

INFLUENCE OF PREVIOUS CROPS ON 1,000 KERNEL WEIGHT AND TEST WEIGHT OF BREAD WINTER WHEAT (*TRITICUM AESTIVUM* L.) IN THE CONDITIONS OF THE CENTRAL PART OF THE FOREST-STEPPE OF UKRAINE

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Topicality. In a changing continental climate, the correct selection of a previous crop for winter wheat is one of the main technological methods available to improve the grain quality of this crop. The selection of varieties and breeding lines with the highest level of grain quality is of practical importance in the development of high-quality source material. **Purpose.** Identification of the influence of previous crops on the 1,000 kernel weight and test weight of bread winter wheat in the Central Forest-Steppe of Ukraine, and selection of genotypes with reliably high grain quality indicators. **Methods.** Seven varieties and four breeding lines of wheat sown after five previous crops during 2020/21–2022/23 at the V. M. Remeslo Myronivka Institute of Wheat of NAAS of Ukraine were evaluated. The 1,000 kernel weight (TKW) and test weight (TW) were determined in accordance with generally accepted methods. **Results.** In 2022/23, the highest average values of the studied traits (TKW = 45.1 g; TW = 777 g/l) were observed, and in 2021/22 – the lowest ones (TKW = 38.0 g; TW = 759 g/l). The maximum value of 1,000 kernel weight (42.4 g) on average by genotypes and years was noted after mustard, and the highest grain test weight (778 g/l) – after green manure fallow. However, differences in the effect of the previous crop on grain quality indices for individual genotypes of bread winter wheat were found. The 1,000 kernel weight was most affected by the weather conditions (44.8 %), and the test weight - by the interaction of such factors as year × previous crop (37.3 %). A significant effect of genotype on the studied traits (TKW – 19.4 %, TW – 21.1 %) was found. The 1,000 kernel weight was least dependent on the previous crop (1.3 %), and the test weight was least dependent on the interaction of genotype × previous crop (5.9 %). The varieties and breeding lines of bread winter wheat that significantly exceeded the standard in terms of 1,000 kernel weight were identified: *Lutescens* 60400 (44.6 g), MIP Darunok (43.7 g), *Lutescens* 37548 (43.5 g), MIP Aelita (43.0 g), MIP Vidznaka (42.7 g), and by test weight of grain – MIP Vidznaka (785 g/l), *Lutescens* 37548 (780 g/l), *Lutescens* 60302 (778 g/l). **Conclusions.** The revealed peculiarities of the effect of previous crops on the 1,000 kernel weight and test weight of grain should be considered in bread wheat cultivation. The selected varieties and breeding lines should be involved in the breeding process as sources of individual studied traits, and the MIP Vidznaka variety and the *Lutescens* 37548 breeding line should be used as sources of a set of high grain quality indicators.

Key words: winter bread wheat, variety, breeding line, physical indicators of grain quality, hydrothermal conditions, previous crop, coefficient of variation, ANOVA

Introduction. An important reserve for production growth is high yield and quality of agricultural crops. The creation and accumulation of nutrients in plants depends on soil and climatic conditions, agrotechnological methods and biological characteristics of new varieties [1]. In the conditions of the changing continental climate of the central Forest-Steppe of Ukraine, the issue of dependence of winter soft

wheat grain quality on abiotic, biotic and anthropogenic factors is insufficiently studied, and given the realities of today is relevant.

All types of agro-ecosystems respond to favourable and unfavourable natural factors in the process of growing crops. Prevention of the negative impact of physical natural phenomena in the winter wheat cultivation requires a comprehensive solution to problems in agriculture,

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in particular, the development of scientifically sound methods [2], namely, the introduction of agrotechnologies with minimal environmental impact. Proper selection of crops in crop rotation is an affordable technological method of improving the grain quality of wheat. A successful choice of a previous crop ensures optimal development of the crop during the growing season, and contributes to the creation of a satisfactory phytosanitary condition of crops [3, 4] and maximises the profit from the grown products. Implementation of the whole complex of agrotechnological practices contributes to the realisation of up to 80 % of the genetic potential of the variety in terms of high quality grain yield [5]. Winter wheat is more demanding on previous crops due to its biological properties compared to other winter crops. Therefore, one of the important factors for improving the grain quality of winter wheat without significant material costs is a scientifically based choice of a previous crop [6].

