

YIELD AND GRAIN QUALITY PARAMETERS IN DOMESTIC AND FOREIGN VARIETIES OF SOFT WINTER WHEAT

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Topicality. One of the main indicators that determine the commercial value of wheat grain, its baking and technological properties is the mass fraction of protein. The results of scientific research and agricultural production practices show that over the past 80–90 years in the southern regions of Ukraine, the protein content of winter wheat grain has decreased from 17–18 % to 10–12 %, and in unfavourable weather conditions, the amount of protein in grain can even decrease to 8.0–9.5 %. Improving the wheat grain quality is one of the challenges facing Ukraine today. Ukraine has a high position in the global grain market: its share in wheat exports averages 5 %. **Purpose.** To estimate the yield and biochemical parameters of grain quality of soft winter wheat at the current stage. **Methods.** Field trials were conducted according to the B. A. Dospekhov's methodology of field experience. Agricultural technology of winter wheat cultivation is generally accepted for the Steppe zone of Ukraine. Accounting the yield was carried out according to the methodology of state variety testing the agricultural crops. The protein content in the grain was determined by infrared spectrometry and the Kjeldahl method. The level of protein sedimentation was determined by the SDS 30 method. **Results.** When comparing the obtained data on yield in the collection, it was found that modern domestic and foreign varieties (I, II, III group) in the optimal conditions of growing season had an average yield of 103–107 % higher than varieties of early stages of breeding. The soft winter wheat varieties developed by the Plant Breeding and Genetics Institute – National Center for Seeds and Cultivar Investigation are the leaders in terms of yield. Foreign varieties are not sufficiently adapted to local weather conditions, which significantly affects the realisation of yield potential. As a result of the negative correlation between yield and grain quality, with each stage of breeding, including in modern varieties, grain protein content decreases by 0.5–1.5 % along with yield growth. In terms of sedimentation level, the varieties of the Plant Breeding and Genetics Institute – National Center for Seeds and Cultivar Investigation prevail over the varieties of the early stages of breeding. The group of varieties of Ukrainian breeding has a great diversity in terms of sedimentation level. Foreign varieties have rather low sedimentation rates. The realisation of the genetic potential of grain yield and quality of the studied varieties depended on weather conditions and doses of mineral fertilisers. **Conclusions.** Given the negative correlation between yield and grain quality, the significant success of breeding in increasing the yield of Ukrainian and foreign varieties was accompanied by decreasing protein content at each stage of breeding by 0.5–1.5 %. Compared to the varieties of the early stages of breeding, the SDS-30 sedimentation index was the highest only in the varieties of Plant Breeding and Genetics Institute – National Center for Seeds and Cultivar Investigation, while domestic varieties of other research institutions were slightly inferior to the varieties of the early stages of breeding. The group of foreign varieties had the lowest sedimentation index. In addition to the genetic factor, such factors as weather conditions and rates of mineral nutrition have a great influence on the formation of grain yield and quality.

Key words: wheat yield, wheat adaptability, grain protein content, sedimentation, fertilizers, biochemical parameters

Introduction. One of the main indicators that determine the commercial value of wheat grain, its baking and technological properties is the mass fraction of protein. By the beginning of the XX century, numerous studies in around the world had identified the leading role of factors

affecting protein accumulation in wheat grain [12]. External factors include climate (temperature, precipitation) and soil fertility (the available nitrogen content for the plant).

Among the internal factors, priority is given to genotype (variety), which determines

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the growth and development of wheat plants, absorption and assimilation of chemical elements from the environment. The next stage of the study of grain quality dates back to the 60s–80s of the 20th century and is related to the search for high-protein genotypes in wild species of *Triticum* L. and *Aegilops* L. [13]. The United States and Canada were the leading countries in this area, where they managed to increase the amount of protein in grain by 0.5–3.0 % [14]. It has been proven that the level of grain protein is polygenic [15]. Today, all wheat chromosomes containing major and minor loci that affect the protein content of grain have been identified [16].

