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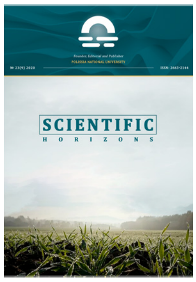

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Creation and analysis of the starting material obtained by hybridisation of *Triticum spelta* L. × *Triticum compactum* Host.

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Abstract. In the conducted studies, as a result of the hybridisation of *Triticum spelta* L. × *Triticum compactum* Host. several new forms were obtained that differ in morphobiological and economically valuable traits. The research aims to expand the genetic diversity of spelt wheat and to obtain new introgressive forms with a high level of manifestation of economically valuable traits. The following methods were used: field, laboratory, hydrological analysis, and statistical analysis. As a result of

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the research, new source material was obtained and valuable genotypes with a unique combination of genetic material of the source species were identified. An intermediate type of inheritance of plant morphology traits (plant height, ear length and density, grain weight per ear) in F_1 hybrids was established. In F_2 hybrids, a split of 3:1, indicates the dominant monogenic nature of inheritance. The shape of the ear is inherited monogenically by the type of incomplete dominance. The analysis of transgressive variability in F_{3-4} hybrids *Triticum spelta* L. × *Triticum compactum* Host. shows that the highest proportion of positive transgressions was recorded for the number of spikelets (28.1-28.5%) and grains (23.4-51.0%) in the ear and grain weight per spikelet (20.3-32.1%). The analysis of stability and adaptability indices allowed us to distinguish line 201, characterised by high stability (S^2_{di}=0.027), homeostasis (Hom=193.3) and breeding value (Sc=3.9), and line 206, combining high yield (5.11 t/ha) with high homeostasis (Hom=182.3) and breeding value (Sc=3.9). The introgressive hybridisation with *Triticum compactum* Host. identified new genetic sources characterised by the presence of deficient traits for breeding and of great practical importance for further breeding and genetic improvement of spelt, as they can enrich the existing gene pool of the crop

Keywords: spelt wheat; inheritance; cleavage; transgression; yield; adaptability

INTRODUCTION

Although the demand for spelt has been growing recently, it remains a widespread species that requires breeding improvement. Leading research institutions are engaged in spelt breeding in Ukraine, but only three varieties are available to farmers, and the source material for breeding is limited to local breeding. This leads to a narrow distribution area of spelt in agricultural production and low demand for its grain. Therefore, the creation and analysis of new source material with a broad genetic basis is an urgent task for crop breeding. The hybridisation of *Triticum spelta* L. × *Triticum compactum* Host. can produce new promising genotypes with improved quantitative traits due to the introduction of genetic material T *Triticum compactum* Host. into the *Triticum spelta* L. genome.

Intensive breeding to increase productivity has led to a significant narrowing of the wheat gene pool. This necessitated the search for natural sources of valuable traits for its breeding improvement (Voss-Fels *et al.,* 2019). The further development of farming and consumption culture has led to an awareness of the negative impact of genetic erosion and has attracted the attention of scientists and the intraspecific diversity of the genus *Triticum* L. and related taxa. L. Babenko *et al.* (2018) showed a positive effect of hybridisation of spelt with durum wheat, in particular, a significant increase in genetic diversity and the development of new transgressive forms. The same conclusion was reached by other scientists involved in the breeding improvement of spelt, in particular, R. Yakymchuk *et al.* (2020), E. Suchowilska *et al.* (2020), and J. Alvarez & C. Guzmán (2018). However, according to Rybalka *et al.* (2018), it is not advisable to limit ourselves to durum wheat, so other tetra-, octa- and diploid wheat species should be included in the hybridisation system, which will allow us to obtain starting material with a wide range of reaction rates to different soil and climatic conditions and improved grain quality. H. Akman (2021) notes the prospects of involving representatives of the closely related genus *Aegilops* L., as well as species of distant genera – *Hordeum, Secale, Agropyron*, etc. in breeding programmes.

In previous studies (Diordiieva *et al.*, 2019; Diordiieva *et al.*, 2021), the gene pool of less common hexaploid and tetraploid wheat species has been successfully used as a source of economically valuable traits for breeding and genetic improvement of wheat and triticale. I. Yadav *et al.* (2022) note that less common wheat species can serve as source material for the search for new mutant variants for genetic analysis and breeding. P. Shewry (2018) and M. Lacko-Bartošová *et al.* (2022) emphasise that ancient wheat species have several advantages over modern varieties, including valuable genes and gene blocks that determine high grain quality and adaptive potential.

