-кліматичними умовами й технологією вирощування. Рівень урожайності залежить і змінюється залежно від попередника, рівня мінерального живлення і впливу погодних умов року вирощування. Тому вивчення впливу попередників і строків сівби на зерно пшениці озимої залишається важливим завданням. **Мета.** Дослідити вплив попередників і строків сівби на урожайність та якість насіння пшениці м'якої озимої. **Матеріали і методи.** У дослідженнях вивчали п’ять попередників: соя, соняшник, кукурудза/МВС, сидеральний пар (гірчиця біла), гірчиця/насіння, а також три строки сівби: 25 вересня, 5 і 15 жовтня. Досліджували сорти пшениці м'якої озимої: Подолянка, МІП Фортуна, МІП Роксолана, МІП Ювілейна, МІП Феєрія, МІП Відзнака, МІП Ніка, МІП Дарунок, МІП Аеліта. Норма висіву – 5 млн. шт насінин на 1 га. Сівба, фенологічні спостереження та облік урожайності загальноприйняті для випробування сортів пшениці. **Результати.** Урожайність сортів пшениці озимої у середньому за 2021 та 2022 роки по досліду становила 6,09 т/га з максимумом після попередника сидеральний пар – 6,72 т/га і мінімумом після попередника соняшник – 5,50 т/га. Зміщення строку сівби з 25 вересня до 15 жовтня знижувало середню врожайність сортів. Лише, після попередника гірчиця вищу урожайність (6,13 т/га) отримано за сівби 5 жовтня. Енергія проростання насіння по сортах була найвища після попередника сидеральний пар і становила 96–97 %. Залежно від строку сівби енергія проростання змінювалась на 1–3 %. Лабораторна схожість сортів була на рівні 96–97 %. **Висновки.** Встановлено, що найбільшу урожайність забезпечують попередники сидеральний пар та соя, оптимальним строком сівби є третя декада вересня. Більший рівень врожайності після всіх попередників відмічено у сортів МІП Аеліта, МІП Відзнака і МІП Феєрія. Виявлено, що досліджувані сорти формували максимальні масу 1000 зерен і масу 1000 кондиційних насінин, а отже і вихід насіння після попередників сидеральний пар (гірчиця біла) і гірчиця на насіння. Попередник кукурудза сприяв більшим показникам енергії проростання та лабораторної схожості. Зміщення строків сівби до пізніших призводило до зменшення виходу кондиційного насіння, решта показників майже не залежала від цього фактору.

Ключові слова: *сорт, попередні культури, рівень урожайності, строки посіву, посівні якості насіння*