First of all, wheat is assessed by physical indicators of grain quality, such as 1,000 kernel weight, its test weight, grain hardness and damage by sunn pest. 1,000 kernel weight characterises the technological qualities of the variety, grain size and uniformity [7]. The new generation of high-intensity varieties is noted to have a higher 1,000 kernel weight [8]. The test weight of grain is one of the class-forming quality indicators [9], which is considered for its transportation and storage [10]. Some scientists believe that the nature of the grain is directly affected by its size [11], while others argue that this indicator largely depends on the shape of the grain and its uniformity in size [12]. Today, these two traits are used to determine the milling properties of grain [13, 14]. Grain lots with higher 1,000 kernel weight and test weight usually have higher flour yields [14, 15]. It should be noted that 1,000 kernel weight is characterised by higher heritability compared to the test weight of the grain [16]. Information on the selection of varieties and breeding lines with higher grain quality indicators is of practical importance in the breeding process.

The study was aimed at determining the influence of previous crops on 1,000 kernel weight and test weight of winter wheat grain in the central part of the Forest-Steppe of Ukraine and selecting genotypes with significantly high

grain quality.

Materials and Methods. The research was conducted at the V. M. Remeslo Myronivka Institute of Wheat of NAAS of Ukraine (MIP) during growing seasons 2020/21–2022/23. We studied the impact of five previous crops: soybean (SB), sunflower (SF), corn (CR), green manured fallow (GM), mustard (MS) on the physical characteristics of grain quality of seven new varieties (MIP Nika, MIP Roksolana, MIP Feieria, MIP Aelita, MIP Vidznaka, MIP Darunok, MIP Dovira), four promising breeding lines (Lutescens 37548, Lutescens 60049, Lutescens 60302, Lutescens 60400) of bread winter wheat and the Podolianka variety (standard).

Bread winter wheat was grown according to the generally accepted technology for the Forest-Steppe of Ukraine [17]. The registration area of the experimental plots was 10 m². The experiment was repeated four times.

1,000 kernel weight (TKW) was determined using two samples of 500 kernels from one batch, each of which was weighed to the nearest 0.1 g (the difference between the weights of both samples did not exceed 5 %), the weights of these samples were summed and the final result was obtained. Test weight of grain (TW) was determined using a litre batch in two repetitions, the difference between parallel measurements did not exceed 5 g, and the final result was the average of the two measurements in g/l.

Statistical processing of the experimental data was carried out using the methods of variation and dispersion analysis.

Results and Discussion. Hydrothermal regime of the study years was contrasting with uneven distribution of precipitation by months (Table 1). The air temperature in these years increased by 1.0–1.5 °C compared to the long-term average. In terms of precipitation, the 2020/21 growing season was close (102.2 %) to the long-term average. Conditions in 2021/22 were characterised by insufficient precipitation (80.5 % of the long-term average). Excessive moisture supply of 132.6% of the long-term average was noted in growing season 2022/23. Critically low amount (< 50 % of the long-term average) of precipitation was recorded in August 2020/21, September 2020/21 and 2021/22, January 2022/23, February and March 2021/22. Abnormally high

(≥ 150 % of the long-term average) precipitation was recorded in August and April 2021/22 and 2022/23, January, February and May 2020/21, September, November and July 2022/23.

The results of the research revealed that different hydrothermal conditions of the years have different effects on the formation of physical indicators of grain quality (Fig. 1).

Table 1. Monthly average of air temperature and precipitation over the research period

Growing season	Month												Average
	VIII	IX	X	XI	XII	I	II	III	IV	V	VI	VII	
Air temperature, °C													
2020/21	21.1	18.6	13.3	3.8	-0.3	-2.3	-4.7	2.3	7.7	14.5	20.2	23.3	9.8
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
long-term average	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
Sum of precipitation, mm													
2020/21	8	21	22	28	38	57	49	28	47	87	100	111	596
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
long-term average	59	51	34	40	43	36	31	34	44	52	79	81	583

Note. Long-term average (1960–2020).