One of these species could be compact or dwarf wheat (*Triticum compactum* Host.), an ancient, rare species that in the past occupied large areas in Eurasia, but nowadays is rarely found in pure cultivation. It is a hexaploid species with the genomic formula BA^uD (Wen *et al.*, 2022). Research by scientists at the V. Yuriev Institute of Plant Industry under the leadership of V. Kyrychenko *et al.* (2018) has shown that hybridisation of durum wheat with *Triticum compactum* Host. in the progeny increases sedimentation, protein, and gluten content in grain, and inherits genes for resistance to major fungal diseases. Therefore, the involvement of this species in interspecific hybridisation allows for enriching the wheat gene pool with new traits and gene blocks.

No data on hybridisation of *Triticum spelta* L. × *Triticum compactum* Host. species were found in the scientific literature. Crossing these species will allow the transfer of valuable genes that control economically valuable traits, in particular, plant height and spike density, to spelt. The research aimed to expand the genetic diversity of spelt wheat and to obtain new introgressive forms with a high level of manifestation of economically valuable traits. For this purpose, the hybridisation of *Triticum spelta* L. and *Triticum compactum* Host species was carried out.

MATERIALS AND METHODS

The research was conducted during 2016-2021 at Uman National University of Horticulture. As a source material for hybridisation, the winter spelt wheat variety Zorya Ukrayiny (maternal form) and the sample of *Triticum compactum* Host. provided for research by the National Centre for Plant Genetic Resources of Ukraine were used. Hybridisation was carried out by manual castration of flowers of the maternal form and subsequently forced pollination with pollen of the paternal form by the limited free method under a parchment insulator. Spelt wheat was used as a mother form and *Triticum compactum* Host. was used as a pollinator. Harvesting and accounting of yield structure elements were performed in the phase of full ripeness.

The nature of inheritance of quantitative traits in F_1 hybrids was determined by the degree of dominance (hp) according to formula (1) of Griffing (1950):

$$\mathrm{hp} = (\mathrm{F_1} - \mathrm{MP})/(\mathrm{P}_{max} - \mathrm{MP}), \quad (1)$$

where he is the degree of dominance; F_1 is the average value of F_1 hybrids; P_{max} is the average value of the best parental shape; MP is the average value of the two original forms.

The ranking of the created materials by the degree of dominance was carried out according to the gradation of Beyl & Atkins (1965): 1) hp>1 – positive dominance (positive heterosis); 2) 0.5<hp≤1 – positive dominance; 3) -0.5≤hp≤0.5 – intermediate inheritance; 4) -1≤hp< -0.5 – negative dominance; 5) hp< -1 – negative dominance (depression).

The proportion of hypothetical (2) and true (3) heterosis was calculated according to H. Daskalev *et al.* (1967):

Hypothetical heterosis:

$$\mathrm{X} = \mathrm{F_1} \times 100/\mathrm{MP}, \quad (2)$$

where F_1 is the level of manifestation of the indicator in the hybrid; MP is the average value of the two original forms. Real heterosis:

$$\mathrm{X} = (\mathrm{F_1} - \mathrm{P}_{max}) \times 100/\mathrm{P}_{max}, \quad (3)$$

where F_1 is the level of manifestation of the indicator in the hybrid; P_{max} is the highest value of the indicator in one of the output forms;

The correspondence of cleavage in hybrid F_2 combinations to the theoretically expected one was assessed using χ2 (Yeshchenko *et al.,* 2014). All records and observations were carried out according to the methodology for the examination of plant varieties of the group of cereals, cereals, and legumes for their suitability for distribution in Ukraine (2016). The frequency (4) and degree (5) of transgressions were calculated according to the method of G. Voskresenskaya & V. Shpota (1967) using the following formulas:

$$Td = \frac{Ph-Pr}{Pr} \times 100, \quad (4)$$

where Td is the degree of transgression; Ph is the highest parameter for the hybrid; Pr is the highest value of the parameter in the best output form.

$$\mathrm{Tf} = \mathrm{A} \times 100/\mathrm{B}, \quad (5)$$

where Tf is the frequency of transgression (%); A – excess of the best parental form in hybrid generations (averaged from the three best hybrid plants); B – the total number of plants analysed for this trait by combination.