The results of scientific research and agricultural practice show that over the past 80–90 years in the southern regions of Ukraine, the protein content in winter wheat grain has decreased from 17–18 % to 10–12 %, and in unfavourable weather conditions, the protein content in grain tends to decrease even to 8.0–9.5 % [1]. One of Ukraine's current challenges is improving the wheat grain quality. Ukraine ranks high in the global grain market: its share in wheat exports averages 5 %; at the same time, Ukraine's share in wheat exports to the EU is 32 % [2]. Unfortunately, Ukrainian wheat is generally inferior in quality to the world best varieties and, as a result, does not fully satisfy the domestic and foreign markets in terms of wheat flour quality. Most of the wheat grown in Ukraine is used for fodder and only 40–50 % is used for food [3]. Among other factors, this is due to the introduction of intensive cultivation technologies and the use of new generation varieties capable to produce high yields. Therefore, current research should be focused on developing varieties that can overcome the inverse crop-protein relationship regardless of weather and climate conditions and on ways of improving agronomic practices for growing this crop.

Traditionally, the priority of the Plant Breeding and Genetics Institute – National Center for Seeds and Cultivar Investigation (PBGI–NCSCI), located in a region with favourable soil and climatic conditions, is to develop winter soft wheat (*Triticum aestivum* L.) varieties with high baking quality grain, the potential of which is fully realised only if the protein content in flour is not less than 12.5 % [4]. A long-term experiment was carried out at the PBGI–NCSCI

to study varieties of different years of origin. The collection consisted of varieties ranging from popular breeding to the newest at the time. The experimental material was divided into 8 groups: the first group included varieties grown in southern Ukraine in the early 20th century, and then groups of varieties of new breeding stages (the difference between the groups was approximately 10–15 years). The experiment was launched in 1972 on the fields of PBGI–NCSCI. The varieties were studied for many parameters: yield, elements of the yield structure, plant height, duration of growing season and protein content in grain. Many years of breeding aimed primarily at increasing grain productivity, have led to accelerated evolution of wheat, which has manifested itself in changes in almost all plant traits and properties. Over the 80 years of scientific breeding, wheat yield in the South of Ukraine has almost tripled from 2.5–3.0 t/ha to 8.0–10.0 t/ha, but the protein content has decreased from 14.4 % to 11.3 % [5].

The objective of this work was evaluation of modern varieties of soft winter wheat in terms of yield and biochemical parameters of grain quality.

Materials and Methods. The field trials were conducted by the Wheat Breeding and Seed Production Department of PBGI–NCSCI in the experimental fields after black fallow in 2019–2022. The experiment was repeated three times, a plot size was 10 m² on two agricultural backgrounds, and ammonium nitrate was applied at a rate of 60 and 120 kg a.i./ha in spring during vegetation recovery. The study was carried out according to the methodology of the field experiment by B. A. Dospiekhov [6]. Agricultural cultivation technology of winter wheat is generally accepted for the Steppe zone of Ukraine.

The collection of the Wheat Breeding and Seed Department includes 50 most widespread and promising varieties from PBGI–NCSCI, seven other Ukrainian institutions and six foreign ones. Varieties of domestic institutions: Novosmuhlianka, Chorniava, Slavna (Institute of Plant Physiology and Genetics); Kvitka Laniv, Shchedra Nyva (Bila Tserkva Experimental Breeding Station); Svitanok (V. M. Remeslo Myronivka Institute of Wheat of NAAS); Rosynka, Soborna, Koshova (Institute of Irrigated Agriculture of NAAS); MIP Valensiia

