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DEGREE OF PLASTICITY OF SOFT WHEAT WINTER VARIETIES IN DIFFERENT ECOTYPES

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Topicality. *Over the past decades, a breeding program of leading scientific institutions has been implemented to improve soft winter wheat varieties in terms of yield, grain weight per main spike, degree of plasticity and genotypic effect. These characteristics demonstrate the ability of varieties to adapt to environmental changes.* ***Purpose.*** *To determine the degree of plasticity, level of stability, breeding value of modern varieties of soft winter wheat developed by leading scientific institutions.* ***Materials and Methods.*** *During 2020-2022, 15 varieties of soft winter wheat were examined in the crop rotation of the Breeding and Seed Production Department of the Dnipro State Agrarian and Economic University. Accounting and observations were carried out according to the methodology of State Variety Testing. Ecological plasticity was determined by the methodology of the Plant Production Institute named after V. Ya. Yuriev according to the package of application programs OSGE Tlite Systems gr.* ***Results.*** *The presented varieties have the sum of ranks 2 and 3 for the trait "grain weight per main spike", which indicates their high plasticity due to the stability of genetic potential realisation and their greater adaptation to the growing conditions in the northern subzone of the Steppe of Ukraine. The level of stability, plasticity and breeding value of varieties in different conditions of growing seasons was determined. The varieties Smuhlianka, Podolianka, Peremoha, Ihrysta, Komertsiina, Korusna and Yednist showed the highest level of plasticity. This allows us to predict the realisation of plasticity under sufficient moisture supply during the growing season and a slight decrease it under drought.* ***Conclusions.*** *The stability, plasticity, and breeding value for 15 varieties of soft winter wheat were determined. Under changing environmental conditions, authors revealed the possibility of their genetic potential for yield and ecological plasticity over the years due to the high stability of the genetic effect of the trait. The breeding value of modern varieties in terms of adaptability was confirmed to use them as a source material and introduce into production in conditions of unstable and insufficient moisture supply.*

Key words: *yield, grain weight of the main spike, genotypic effect, stability, breeding value*

Introduction. Winter crops are the main contributors to the food balance of agricultural production in Ukraine. The area under these crops annually ranges from 6 to 8 million hectares. Among these crops, soft winter wheat plays a leading role.

According to various sources, global wheat production is estimated at 620 million tonnes, including more than 50 million tonnes grown in Ukraine. However, in 2022, the Ministry of Agrarian Policy and Food of Ukraine reported a wheat harvest of around 4.0 tonnes per hectare, most of which was 3rd grade food grain. Sustained high harvests of quality grain require comprehensive efforts by breeders and producers, since the realisation of genotypically determined valuable economic traits can be achieved only by meeting the requirements of modern cultivation technology. The material support for grain production varies significantly between farms of different ownership forms. Soft winter wheat is grown in three ecological and geographical zones: Steppe, Forest-Steppe, and Polissia, each of which covers large areas and has significantly different soil and climatic conditions.

The main objective of soft winter wheat breeding is creating flexible varieties with high adaptive potential and the ability to effectively use favourable environmental factors [1–3].

The response degree of genotypes to changes in abiotic conditions is characterised by the environmental plasticity coefficient, which determines the direction and degree of changes in individual characteristics of the cultivar relative to the adaptive norm.

Plasticity of a trait is an independent property and is genetically controlled. In genetic

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terms, plasticity is the degree of modification in the trait (yield) that determines the ability of varieties to adapt to environmental conditions. Genetic mechanisms of plants determine the stability and plasticity of varietal traits through the ability to minimise the negative effects of the environment.

The genetic diversity of any biological species allows it to survive and even develop in the face of environmental changes.

High-quality breeding requires the introduction of modern varieties, lines and forms of winter wheat with a set of valuable traits that can produce both a high yield and grain quality. Collections of plant genetic resources play an important role in the development of such samples. Preservation and enrichment of genetic diversity in forms with valuable traits, i.e. increasing the heterogeneity of such collections, mitigates the threat of genetic erosion of modern production varieties [4–12].

The quality of breeding work to enrich collections is enhanced by knowledge of the genetics of the source material.