Ecological plasticity (6) was assessed by the regression coefficient (b_i), and stability (7) by the variant of the trait (S^2_{di}). The calculations were performed according to the method of Eberhart & Russel (1966) using the formulas:

$$\mathrm{b}_i = \sum_j Y_{ij} I_j \,/\, \sum_j I^2, \quad (6)$$

where b_i is the regression coefficient of the variety sample in environments with contrasting growing conditions; Y_{ij} – the yield of a particular variety under any growing conditions; lj – index of year conditions.

$$\mathrm{S}^2_{di} = \sum_i \delta^2_{ij} \,/\, (n-1), \quad (7)$$

where δ^2_{ij} is the difference between theoretical and actual yields:

The samples were ranked by environmental plasticity according to the following gradation: 1) b_i>1 – highly plastic, well adapted to unfavourable growing conditions genotype; 2) b_i=0 – medium plastic sample; 3) b_i<1 – low plastic genotype. Homeostatic (8) and breeding value coefficient (9) were determined according to V. Khangildin & N. Lytvynenko (1981) using the following formulas:

$$Hom = \frac{x^2}{\sigma(X_{opt} - X_{\min})}, \quad (8)$$

$$\mathrm{Sc} = \mathrm{X}\,(\mathrm{X}_{lim}/\mathrm{X}_{opt}), \quad (9)$$

where X, X_{opt}, X_{lim} – the average, highest and lowest value of a feature; σ – standard deviation.

The experimental data were analysed statistically using Microsoft Excel 2010. The smallest significant difference ($HIP_{0.5}$) and coefficient of variation (V, %) were calculated according to the method of V. Yeshchenko *et al.* (2014).

RESULTS AND DISCUSSION

Triticum compactum Host. is a hexaploid wheat species with a similar genomic composition to spelt, so there are no significant difficulties associated with genetic incompatibility during hybridisation. In the hybridisation of *Triticum spelta* L. × *Triticum compactum* Host. in the first generation, the hybrids occupied an intermediate position between the original species. F_1 hybrids were similar in spike morphology and general plant habit. They had a pubescent spike of medium length and density. The analysis of the degree of dominance and the level of heterosis revealed that plant height, spike length and density, and grain weight per spike in F_1 hybrids *Triticum spelta* L. × *Triticum compactum* Host. are inherited by the type of intermediate inheritance (Table 1). A negative level of true heterosis was also recorded. Seeds of F_1 hybrids were sown in a breeding nursery at sparse sowing. Self-pollination of the first-generation hybrids provided a significant range of variability in the phenotype of F_2 samples, in populations of which, after the end of the growing season, the phenotypic manifestation of the characteristics of ear morphology, in particular, the shape of the ear, its pubescence and filminess, was evaluated.

Table 1. *The degree of dominance and level of heterosis in F_1 hybrids of Triticum spelta L. × Triticum compactum Host., 2017 year*

Indicator	♀	♂	F_1	LSD_{05}	Degree of dominance, (hp)	Nature of inheritance	True heterosis, %	Hypothetical heterosis, %
Plant height	118	105	114	4	0.4	PU	-3.4	102.2
Length of the ear	15.8	6.5	10.1	0.5	-0.2	PU	-36.1	90.6
Ear density	15.4	21.5	16.8	0.8	-0.5	PU	-21.9	91.1
Grain weight per ear	1.38	1.05	1.15	0.09	-0.4	PU	-16.7	94.7

Source: *compiled by the authors*

Hybridological analysis showed that in the second generation of crosses of *Triticum spelta* L. × *Triticum compactum* Host. the spike shape was inherited according to the monogenic scheme 1:2:1 (Table 2). That is, in the F_2 descendants there was a quantitative advantage of intermediate forms over speltae and compactoids.