(Institute of Experimental Botany); Yaroslavna (Kherson State Agrarian University); Analoh, Kesariia (NSC Institute of Agriculture of NAAS). Varieties of foreign institutions: Ortegus, Ponticus, Faustus, Lenox – Strube (Germany); Colonia – Limagrain (France); Baletka, Matchball – RAGT (Czech Republic); Mulan – Nordsaat Saatucht (Belgium); Turandot – Selgen (Czech Republic); Torrild – SAATEN-UNION (Germany). To confirm the changes in the characteristics of the varieties, varieties of earlier stages of selection were involved in the experiment: the Odeska 16 variety of extensive type for steppe ecology (1952), the Bezosta 1 variety of tall intensive type for forest-steppe ecology (1959), the Odeska 51 variety of tall intensive type of steppe ecology (1969), the Pylypivka variety of tall intensive type of steppe ecology (2011). It should be noted that the Pylypivka variety was included in the State Register relatively recently, but by its variety type it belongs to tall intensive varieties. For the analysis of the experimental data, the wheat varieties in the collection were grouped by location, economically valuable traits, and origin (institutions by geographical location) into the following groups: I – varieties bred by PBGI-NCSCI; II – varieties bred by other institutions in Ukraine; III – varieties bred by foreign companies.

According to the meteorological service of Odesa airport, 290 mm of precipitation fell during the 2019/20 growing season, most of which was observed in autumn and winter, while in March and April there was a significant moisture deficit. In general, the year can be described as very unfavourable in terms of weather conditions. In the next growing season (2020/21), 500 mm of precipitation fell, which was 70 % more than in the first year of research. This year in terms of abiotic factors was optimal for the growing season of winter crops. During the 2021/22 growing season, 300 mm of precipitation fell, but unlike in 2020, the amount of precipitation in March-April was slightly higher. Weather conditions this year can be considered dry, although moisture reserves were satisfactory at the time of the growth resumption. In general, the Right-Bank Steppe zone is classified as a region with a less than optimal ratio of such weather criteria as heat and moisture.

The total protein content was determined using a modern and generally accepted method

of infrared spectrometry (NIR). The analyses were performed using an Inframatic 8600 instrument (Pertent, Sweden) [7]. As a reference method, the determination of total protein content by the Kjeldahl method was used [11]. Level of sedimentation was determined by a method with preliminary autolysis, in particular, the SDS-30 method [8]. The calculation of statistical indicators and the correlation between the studied parameters was carried out according to generally accepted methods using the computer program MS Excel and Statistics 8.

The determination of the protein content in the test material using the two methods allowed us to conclude that the data obtained by infrared spectrometry differed by 0.3–0.7 % from the results obtained by the Kjeldahl method. At the same time, a strong positive correlation ($r = 0.90$ – 0.95) was noted between the results obtained by these two methods. In addition, the infrared spectrometry method has a number of advantages, such as: speed, simplicity of execution, no reagents required and, moreover, minimal labour costs. The high correlation, low percentage of deviation and the above arguments make this method quite suitable for mass analyses in the breeding process. However, when determining the grain class in accordance with current regulations, to avoid inaccuracies, it is better to use the most accurate method available today, the Kjeldahl arbitration method, including for calibrating an infrared spectrophotometer for protein content.

Results and Discussion. During two years of winter wheat cultivation (2020/21 and 2021/22) with contrasting weather conditions, the following pattern was established: each new stage of breeding, including the development of modern varieties, leads to an increase in their yield. A positive response of wheat varieties to an increased rate of nitrogen fertiliser was also noted, namely the growth of yield and its significant differentiation by group (Table 1, 2). There were significant differences in the yield increase depending on fertiliser rates in both years. The yield of the standard varieties, depending on the growing conditions and mineral nutrition rates, varied from 3.05 t/ha in the extensive Odeska 16 variety to 4.76 t/ha in the intensive tall Pylypivka variety. In contrast, the grain protein content index tended to decrease. On average over the years, the difference in protein content (from

12.0 % in Odeska 16 variety to 10.5 % in Pylypivka variety) between the standard varieties in the N₆₀ fertiliser variant was 1.5 %. The same trend was observed in the N₁₂₀ fertiliser variant, where the difference between Pylypivka and

Odeska 16 varieties was 1.7 % on average over the years. In addition, it was found that with certain calculations of fertiliser rates, high yields and grain protein levels can be achieved in certain varieties.