The greatest variation in 1,000 kernel weight and test weight of grain, and the lowest average values of these parameters (TKW = 38.0 g; TW = 759 g/l) were obtained in the dry year 2021/22. The weather conditions in 2022/23 contributed to the maximum average of 1,000 kernel weight (45.1 g) and test weight

(777 g/l), and the lowest variation of these indicators was also noted. Thus, a shrunk grain with a lower test weight is formed under dry growing conditions, and excessive moisture has a positive effect on the size and plumpness of wheat grains. Our experimental data confirm the results of other researchers [18].

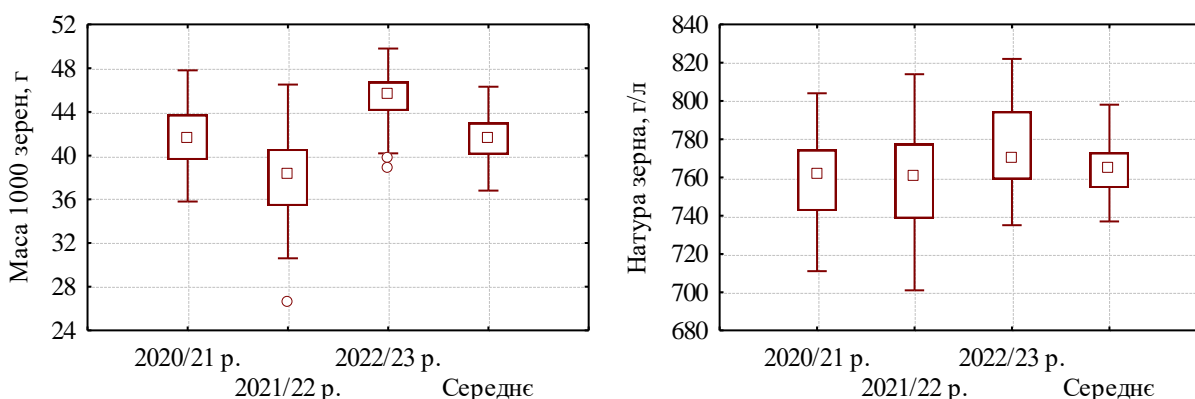
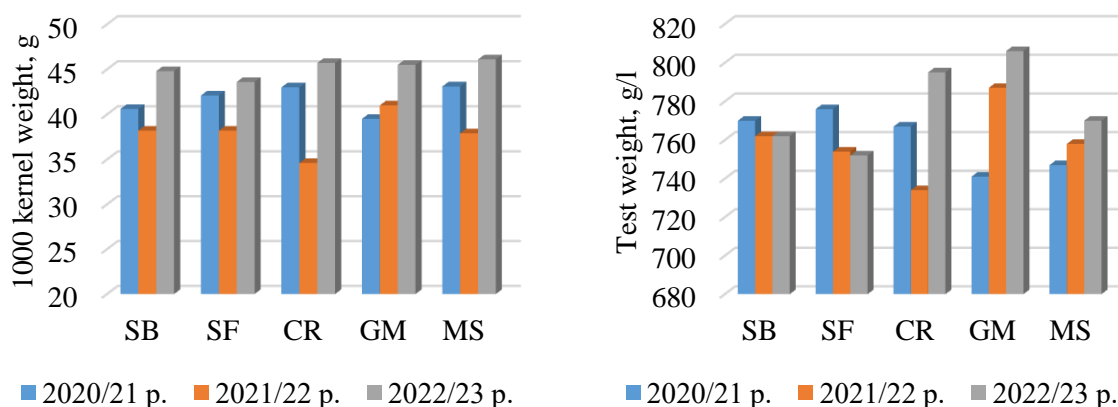


Fig. 1. 1,000 kernel weight and test weight of winter wheat over the years of research.