Table 2. *Descendants F_2 breakdown by grain morphological traits*

Breakdown	Plant correlation			χ2 factors	χ2 theories
By ear form (1:2:1)					
Phenotype	speltoid	Intermediary	compact	–	
Expected amount	21	42	21	–	3.84
Factual amount	24	39	21	0.642	–
By ear pubescence (3:1)					
Phenotype	pubescent		non-pubescent	–	
Expected amount	63		21	–	3.84
Factual amount	65		19	0.126	–
Based on the ear filminess (3:1)					
Phenotype	membranous		naked	–	
Expected amount	63		21	–	3.84
Factual amount	65		19	0.126	–

Source: *compiled by the authors*

The original form of *Triticum compactum* Host. was characterised by a pubescent ear, while spelt wheat was not pubescent. In the F_2 progeny of 84 plants, 65 pubescent and 19 non-pubescent were obtained. The hybridological analysis showed that the actual results obtained are a consequence of monohybrid cleavage, which corresponds to the theoretical ratio 3:1. Thus, the trait "pubescence of the ear", which is phenotypically manifested in *the Triticum compactum* Host. was dominant to the alternative trait of spelta. The analysis of the splitting of the filminess trait in plants of the F_2 population of *Triticum spelta* L. × *Triticum compactum* Host. hybrids revealed that ear filminess is controlled monogenically, with filminess being the dominant trait concerning hulling. Similar results were obtained by R. Yakymchuk *et al.* (2020) when hybridising durum wheat with mutant forms of spelt. This indicates the dominant nature of spelt grain hulling genes concerning alternative traits of other hexaploid wheat species.

In the third-fourth hybrid generation, a wide formation process was observed. A significant range of variability was observed in almost all morphological and physiological traits, in particular, length, shape, density, colour, pubescence and graininess of the ear, plant height, shape and colour of the leaf blade and grains, pubescence and stiffness of the spike scales and the nature of threshing, duration of the growing season and plant productivity. It was found that in 2019 (F_3) the frequency of positive transgressions for ear productivity ranged from 18.8-28.1% (Table 3). The highest proportion of positive transgressions was recorded for the number of spikelets (28.1%) and grains (23.4%) in the ear. In 2020 (F_4), the frequency of positive transgressions increased. This is consistent with the scientific literature, which states that the degree and frequency of positive transgressions increase in later generations. The frequency of positive transgressions was the highest for grain weight per ear (32.1%) and for the number of grains per ear (26.8%) (Table 3).

***Table 3.** Degree and frequency of transgressions in F_{3-4} hybrids of Triticum spelta L. × Triticum compactum Host., 2019-2020*

Indicator	Td, %	Tf, %	Pr	Ph
		F_3		
Length of the ear	2.5	18.8	16.1	16.5
Number of grains per ear	2.0	23.4	51	52
Number of spikelet per ear	-10.7	28.1	28	25
Grain weight per ear	1.9	20.3	1.58	1.61
		F_4		
Length of the ear	1.6	25.6	18.2	18.5
Number of grains per ear	3.9	26.8	51	53
Number of spikelet per ear	-6.0	26.5	28.5	26.8
Grain weight per ear	3.7	32.1	1.62	1.68

***Note:** Pr is the maximum value of the trait in the best parental form; Pg is the maximum value of the trait in hybrids; Td is the degree of transgression; Tf is the frequency of transgression*
***Source:** compiled by the authors*

A significant disadvantage of many introduced lines is their high stemness, late maturity and tendency to lodging, which often causes their rejection in the early stages of the breeding process. It is known that only forms with a short and strong stem can ensure the practical realisation of the high genetic potential of productivity. Comparative analysis of the created samples and the original forms indicates a different nature of inheritance of plant height. Most of the forms were tall or medium tall and were close to spelt wheat in this respect (Fig. 1). Further breeding work with the created forms consisted of individual selections, which reduced the proportion of tall-stemmed forms. To preserve the valuable genetic material of the created high- and medium-stemmed forms, they were hybridised with low-stemmed forms of spelt wheat obtained in our previous studies. As a result, undersized (81-95 cm) samples were obtained.

Another disadvantage characteristic of *Triticum spelta* L. × *Triticum compactum* Host. hybrids are their late maturity. The species *Triticum spelta* L. is late ripening (vegetation period is about 300 days). Although *Triticum compactum* Host. ripens 5-6 days earlier, it is also late-ripening. As a result of hybridisation, the vast majority of the offspring were mid-season. Individual selection allowed to selection of a small number of mid-season (vegetation period 275-285 days) introgressive lines of spelt wheat, which matured simultaneously with mid-season durum wheat varieties.