Table 1. Yields and grain quality parameters of soft winter wheat varieties of previous breeding stages

Variety	Rate of nitrogen fertilisers, kg/ha	Yield, t/ha			Protein content in grain, %				Sedimentation, ml			
		years		average \bar{X}	years			average \bar{X}	years			average \bar{X}
		2021	2022		2020	2021	2022		2020	2021	2022	
Odeska 16	N ₆₀	3.08±0.12	3.01±0.14	3.05	11.1±0.1	12.5±0.2	12.4±0.2	12.0	50±1.2	70±1.3	57±2.2	59
	N ₁₂₀	3.53±0.11	3.54±0.32	3.54	12.5±0.2	13.3±0.1	14.1±0.3	13.3	66±2.2	75±1.2	68±2.1	70
Bezosta 1	N ₆₀	3.53±0.12	3.35±0.21	3.44	10.8±0.2	12.4±0.2	12.2±0.1	11.8	43±2.4	64±2.0	53±1.2	53
	N ₁₂₀	4.72±0.21	3.99±0.30	4.36	11.9±0.3	13.4±0.3	13.7±0.3	13.0	61±1.4	74±2.2	63±0.9	66
Odeska 51	N ₆₀	3.57±0.21	3.41±0.13	3.49	10.6±0.2	11.0±0.2	12.1±0.4	11.2	42±1.6	57±1.2	52±2.1	50
	N ₁₂₀	4.88±0.12	4.19±0.12	4.54	11.5±0.1	12.3±0.1	12.9±0.2	12.2	57±1.5	71±1.5	62±1.2	63
Pylypivka	N ₆₀	4.13±0.21	4.08±0.19	4.11	9.4±0.2	10.3±0.3	11.8±0.2	10.5	39±2.4	55±1.4	49±1.7	48
	N ₁₂₀	4.92±0.22	4.60±0.18	4.76	10.1±0.2	11.7±0.3	13.0±0.1	11.6	54±2.1	69±1.1	58±1.6	60

Also, characteristic changes in tall varieties were observed in the level of sedimentation, which, according to the literature, has a high correlation with gluten quality and baking characteristics [17]. There was a significant differentiation in sedimentation levels of these varieties in the dry years of 2020 and 2022. In these years, the average sedimentation level for the two fertilisation variants was 51.5–57.7 ml, and in the wetter year of 2021, it was 66.8 ml. A significant response to fertiliser application was found. On average over the years, the sedimentation value in the N₆₀ fertiliser variant was 52.6 ml, and in the N₁₂₀ fertiliser variant it was 64.8 ml. Moreover, under the same conditions, the sedimentation rates did not change significantly. At the same time, there is a pattern of increasing the genetic potential of yield and a positive response to increasing doses of nitrogen fertilisers.

It should be noted that all modern varieties of different groups are of the short-stemmed semi-dwarf type with plant height from 72 to

96 cm, depending on the expression of short-stemmed genes in specific conditions [18]. According to the literature, significant progress has been achieved in soft winter wheat breeding both in Ukraine and abroad to increase yields. According to research results, depending on the year conditions and rates of mineral nutrition, modern varieties exceed varieties of previous breeding stages by 103–107 %.