An analysis of numerous studies by domestic and foreign scientists shows that different growing conditions can result in genetic changes in varieties and their characteristics. The most common method of wheat hybrid breeding is intraspecific hybridisation. The main principle of selection of parental pairs for crossing is ecological and geographical.

Wheat breeding is mainly focused on increasing productivity, which is a complex quantitative trait divided on components. Effective breeding requires understanding the specificity of the manifestation and genetic control of specific economically valuable traits.

Genotype properties are most fully revealed by crossing, the most effective method of evaluation is diallel crosses and analysis of hybrid offspring and breeding of the obtained combinations. The labour intensity of the diallel crossing method is compensated by the diversity of the source hybrid material for practical breeding [13–17].

The analysis of literature sources on the main directions of breeding research to improve the adaptive potential of varieties has confirmed that intensive cultivation technologies of soft winter wheat resulted in a significant increase in the potential yield of new varieties. The traits of productivity and plasticity of varieties in specific arid climatic conditions are insufficiently studied, so the main objective of breeding programmes in developing varieties with appropriate adaptability in specific growing conditions is implementation of ecological breeding methods.

Materials and Methods. The ecological plasticity and breeding value by yield of modern varieties developed by the Institute of Plant Physiology and Genetics of NAS of Ukraine (IPPG), Donetsk State Agricultural Research Station of NAAS (DSARS), Dnipro State Agrarian and Economic University (DSAEU) and the Breeding and Genetic Institute – National Centre for Seed and Cultivar Investigation (BGI) were studied to determine the genetic potential and response to changing weather conditions. The research was conducted on the experimental fields of DSAEU (the Department of Plant Breeding and Seed Production) in 2020–2022. Ecological plasticity was determined by the method of the Plant Production Institute named after V. Ya. Yuriev according to the package of application programs OSHE *Tlite Systems gr*. [18].

The area of the registration plot was 10 m2, experiment was repeated three times, sowing was carried out with a SN-16 seeder, harvesting with a Sampo 130 combine. Records and observations were carried out in accordance with the methodology of State Variety Testing. Response of varieties to environmental changes and their valuable traits were determined by the rank of genotypic background, the rank of plasticity degree and their sum.

The meteorological conditions during the years of research were uneven. In 2019–2020, during the autumn growing season, the active temperature sum was 384.0 °C, the precipitation was 35.3 mm, during the spring-summer growing season – 1433.4 °C and 151.4 mm, and for the entire growing season – 1817.4 °C and 186.7 mm, respectively. The pre-sowing and post-sowing periods of 2020–2021 were arid, but after the resumption of the spring growing season, the weather conditions were generally favourable for plant growth and development. The average air temperature in April was 9.3 °C, and in May – 16.4 °C. The total rainfall for this period was 66.3 mm. In June and July, rainfall was 272.8 mm, which had a negative impact on plant growth and development. The average air temperature in June was 20.2 °C, and in July – 22.9 °C. In 2021–2022, conditions of

the autumn sowing season were cool and dry. In September, the average monthly air temperature was 13.7 °C, which is 0.8 °C less than the long-term average, the active temperature sum was 410.3 °C, and the precipitation was 26.4 mm, which is 6.6 mm less than the long-term average. The winter period was characterised by mild conditions for overwintering of wheat. The prolonged cool spring had a negative impact on the development of crops. The first half of the growing season was characterised by optimal conditions for plant growth and development. In May, the average monthly air temperature was 14.9 °C, the active temperature sum was 464.6 °C, and precipitation was 66.7 mm, which is 9.7 mm more than the long-term average. In June, the average monthly air temperature was 21.8 °C and precipitation was 10.5 mm, which is 40.5 mm less than the long-term average.

The aim of the study is to determine the plasticity degree, stability level, and breeding value of modern soft winter wheat varieties developed by leading scientific institutions.

Results and Discussions. Yield is a quantitative characteristic of the ability of plants to produce a certain amount of organic matter per unit area during the growing season and is determined by the corresponding complex of interrelated genes. However, genetic control of the complex trait "yield" is carried out through physiological and biochemical reactions due to the absence of "yield genes". Therefore, knowledge of the genetic variability of such components as number and weight of grains per head and other quantitative traits is required.