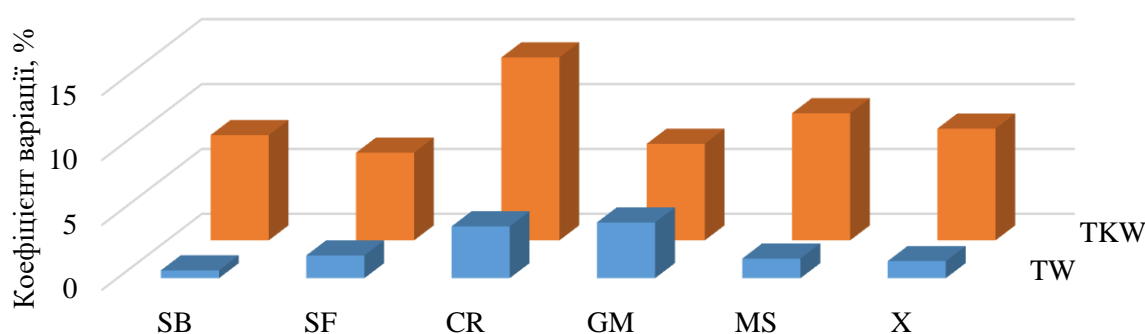
The contrasting hydrothermal conditions of the study years had an ambiguous effect on the formation of physical indicators of grain quality after different previous crops (Fig. 2). In 2020/21 and 2022/23, higher values of 1,000 kernel weight were found after mustard, and in 2021/22 – after green-manured fallow according to winter wheat genotypes. In 2020/21, the highest test weight of wheat grain was recorded after sunflower, as well as in 2021/22 and 2022/23 – after green manured fallow.

Different coefficients of variation (CV) of physical indicators of grain quality between years of research after different previous crops were found (Fig. 3). The nature of the grain was characterised by a weak variation (CV = 0.6–4.3 %) after all the previous crops. A significant (CV = 14.1 %) variation in 1,000 kernel weight after maize and moderate (CV = 7.4–9.5 %) after other previous crops, depending on the weather conditions, on average by varieties and breeding lines, was determined.



Note. Previous crops: SB – soybean, SF – sunflower, CR – corn, GM – green-manured fallow, MS – mustard.

Fig. 2. 1,000 kernel weight and test weight of grain depending on the previous crop (average for winter wheat genotypes)



Note. Previous crops: SB – soybean, SF – sunflower, CR – corn, GM – green-manured fallow, MS – mustard; X – average by previous crops; TW – test weight, TKW – 1,000 kernel weight.

Fig. 3. The coefficient of variation in 1,000 kernel weight and test weight of winter wheat over the years of research (average for winter wheat genotypes).

A higher level of 1,000 grain weight (42.4 g) was obtained after mustard, and test weight (778 g/l) - after green-manured fallow on average by years and genotypes of bread winter wheat (Table 2). However, differences in the effect of the previous crop on the formation of traits for individual varieties and breeding lines were observed. On average, the maximum 1,000 kernel weight in Podolianka variety (42.8 g) and breeding lines Lutescens 37548 (46.3 g), Lutescens 60400 (45.8 g), Lutescens 60302 (41.3 g) was obtained after green manured fallow; in breeding line Lutescens 60049 (43.0 g) – after soybean. However, the maximum 1,000 kernel weight was found in most varieties MIP Darunok (44.3 g), MIP Aelita (44.1 g), MIP Vidznaka (43.2 g), MIP Dovira (42.0 g), MIP Feieriia (41.5 g), MIP Roksolana (39.9 g), and MIP Nika (39.0 g) after mustard. It should be noted that the Lutescens 37548 line was charac-

terised by a moderate (CV = 6.9 %) variability of this trait depending on the previous crops, while other genotypes had a weak (CV = 1.1–3.8 %) variability.

The majority of varieties and breeding lines formed a higher test weight of grain after green manured fallow, in particular, Lutescens 60302 (798 g/l), Lutescens 37548 (795 g/l), Podolianka (792 g/l), MIP Darunok (784 g/l), MIP Aelita (777 g/l), Lutescens 60400 (770 g/l), MIP Roksolana (763 g/l). However, genotypes with the highest values of this indicator were also noted after other previous crops. In particular, the varieties MIP Nika (772 g/l), MIP Feieriia (755 g/l), MIP Vidznaka (795 g/l), MIP Dovira (767 g/l) had a higher test weight after the maize, and the breeding line Lutescens 60049 (779 g/l) – after soybean. A weak variation of this trait was found for all bread winter wheat genotypes depending on the previous crop on ave-