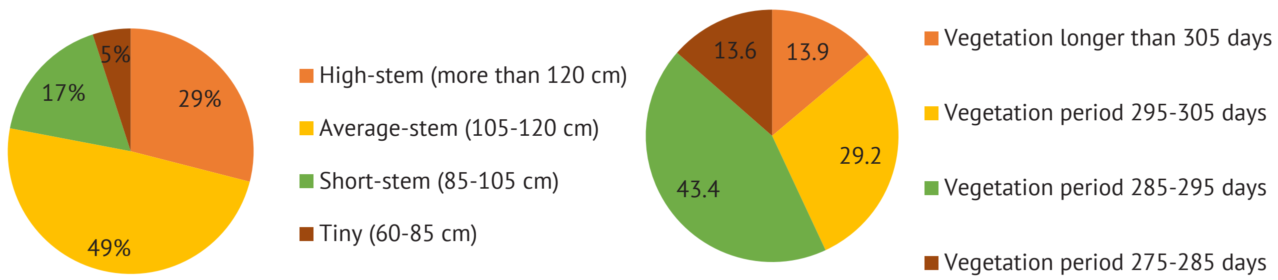

***Figure 1.** Distribution (%) of created lines by plant height and length of the growing season, 2019-2020*

The parameters of adaptability, in particular, ecological plasticity and stability, of the created forms were determined in the course of the research to differentiate them by the level of adaptive potential. The analysis of yields for 2019-2021 shows that on average they ranged from 4.64-5.11 t/ha (Table 4).

Table 4. *Parameters of stability and adaptability of introgressive forms of spelt wheat in terms of yield*

Genotype	Yield, t/ha			Average	Stability parameters		Adaptiveness parameters		
	2019	2020	2021		b_i	S^2_{di}	Hom	V, %	Sc
Zoria Ukrainy (st)	5.45	4.27	5.64	5.12	1.05	0.042	175.7	4.0	3.9
192	5.15	4.21	5.28	4.88	0.83	0.031	175.7	4.0	**3.9**
195	5.25	4.32	5.36	4.98	0.81	0.035	164.3	4.1	3.7
201	5.08	4.12	5.24	4.81	0.86	**0.027**	**193.3**	4.4	**3.9**
205	4.95	4.01	5.24	4.73	0.91	0.037	170.7	4.0	3.8
206	5.38	4.41	5.54	**5.11**	0.86	0.061	**182.3**	4.1	**3.9**
208	5.05	3.98	5.21	4.75	**0.95**	**0.025**	143.5	5.6	3.2
210	4.89	3.92	5.12	4.64	0.90	0.031	170.7	4.0	3.8
LSD_{05}	*0.26*	*0.19*	*0.28*			–			

Source: *compiled by the authors*

The three studied samples were found to be not significantly inferior to the variety Zorya Ukrayiny in terms of yield. The highest yield was recorded in sample 206 – 5.11 t/ha. Calculations of the regression coefficient of the studied genotypes showed that all samples are low plastic, except for sample 208 (b_i=0.95), which belongs to medium plastic forms.

Calculations of S^2_{di} showed that the best stability parameters were characterised by samples 201 (S^2_{di}=0.027) and 208 (S^2_{di}=0.025). The relationship between homeostasis (Hom) and the coefficient of variation (V) characterises the stability of a genotype under changing environmental conditions. The most stable among the created samples were numbers 201 and 206, as indicated by a high level of homeostasis (182.3 and 193.3) and a low coefficient of variation (V=4.1-4.4%). The coefficient of breeding value (Sc) made it possible to identify highly productive forms characterised by stable realisation of productivity potential in a changing environment. In our research, the highest coefficient of breeding value was 206 (Sc=4.1), 195 (Sc=4.0) and 192 (Sc=3.9). Line 206, characterised by high yield (5.11 t/ha) and breeding value coefficient (3.9), was singled out.