The studies revealed the level of stability, plasticity and breeding value of varieties in terms of yield under different conditions of the growing season (Table 1).

The average yield among the varieties was between 6.46 and 7.97 t/ha. The high yield was characterised by the varieties Ihrysta, Smuhlianka, Spivanka and Komertsiina. The genotypic effect ranged from 5.32 in Bohdana to 7.89 in Spivanka.

Table 1. Characteristics of winter wheat varieties by yield and environmental plasticity, 2020–2022

Variety	Originator	Yield, t/ha	Genotypic effect		Degree of plasticity		Sum of ranks
			E_i	rank	R_i	rank	
Podolianka	IPPG	7.30	7.12	1	1.11	2	3
Smuhlianka	IPPG	7.60	6.77	1	0.48	1	2
Novosmuhlianka	IPPG	7.70	6.89	1	0.51	1	2
Hoduvalnytsia	IPPG	7.35	6.59	1	1.10	2	3
Bohdana	IPPG	6.46	5.32	1	1.13	2	3
Yuzivska	DSARS	6.87	5.43	1	1.15	1	2
Peremoha	DSARS	7.10	6.14	1	0.98	2	3
Ihrysta	DSARS	6.97	6.01	1	1.17	1	2
Dyvo Donetske	DSARS	6.93	6.96	1	1.21	1	2
Bohynia	DSARS	7.37	6.91	1	1.14	2	3
Spivanka	DSAEU	7.66	7.89	1	0.89	1	2
Komertsiina	DSAEU	7.30	6.98	1	0.77	1	2
Korysna	DSAEU	7.66	7.84	1	0.86	1	2
Yednist	BIG	7.30	7.14	1	0.74	1	2
Peizazh	BIG	7.22	6.99	1	0.76	1	2
Average *st*		7.22	6.12	1	1.12	2	3
LSD_{05}			2.25		0.23		

The presented varieties have the sum of ranks two, and the varieties Podolianka, Hoduvalnytsia, Bohdana, Peremoha, Bohynia have the rank three, which indicates their high plasticity resulting from the stability of genetic potential and their higher adaptability to growing conditions in the northern subzone of the Steppe of Ukraine.

Grain weight of the main spike is used in the selection of productive plants, both in hybrid generations and in pre-basic seed production.

The studies have revealed the stability, plasticity and breeding value of varieties on the basis of the trait – grain weight per main spike in different conditions of the growing season (Table 2).

The grain weight from the main spike

Table 2. Ecological plasticity of varieties of different origin by the grain weight of the main spike, 2020–2022

Variety	Originator	Grain weight per main spike, g	Genotypic effect		Degree of plasticity		Sum of ranks
			E_i	rank	R_i	rank	
Podolianka	IPPG	1.6	3.33	1	1.01	2	3
Smuhlianka	IPPG	1.7	4.15	1	0.47	1	2
Novosmuhlianka	IPPG	1.5	2.45	1	0.56	1	2
Hoduvalnytsia	IPPG	1.1	3.27	1	0.80	2	3
Bohdana	IPPG	0.9	4.68	1	0.48	1	2
Yuzivska	DSARS	1.0	4.15	1	0.74	1	2
Peremoha	DSARS	1.05	5.96	1	1.11	2	3
Ihrysta	DSARS	1.02	6.13	1	1.13	2	3
Dyvo Donetske	DSARS	1.05	5.97	1	0.98	1	2
Bohynia	DSARS	1.3	5.41	1	0.77	1	2
Spivanka	DSAEU	1.1	5.03	1	0.68	1	2
Komertsiina	DSAEU	1.2	3.43	1	0.93	2	3
Korysna	DSAEU	1.1	4.01	1	0.98	2	3
Yednist	BIG	1.03	4.67	1	1.03	2	3
Peizazh	BIG	1.04	3.97	1	0.87	1	2
Average *st*		1.2	4.44	1	0.87	2	3
LSD_{05}			1.97		0.21		

ranged from 0.9 g in Bohdana variety to 1.7 g in Smuhlianka variety. The highest values were observed in Podolianka, Smuhlianka and Novosmuhlianka varieties: 1.6 g, 1.7 and 1.5 g, respectively. The genotypic effect ranged from 2.45 to 6.13. The highest genotypic effect was observed in the varieties Ihrysta, Divo Donetske and Peremoha. The Podolianka, Hoduvalnitsa, Peremoha, Ihrista Komertsiina, Korysna and Ednist are plastic varieties. The sum of the ranks of these varieties was 3.