Table 2. Dependence of 1,000-kernel weight and test weight of bread winter wheat varieties and breeding lines on the previous crop, average for 2020/21–2022/23

Previous crop	Podolianka	MIP Nika	MIP Roksolana	MIP Feieria	MIP Aelita	MIP Vidznaka	MIP Darunok	MIP Dovira	Lutescens 37548	Lutescens 60049	Lutescens 60302	Lutescens 60400	X	LSD ₅	CV, %
1,000-kernel weight, g															
SB	41.1	36.8	38.1	40.2	41.7	43.0	42.4	38.3	46.0	43.0	39.2	44.5	41.2	0.6	6.7
SF	41.3	38.1	39.7	41.1	42.9	42.1	44.0	40.1	40.5	41.6	39.5	44.8	41.3	0.6	4.7
CR	42.3	38.1	39.0	41.3	42.6	42.8	43.5	41.9	40.1	40.6	38.2	42.8	41.1	0.7	4.6
GM	42.8	37.1	37.5	41.4	43.5	42.3	44.2	41.0	46.3	40.8	41.3	45.8	42.0	0.8	6.7
MS	42.2	39.0	39.9	41.5	44.1	43.2	44.3	42.0	44.4	41.7	41.1	45.1	42.4	0.7	4.5
X	41.9	37.8	38.8	41.1	43.0	42.7	43.7	40.7	43.5	41.5	39.9	44.6	41.6	0.7	4.9
LSD ₀₅	0.7	0.6	0.7	0.7	0.6	0.7	0.6	0.7	0.6	0.7	0.7	0.7	0.7	-	-
CV, %	1.7	2.3	2.6	1.3	2.1	1.1	1.8	3.8	6.9	2.3	3.3	2.5	1.4	-	-
Test weight, g/l															
SB	772	753	746	737	766	787	759	747	793	779	783	754	765	4	2.4
SF	764	767	752	744	761	779	764	755	767	761	769	745	761	5	1.3
CR	763	772	747	755	758	795	768	767	772	773	764	752	766	5	1.6
GM	792	771	763	754	777	792	784	765	795	773	798	770	778	4	1.8
MS	770	761	737	737	756	773	760	753	773	759	775	741	758	5	1.8
X	772	765	749	745	764	785	767	757	780	769	778	752	765	5	1.6
LSD ₀₅	5	4	5	5	5	4	5	5	5	5	4	4	5	-	-
CV, %	1.5	1.0	1.3	1.2	1.1	1.2	1.3	1.1	1.7	1.1	1.7	1.5	1.0	-	-

Notes. Previous crops: SB – soybean, SF – sunflower, CR – corn, GM – green-manured fallow, MS – mustard; X – average; LSD – least significant difference; CV – coefficient of variation.

rage for 2020/21–2022/23.

The genotypes of bread winter wheat which were significantly superior to the Podolianka variety-standard by 1,000 kernel weight were identified: Lutescens 60400 (44.6 g), MIP Darunok (43.7 g), Lutescens 37548 (43.5 g), MIP Aelita (43.0 g), MIP Vidznaka (42.7 g), and test weight: MIP Vidznaka (785 g/l), Lutescens 37548 (780 g/l), Lutescens 60302 (778 g/l). Thus, the highlighted varieties and breeding lines are suitable for practical plant breeding as sources of the above traits, and MIP Vidznaka and Lutescens 37548 as sources of a complex of high physical parameters of grain quality.

According to the results of the analysis of variance (Fig. 4), it was found that the formation of 1,000 kernel weight was most affected by the weather conditions (44.8 %), and the test weight of grain depended more on the interaction of the factors year × previous crop (37.3 %). A significant effect of genotype on the studied

traits (TKW – 19.4 %, TW – 21.1 %) was also determined. It was found that previous crops had the least impact (1.3%) on 1,000 kernel weight, as well as the interaction of factors genotype × previous crop (5.9 %) on the test weight of grain. A significant contribution to the total variance of other factors was noted.

In the literature sources of scientific institutions both in Ukraine and abroad, differences in the impact of factors on grain quality indicators were noted. In particular, a number of studies state that 1,000 kernel weight and test weight of grain depends most on the weather conditions [19–21].