Thus, the introgressive hybridisation of *Triticum spelta* L. × *Triticum compactum* Host. resulted in the creation of new source material and analysis of the patterns of trait inheritance and the formation process. A comparative analysis of productivity and adaptability parameters was carried out, which allowed the selection of valuable genotypes. Modern breeding and genetic studies have shown that morphological traits of hexaploid wheat species are determined by a small number of genes. The analysed morphological traits are controlled by the "large morphology" genes, as they significantly affect the plant phenotype. F. Hao & N. Goncharov (2019) note that the division into hexaploid wheat species is based on the shape and morphological structure of the ear, which is determined by the allelic state of these genes.

B. Xu *et al.* (2018), studying the shape of the spike in spelt, found that it is controlled by the *Q* gene, which is located on chromosome 5A. Recessive alleles of this gene determine the speltaic type of spike. M. Wen *et al.* (2022) noted that in wheat *Triticum compactum* Host. the spike shape is controlled by the *C* gene, which has the opposite effect of the *Q* gene. It causes a reduction in the length of the ear and stem, which leads to the formation of a stunted plant with a short, superdense ear and determines the main phenotypic differences of the *Triticum compactum* Host species. The spike density is also regulated by the length genes L_1, *and* L_2. In the presence of recessive alleles of all these genes (genotype $ccl_1l_1l_2l_2$), hexaploid wheat develops a short, dense club-shaped ear of the "squarhead" type.

M. Wen *et al.* (2022) noted that in the hybridisation of *Triticum compactum* Host. with durum wheat, the compact form of the ear dominates in the first generation. R. Yakymchuk *et al.* (2020) found a dominant inheritance of speltoid mutants with different types of wheat when hybridising speltoid traits with different wheat species. The results of the study indicate an intermediate inheritance of the spike shape in the hybridisation of *Triticum spelta* L. × *Triticum compactum* Host. The emergence of speltoid and compacted forms in studies is associated with different dosages of the *Q* gene in the offspring. Plants homozygous for the *qq* locus have a speltoid ear type. Increasing the dose of the *Q* gene produces offspring with a compactoid ear shape. Heterozygous genotypes (*Qq*) – have an intermediate phenotype. The presence of a significant number of plants with an intermediate spike shape can be explained by the independent recombination of genes controlling the spike shape in the original species and the presence of modifier genes.

M. Haas *et al*. (2019), while studying genetic changes in wheat during domestication, noted that the determining factor of the free threshing phenotype is the gene for coarse spike scales (*Tg*), which is located on chromosome 2DS. Spelta contains the dominant *Tg* gene in the homozygous state, which, in combination with recessive alleles of the q gene, causes the formation of a speltoid ear type with coarse spike scales and difficult threshing. The species *Triticum compactum* Host. contains recessive alleles of the *Tg* gene, which causes free threshing of grain. This is confirmed by the lack of data in the scientific literature on filmy forms of wheat compactum with coarse spikelet scales. The conducted studies show that in the hybridisation of *Triticum spelta* L. × *Triticum compactum* Host. the progeny in the F_1 generation were characterised by a filmy ear with difficult threshing of grain. In the F_2 generation, a split was obtained in the ratio 3:1 ratio, where three parts are filmy forms and one part is hulled. Thus, filmy grain and complicated threshing of spelta are dominant traits to alternative traits of *Triticum compactum* Host.

The groups of researchers N. Grant *et al.* (2018) and U. Devi *et al.* (2019) independently found that the progeny obtained from interspecific hybridisation of wheat occupy an intermediate position between the original forms in terms of plant height. However, W. Sannemann *et al.* (2018) describe the fact of dominance and predominance of the tall parental form. They also recorded selection (additive interaction of genes) and hybrid (complementary interaction of genes) dwarfism in the offspring. There is data in the studies on the genetic control of plant height in *Triticum spelta* L. and *Triticum compactum* Host. Most scientists point to the dominant tallness of spelt. D. Packa (2018) and N. Grant *et al.* (2018) note that hybridisation of spelt with wheat forms with dominant or recessive dwarfism results in different types of gene interaction (complementary, epistatic, polymeric) and the formation of progeny with a wide range of plant height variability. In our studies, similar results were obtained with significant variation in plant height of F_{3-4} offspring (from 60 to 130 cm).