Therefore, we can predict the realisation of the trait at sufficient moisture during the growing season and a slight decrease in drought conditions. The breeding value of modern varieties in the optimisation of breeding for adaptability and their using as source material was confirmed.

Conclusions. The level of stability, plasticity and breeding value of 15 different varieties of soft winter wheat was determined. Their genetic yield potential and ecological plasticity over the years in changing environmental conditions were revealed. The studied varieties with the sum of ranks two, and the varieties Podolianka, Hoduvalnytsia, Bohdana, Peremoha, Bohynia with the sum of rank three show high plasticity resulting from the stability of genetic potential realisation and their higher adaptability to the conditions of the northern subzone of the Steppe of Ukraine.

The breeding value and adaptability of modern varieties for use as source material and introduction into production for conditions of unstable and insufficient moisture were confirmed. We have determined the possibility of predicting the manifestation of a variety trait and the effectiveness of selection for it in hybrid progeny and in nursery of pre-basic seed production.

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Шевченко О. О., Ващенко В. В., Лобко Т. К. Ступінь пластичності сортів пшениці м’якої озимої різних екотипів. *Grain Crops. 2023. 7 (1). 36–41.*
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Актуальність. За останнє десятиріччя здійснено реалізацію селекційних програм провідних наукових установ по удосконаленню сортів пшениці м’якої озимої за врожайністю, масою зерна з колоса, ступенем пластичності, генотиповим ефектом. Це характеризує сорти за здатністю пристосовуватись до змін середовища. Наведені показники пластичності сортів доповнюють додатковою інформацією для вивчення за комплексом інших ознак і властивостей. **Мета роботи.** встановити ступінь пластичності, рівень стабільності, селекційної цінності сучасних сортів пшениці м’якої озимої провідних наукових установ. **Матеріали і методи.** Дослідження проводили дослідних полях кафедри селекції і насінництва ДДАЕУ впродовж 2020–2022 рр., вивчали 15 сортів пшениці м’якої озимої. Обліки і спостереження проводили згідно з методикою державного сортовипробування. Екологічну пластичність визначено за методикою ІР ім. В. Я. Юр’єва згідно з пакетом прикладних програм “OSGE” Tlite Sistems gr. **Результати.** Представлені сорти за ознакою ”маса зерна головного колосу” мають суму рангів два, а сорти Подолянка, Годувальниця, Богдана, Перемога, Богиня – ранг три, що свідчить про їх високу пластичність, обумовлену стабільністю реалізації генетичного потенціалу і їх більшу пристосованість до умов вирощування в північній підзоні Степу України. З’ясовано рівень стабільності, пластичності і селекційної цінності сортів у різних умовах вегетаційних періодів. Пластичними є сорти Смуглянка, Подолянка, Перемога, Ігриста, Комерційна, Корисна і Єдність. Це

надає можливість прогнозувати реалізацію ознаки в умовах достатнього вологозабезпечення в період вегетації рослин та незначного зниження за посухи. **Висновки.** Встановлено рівень стабільності, пластичності, рівень селекційної цінності 15 сортів різних різновидів пшениці м'якої озимої. В мінливих умовах середовища виявили можливість їх генотипового потенціалу урожайності та екологічної пластичності за роками, що обумовлено проявом високої стабільності генетичного ефекту ознаки. Підтверджено селекційну цінність сучасних сортів на адаптивність з метою їх використання в якості вихідного матеріалу та впровадження в виробництво для умов нестійкого та недостатнього зволоження.

Ключові слова: *урожайність, маса зерна головного колосу, генотиповий ефект, стабільність, селекційна цінність*