However, according to the results of S. Li et al. [16], O. Zavadska and T. Baiba [15], these indicators depended largely on the genotype. Other scientists argue that grain quality indicators depend on both varietal characteristics and weather conditions of the year [14, 22].

According to the results of analysis of variance, higher proportions of the impact of geno-

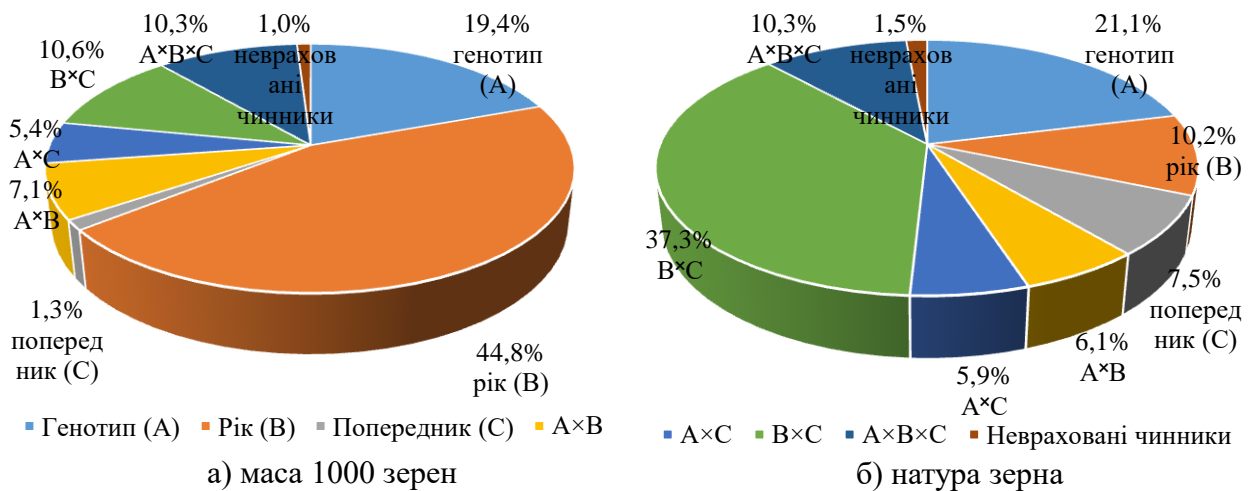


Fig. 4. Percentage of factor impact on 1,000 kernel weight (a) and test weight (b) of bread winter wheat, 2020/21–2022/23.

type, previous crop and their interaction on the physical quality of grain were observed over the years (Fig. 5). It should be noted that the ratio of these proportions of the impact varied over the years. A significant impact of the genotype on the studied traits was found in 2020/21. In 2021/22, a similar level of factors' impact on physical parameters of grain quality was ob-

served. A significant difference in the impact of factors on these traits was found in 2022/23, i.e. 1,000 kernel weight was determined by genotype (72.5 %) and the test weight of grain by its previous crop (75.8 %). The greatest impact of the interaction of factors genotype × previous crop on the physical parameters of grain quality was obtained in the dry 2021/22.