Factors that contributed to the increase in yields for modern short-stemmed varieties include an increasing of grain mass in total biomass by 40–45 % and an increased positive response to mineral fertilisers. Grain quality indicators of modern varieties show the following general pattern: with the growth of genetically determined yield, the protein content in grain and sedimentation indicators by SDS-30 method decrease (Table 2). However, in each group of varieties, under the same growing conditions (year, fertilisers), there were some varieties that exceeded the average values of varieties of previous stages of selection in terms of protein

Table 2. Yield and grain quality indicators of modern winter soft wheat varieties

Group of varieties, n*	Rate of nitrogen fertilisers, kg/ha	Yield, \bar{X} , 2021–2022, t/ha	Protein content in grain, %				Sedimentation, ml			
			years			\bar{X} , 2020–2022	years			\bar{X} , 2020–2022
			2020	2021	2022		2020	2021	2022	
I n=22	N ₆₀	6.33	9.7± 0.10	10.1± 0.16	10.2± 0.14	10.0	43± 1.20	53± 1.70	51± 1.50	49
	N ₁₂₀	7.20	9.9± 0.10	12.3± 0.19	11.3± 0.19	11.2	47± 1.40	63± 1.20	62± 1.70	57.3
II n=15	N ₆₀	5.78	9.9± 0.28	10.0± 0.14	10.7± 0.18	10.2	40± 2.10	50± 2.20	44± 0.18	44.7
	N ₁₂₀	6.72	10.4± 0.21	11.0± 0.14	11.5± 0.09	11.0	43± 2.10	60± 1.55	57± 0.26	53.3
III n=11	N ₆₀	5.40	9.0± 0.22	10.3± 0.27	10.5± 0.23	9.9	39± 1.50	47± 2.80	41± 1.50	42.3
	N ₁₂₀	6.36	9.6± 0.25	11.4± 0.30	11.4± 0.26	10.9	40± 1.88	54± 2.30	50± 1.80	48

Note: *n – number of varieties.

content in grain and sedimentation level. The advantage in several experimental variants was confirmed by individual varieties: Albatros Odeskyi, Hoduvalnytsia Odeska, Mudrist Odeska varieties from PBGI-NCSCI; MIP Valencia, Analog among domestic varieties from other institutions; Torrild, Faustus, Matchball from foreign varieties. However, these varieties cannot be confidently attributed to high-protein

or high-yielding varieties, because in addition to the genotype factor, the year conditions and mineral nutrition rates are also crucial (Table 3). Although the factor of the year has the greatest impact on protein content, yield and sedimentation level, the influence of other factors (year – fertilisers) reduces the probability of identifying varieties with genetically determined traits.

So, in the dry years of 2020 and 2022, the

Table 3. Influence of factors on the variability of yield and grain quality parameters of winter wheat

Factors	Share of influence on variability, %		
	Yield	Protein content in grain	Sedimentation SDS-30
Year (A)	*	*	5.6
Variety (B)	48.5	39.4	22.5
Fertilisers (C)	24.6	29.6	42.7
Year – variety (A-B)	5.6	11.2	11.9
Year – fertilisers (A-C)	9.8	0.2	0.1
Copr – fertilisers (A-C)	*	3.7	*
Year – variety – fertilisers (A-B-C)	11.2	15.5	16.9
Other factors	0.3	0.3	0.3

Note: * - This factor is not significant.

positive response of varieties to increased rates of nitrogen mineral fertilisers was reduced, and in some cases changed to a negative response. In 2021, the varietal differences both absolute indicators and responses to the nitrogen background were better manifested under favourable weather conditions for plant growth and development.

Varieties of PBGI-NCSCI had the highest response to nitrogen fertilisation (10.8–21.8 %), followed by varieties of foreign selection (8.6–12.6 %), and the lowest response was observed in varieties of other breeding institutions of Ukraine (7.5–11.0 %). At the same time, the level of correlation between the traits was influenced by the year conditions and nitrogen ferti-

liser rates, and differed for the groups of varieties by origin (Table 4). A negative correlation between yield and grain quality was observed in all variants of the field trial, but in the dry year of 2020 it was almost the same in the variants both application rate of N₆₀ and N₁₂₀. In the optimal weather conditions of 2021, the inverse relationship was more significant in the variant with application rate of N₁₂₀. This pattern was most manifested in the relationship between yield and grain protein content in varieties of PBGI–NCSCI breeding. The negative correla-

tion between yield and sedimentation was strongest in varieties from other Ukrainian institutions. Probably, these traits are influenced by the adaptability level of the varieties. In particular, varieties with poor drought tolerance produce unfilled (shrunken) grain, which changes the structure and biochemical characteristics of the kernel and negatively affects yield [19]. This explains the very strong negative correlation between yield and grain quality in foreign-bred varieties.