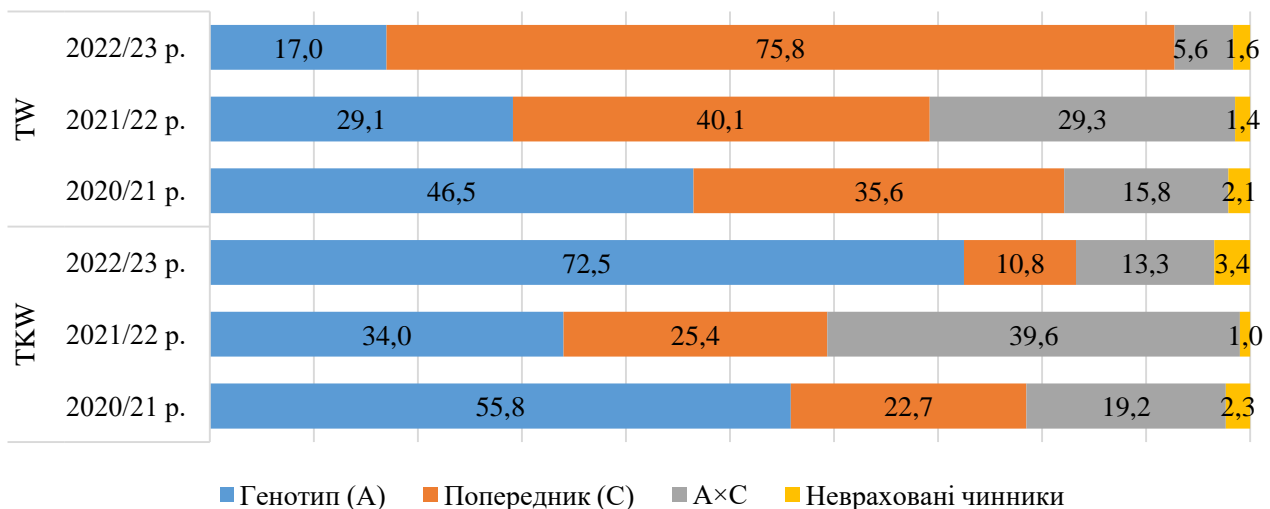


Fig. 5. Percentage of factor impact on 1,000-kernel weight (TKW) and test weight (TW) of bread winter wheat depending on growing conditions

Proportions of the studied factors impact for each genotype (Table 3) once again confirmed the above results. Thus, the interaction of factors *year × previous crop* had the maximum impact on the formation of test weight for all genotypes with a variation from 45.7 to 80.3 %, and 1,000 kernel weight was affected by the growing conditions of year for most varieties

and breeding lines (45.8–80.8 %).

It was noted that 1,000 kernel weight of MIP Vidznaka variety depended both on the year (43.0 %) and on the interaction of factors *year × previous crop* (49.1%), but the proportion of impact of the interaction of factors was higher. The greatest impact of the previous crop on the physical parameters of grain quality was

Table 3. Percentage of factor impact on 1,000-kernel weight and test weight of the varieties and breeding lines of bread winter wheat, 2020/21–2022/23 pp.

Factor	Podolianka	MIP Nika	MIP Roksolana	MIP Feieria	MIP Aelita	MIP Vidznaka	MIP Darunok	MIP Dovira	Lutescens 37548	Lutescens 60049	Lutescens 60302	Lutescens 60400
1,000-kernel weight												
Year (B)	80.8	48.5	76.9	72.3	66.0	43.0	67.1	67.5	45.8	52.1	65.4	64.6
Previous crop (C)	1.8	9.3	5.1	1.4	4.4	4.5	3.4	12.5	27.0	6.6	5.5	6.9
B×C	16.7	39.8	16.5	24.9	28.0	49.1	28.0	18.6	26.6	39.3	28.2	27.0
Unaccounted factors	0.7	2.4	1.5	1.3	1.6	3.4	1.5	1.4	0.6	2.0	0.9	1.5
Test weight												
Year (B)	25.7	24.6	39.1	14.0	27.5	9.5	21.4	40.4	6.3	3.9	23.6	13.4
Previous crop (C)	19.8	19.5	13.2	12.9	16.1	17.1	19.9	11.7	25.5	13.7	17.8	15.4
B×C	53.1	53.0	45.7	70.6	53.4	71.6	56.3	45.7	66.3	80.3	57.5	70.0
Unaccounted factors	1.4	2.9	2.1	2.5	3.0	1.9	2.4	2.2	1.9	2.2	1.2	1.2

found in the breeding line Lutescens 37548, and the lowest impact – in the MIP Feieria variety (1.4 %) by 1,000 kernel weight, and in the MIP Dovira variety (11.7 %) – by test weight of grain.

Conclusions. The study results showed that dry growing conditions resulted in the formation of shrunk grain with a lower test weight, and conditions with a higher moisture supply had a positive effect on grain size and plumpness.

Over the years of research, the highest values of 1,000 kernel weight after mustard and test weight after green-manured fallow were obtained for all genotypes. However, for individual varieties and breeding lines, differences in the impact of the previous crop on the studied traits were observed.

A moderate (CV = 6.9 %) variability of 1,000 kernel weight in the breeding line Lutescens 37548 was determined, depending on the previous crop, while other genotypes were characterised by a weak (CV < 5 %) variability in

both 1,000 kernel weight and test weight of grain.