It should be noted that high positive corre-

Table 4. Correlations between yield and grain quality in different groups of winter wheat varieties

Group of varieties	Protein content – yield				Sedimentation – yield				Protein content – sedimentation			
	2021		2022		2021		2022		2021		2022	
	N ₆₀	N ₁₂₀	N ₆₀	N ₁₂₀	N ₆₀	N ₁₂₀	N ₆₀	N ₁₂₀	N ₆₀	N ₁₂₀	N ₆₀	N ₁₂₀
*	-0.80	-0.93	-0.99	-0.84	-0.84	-0.74	-0.94	-0.95	0.91	0.98	0.97	0.86
I	-0.42	-0.79	-0.82	-0.63	-0.45	-0.74	-0.74	-0.65	0.83	0.88	0.83	0.85
II	-0.47	-0.53	-0.81	-0.72	-0.23	-0.68	-0.71	-0.53	0.95	0.86	0.80	0.77
III	-0.67	-0.81	-0.84	-0.75	-0.61	-0.82	-0.77	-0.70	0.85	0.86	0.91	0.85
All groups	-0.57	-0.76	-0.86	-0.73	-0.53	-0.74	-0.74	-0.70	0.88	0.89	0.85	0.83

Note * – Varieties of the early breeding stages.

lation between grain protein content and sedimentation level is observed. The protein content is a quantitative characteristic, while the sedimentation level is a qualitative indicator of the protein complex. As a result, in the process of winter soft wheat breeding in Ukraine and around the world, significant progress has been achieved in increasing the genetic yield potential. The negative correlation between productivity and grain quality has not led to significant results in increasing grain protein content.

For modern varieties, there is a tendency to reduce grain protein content, although the level of sedimentation tends to increase in some cases compared to varieties of previous stages of breeding. We can conclude that modern plant breeding requires breaking the negative relationship between quantitative and qualitative indicators. This requires the creation, identification and implementation of new genetic sources

of high protein content as well as other biochemical parameters of grain.

Conclusions. Winter soft wheat breeding has made significant progress in increasing yields both in Ukraine and around the world. The yield of modern short-stemmed varieties is higher by 103–107 % compared to varieties developed at earlier breeding stages. However, the negative correlation between grain quality and productivity at each stage of breeding results in a 0.5–1.5 % decreases in grain protein content. Modern varieties of PBGI–NCSCI breeding show an increase in the average level of SDS-30 sedimentation. Varieties from other institutions in Ukraine are characterised by a large variation in this indicator. Almost all foreign-bred varieties have the lowest sedimentation index. The year and fertiliser factors, as well as the interaction of year – fertiliser – variety factors have a significant influence on grain quality indicators.

References

1. Nikolayev, E. V. (1991). *Rezervy uvelicheniya proizvodstva zerna silnoy i tsennoy pshenitsy* [Reserves for increasing the production of strong and valuable wheat grain]. Kyev: Urozhai. [in Russian].
2. Makhanova, Yu. M. (2015). Export of grain crops of Ukraine, the EU and the countries of the world in the conditions of modern integration processes. *Problemy ekonomiky* [The Problems of Economy], 1. 27–36. [in Ukrainian].
3. Rybalka, O. I., Morhun, B. V., Pochynok, V. M., (2012).

- Modern studies of wheat grain quality in the world: genetics, biotechnology and nutritional value of reserve proteins. *Fiziolohiia i biokhimiia kulturnykh roslyn* [Physiology and Biochemistry of Cultivated Plants], 44. 1. 3–22. [in Ukrainian].
4. Lytvynenko, M. A., Holub, Ye. A., Khomenko, T. M. (2018). Peculiarities of creation and identification of extra-strong varieties of soft winter wheat in terms of bread-making properties. *Sortovyvchennia ta okhrona prav na sorty roslyn* [Plant Varieties Studying and Protection], 14 (1). 66–74. doi: 10.21498/2518-1017.14.1.2018.126511. [in Ukrainian].
 5. Lytvynenko, M. A. (1996). Realization of genetic potential, problems of productivity and grain quality of modern winter wheat varieties. *Zb. nauk. pr. SHI*. 6–12. [in Ukrainian].
 6. Dospekhov, B. A. (1986). *Metodika polevoho opyta* [Methodology of field experience]. M.: Kolos., 336. [in Russian].
 7. Zerno i produkty yeho pererabotky. Metod opredeleniya belka [Grain and its processing products. Protein determination method]. (2009). *DSTU 10846-91 – Mezghosudarstvennyi standart*. [in Russian].
 8. Pat. № 17023 Ukraina, (2006) A01N 1/04. Sposib nepriamoi otsinky «syly» boroshna – sedymentatsiia SDS-30. [SDS-30 sedimentation is a method of indirect assessment of the "strength" of flour]. O. I. Rybalka, M. V. Chervonis, M. H. Parfentiev, D. V. Akselrud; Seleksiino-henetychnyi instytut. – №200610062; zaiavl. 06.02.2006; opubl. 15.09.2006; Biul. 9. 6. [in Ukrainian].
 9. *Metodyka derzhavnoho sortovyvchennia silskohospodarskykh kultur. Zernovi, krupiani ta zernobobovi*. [Methodology of state variety testing of agricultural crops. Cereals, cereals and legumes]. 2001. Kyiv, 66 p. [in Ukrainian].
 10. Gierat, K., Kumelowska, J. (1977). Reakcija pszenicy jarej i jeczmenia jarego na zróznicowany poziom wilgotności głęby i nawożenia azotem. *Biul. IHAR*, 1–2. 99–102. [in Polish].
 11. Zerno ta produkty yoho pererobky. *Vyznachennia pokaznykiv yakosti metodom infrachervonoj spektroskopii* [Grain and products of its processing. Determination of quality indicators by infrared spectroscopy]. (2007). *DSTU 4117:2007. Derzhspozhyv-standart Ukrainy*. 8 p. [in Ukrainian].
 12. Ivanov, N. N. (1947). *Problema belka v rastenievodstve* [Protein Problem in Plant Industry]. Moscow; Leningrad, OGIZ-Selhozgiz Publ. [in Russian].
 13. Yakubtsiner, M. M., Pokrovskaya, N. F. (1969). Biochemical characterization of grains for tetraploid wheats. *Selskokhozyaystvennaya Biologiya [Agricultural Biology]*, 4 (3). 348–357. [in Russian]
 14. Shewry, P. R. (2007). Improving the protein content and composition of cereal grain. *J. Cereal Sci.*, 46. 239–250. doi: 10.1016/j.jcs.2007.06.006.
 15. Johnson, V. A., Mattern, P. J., Peterson, C. J., Kuhr, S. L. (1985). Improvement of wheat protein by traditional breeding and genetic techniques. *Cereal Chem.*, 62 (5). 350–355.
 16. Balyan, H. S., Gupta, P. K., Kumar, S., Dhariwal, R., Jaiswal, V., Tyagi, S., Agarwal, P., Gahlaut, V., Kumari, S. (2013). Genetic improvement of grain protein and other health-related constituents of wheat grain. *Plant Breeding*. <http://wileyonlinelibrary.com>. doi: 10.1111/pbr.12047.
 17. Morhun, V. V., Rybalko, O. I. (2017). A strategy for the genetic improvement of cereals in order to ensure food security, medical and preventive nutrition and the needs of the processing industry. *Visnyk NAN Ukrainy*, 3. 54–64. [in Ukrainian].
 18. Berry, P. M., Kendall, S., and Rutterford, Z. (2015). Historical analysis of the effects of breeding on the height of winter wheat (*Triticum aestivum*) and consequences for lodging. *Euphytica*, 203. 375. doi: 10.1007/s10681-014-1286-y.
 19. Hospodarenko, H. M., Chernov, O. D., Liubych, V. V., Riabovol, Ya. S., Kryzhanivskiy, V. H. (2020). Yield and bread-making properties of winter wheat grain at different doses and terms of application of nitrogen fertilizers. *Visnyk Poltavskoi derzhavnoi ahrarnoi akademii*, 3. 21–31. [in Ukrainian].