It was found that the greatest impact of growing conditions (44.8 %) on 1,000 kernel weight and the interaction of factors year × previous crop (37.3 %) on the test weight of grain. A significant impact of genotype on the studied traits (TKW – 19.4 %, TW – 21.1 %) was revealed. The formation of 1,000 kernel weight was least affected by the previous crop (1.3%), and the test weight was least affected by the interaction of factors genotype × previous crop (5.9%).

The varieties and breeding lines of bread winter wheat that significantly exceeded the standard in terms of 1,000 kernel weight were identified: Lutescens 60400 (44.6 g), MIP Darunok (43.7 g), Lutescens 37548 (43.5 g), MIP Aelita (43.0 g), MIP Vidznaka (42.7 g), as well as by test weight of grain: MIP Vidznaka (785 g/l), Lutescens 37548 (780 g/l), Lutescens 60302 (778 g/l).

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Правдзіва І. В.¹, Василенко Н. В.¹, Хорошко Н. М.¹, Шевченко Т. В.² Вплив попередників на масу 1000 зерен та натуру зерна пшениці м'якої озимої (*Triticum aestivum* L.) в умовах центральної частини Лісостепу України. *Зернові культури*. 2024. 8 (1). 127–135.

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Актуальність. Правильний підбір попередньої культури для пшениці озимої в умовах мінливого континентального клімату є одним із основних доступних технологічних заходів підвищення якості зерна даної культури. А виділення сортів та селекційних ліній з вищим рівнем показників

якості зерна має практичне значення в селекційному процесі при створенні високоякісного вихідного матеріалу. **Мета.** Виявлення впливу попередників на масу 1000 зерен та натуру зерна пшениці м'якої озимої в умовах центральної частини Лісостепу України та виокремлення генотипів з достовірно високими показниками якості зерна. **Методи.** Оцінювали сім нових сортів та чотири селекційні лінії пшениці, які висівали після п'яти попередників впродовж 2020/21–2022/23 рр. в умовах Миронівського інституту пшениці імені В. М. Ремесла НААН України. Визначали масу 1000 зерен (TKW) та натуру зерна (TW) відповідно до загальноприйнятих методик. **Результати.** У 2022/23 р. відмічено вищі середні значення досліджуваних ознак (TKW = 45,1 г; TW = 777 г/л), а у 2021/22 р. – найменші (TKW = 38,0 г; TW = 759 г/л). Максимальну масу 1000 зерен (42,4 г) у середньому за генотипами та роками отримано після гірчиці, а натуру зерна (778 г/л) – після сидерального пару. Проте, виявлено відмінності впливу попередньої культури на показники якості зерна для окремих генотипів пшениці м'якої озимої. На масу 1000 зерен найбільше впливали умови року (44,8 %), а на натуру зерна – взаємодія чинників: рік × попередник (37,3 %). Виявлено суттєвий вплив генотипу на ознаки (TKW – 19,4 %, TW – 21,1 %). Маса 1000 зерен найменше залежала від попередника (1,3 %), а натура зерна – від взаємодії чинників генотип × попередник (5,9 %). Виокремлено сорти та селекційні лінії пшениці м'якої озимої, які достовірно перевищували стандарт за масою 1000 зерен – Лютесценс 60400 (44,6 г), МПП Дарунок (43,7 г), Лютесценс 37548 (43,5 г), МПП Аеліта (43,0 г), МПП Відзнака (42,7 г) та натурою зерна – МПП Відзнака (785 г/л), Лютесценс 37548 (780 г/л), Лютесценс 60302 (778 г/л). **Висновки.** Виявлені особливості впливу попередників на масу 1000 зерен та натуру зерна варто враховувати при вирощуванні пшениці м'якої озимої. Виділені сорти та селекційні лінії слід використовувати у селекційному процесі як джерела окремих ознак, а сорт МПП Відзнака та селекційну лінію Лютесценс 37548 – як джерела комплексу високих показників якості зерна.

Ключові слова: пшениця м'яка озима, сорт, селекційна лінія, фізичні показники якості, гідротермічні умови, попередня культура, коефіцієнт варіації, ANOVA