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Актуальність. Одним з основних показників, з яким пов'язана товарна цінність зерна пшениці, її хлібопекарські, а також технологічні властивості, є масова частка білка. Результати наукових досліджень та практика сільськогосподарського виробництва свідчать про те, що за останні 80–90 років у південних областях України вміст білка в зерні пшениці озимої понизився з 17–18 % до 10–12 %, а в несприятливій, за погодними умовами, роки кількість білка в зерні може зменшуватися навіть до 8,0–9,5 %. Однією із проблем сьогодення України є питання покращення якості зерна пшениці. Україна посідає високе місце на світовому ринку зернових: частка в експорті пшениці складає в середньому 5 %. **Мета роботи.** Оцінка сучасних сортів озимої м'якої пшениці за врожайністю і біохімічними показниками якості зерна. **Методи.** Польові дослідження вели згідно з методикою польового дослідження Б. А. Доспехова. Агротехніка вирощування пшениці озимої – загальноприйнята для степової зони України. Облік врожайності проводився за методикою державного сортовипробування сільськогосподарських культур. Вміст білка в зерні визначали методами інфрачервоної спектрометрії

та К'ельдаля, рівень седиментації білків – методом SDS-30. **Результати.** При порівнянні отриманих даних за врожайністю у колекції встановлено, що у сучасних вітчизняних сортів та сортів закордонної селекції за умов оптимального вегетаційного періоду врожайність була більшою в середньому на 103–107 %, ніж у сортів ранніх етапів селекції. Лідерами за врожайністю є сорти Селекційно-генетичного інституту – Національного центру насіннєзнавства та сортовивчення. На реалізацію потенціалу врожайності закордонних сортів значно впливає їх недостатня пристосованість до погодних умов. Паралельно з ростом врожайності внаслідок впливу негативної кореляції між урожайністю та якістю зерна, з кожним етапом селекції, в тому числі і у сучасних сортів, відбувається зниження білковості зерна на 0,5–1,5 %. Встановлено, що за рівнем седиментації сорти селекції СГІ-НЦНС переважають сорти ранніх етапів селекції. Велике різноманіття за рівнем седиментації має група сортів української селекції. У сортів іноземної селекції відмічено доволі низькі показники седиментації. Реалізація генетичного потенціалу врожайності та якості зерна досліджуваних сортів залежала від погодних умов та доз мінеральних добрив. **Висновки.** Значний успіх селекції на збільшення врожайності в українських і закордонних сортів через негативну кореляцію між цим показником і якістю зерна супроводжувався зменшенням рівня білковості на кожному етапі селекції на 0,5–1,5 %. У порівнянні з сортами ранніх етапів селекції показник седиментації SDS-30 був найбільший тільки у сортів СГІ-НЦНС, тоді як вітчизняні сорти інших наукових установ дещо поступалися сортам ранніх етапів селекції. Група закордонних сортів відрізнялася найменшим рівнем седиментації. Крім генетичного фактору, великий вплив на формування врожайності і якості зерна мають такі чинники, як погодні умови року і дози мінерального живлення.

Ключові слова: *врожайність пшениці, адаптивність пшениці, білковість зерна, седиментація, добрива, біохімічні показники*