For successful breeding, positive transgressions obtained in hybrid offspring as a result of the formation of recombinations for individual valuable traits are of practical importance. N. Dubovik *et al.* (2018), studying the elements of wheat ear productivity, pointed out the wide range of transgressive variability, in particular, the frequency of positive transgressions for the number of grains per ear ranged from 16.0 to 62.0%, and for the weight of grains per year from 6.0 to 30.0%. M. Lozinsky & G. Ustinova (2020) note that the maximum frequency of positive transgressions in ear productivity is observed in later generations of hybrids, which in the first generation have a high degree of positive dominance in such important traits as grain weight per ear and number of grains per ear. Similar trends were observed in the studies conducted, where the frequency of positive transgressions for ear productivity increased in later generations.

The analysis of breeding material by stability and adaptability parameters provides researchers with information on the peculiarities of the normal response of genotypes to changing environmental conditions. The groups of researchers Y. Kuzmenko *et al.* (2023) and S. Popov *et al.* (2019) analysing wheat source material for adaptability concluded that these indicators can be most fully assessed by environmental plasticity or regression coefficient (b_i), environmental stability or stability variant (S^2_{di}) and homeostasis. Genotypes with low ecological plasticity and low S^2_{di} values are considered extensive and unprofitable. Genotypes with high environmental plasticity and low S^2_{di} are considered intensive. The results of the study indicate a high yield of sample 206 combined with high homeostatic and medium ecological plasticity and high stability of sample 208, which makes it possible to use them for breeding improvement of spelt by adaptive potential.

CONCLUSIONS

The hybridisation of *Triticum spelta* L. × *Triticum compactum* Host. resulted in the production of new source material with a broad genetic basis and the identification of valuable forms with a high level of manifestation of economically valuable traits. It was found that in F_1 hybrids *Triticum spelta* L. × *Triticum compactum* Host. morphological traits of plants (plant height, length and density of spikelet, weight of grain per spike) are inherited by the type of intermediate inheritance. The pubescence and filminess of the ear are dominantly monogenic. The shape of the ear is inherited monogenically by the type of incomplete dominance. In hybrids F_{3-4} *Triticum spelta* L. × *Triticum compactum* Host. the highest frequency of positive transgressions was recorded for the number of spikelets (28.1-28.5%) and grains (23.4-51.0%) in the ear and grain weight per ear (20.3-32.1%).

The calculation of adaptability indices allowed to differentiate the created forms by the norm of reaction to changing growing conditions. The line 201, characterised by high stability (S^2_{di}=0.027), homeostasis (Hom=193.3) and breeding value (Sc=3.9), and line 206, combining high yield (5.11 t/ha) with high homeostasis (Hom=182.3) and breeding value (Sc=3.9), were identified. A promising direction for further research is the involvement of the created forms in the selection and genetic improvement of spelt wheat to induce the formative process and isolate valuable genotypes with improved quantitative and qualitative productivity.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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Створення та аналіз вихідного матеріалу отриманого за гібридизації *Triticum spelta* L. × *Triticum compactum* Host.

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Анотація. У проведених дослідженнях в результаті гібридизації *Triticum spelta* L. × *Triticum compactum* Host. отримано декілька нових форм, які відрізняються за морфобіологічними та господарсько-цінними ознаками. Метою дослідження є розширення генетичного різноманіття пшениці спельти та отримання нових інтрогресивних форм з високим рівнем прояву господарсько-цінних ознак. У роботі використовували такі методи: польовий, лабораторний, гідрологічний аналіз, статистичний аналіз. В результаті досліджень отримано новий вихідний матеріал та виділено цінні генотипи з унікальним поєднанням генетичного матеріалу вихідних видів. Встановлено проміжний тип успадкування морфологічних ознак рослин (висота рослин, довжина і щільність колоса, маса зерна з колоса) у гібридів F_1. У гібридів F_2 розщеплення 3:1, що свідчить про домінантний моногенний характер успадкування. Форма колоса успадковується моногенно за типом неповного домінування. Аналіз трансгресивної мінливості у F_{3-4} гібридів *Triticum spelta* L. × *Triticum compactum* Host. показав, що найбільша частка позитивних трансгресій зафіксована за кількістю колосків (28,1-28,5 %) і зерен (23,4-51,0 %) у колосі та масою зерна з колоса (20,3-32,1 %). Аналіз показників стабільності та адаптивності дозволив виділити лінію 201, що характеризується високою стабільністю (S^2_{di}=0,027), гомеостазом (Hom=193,3) та селекційною цінністю (Sc=3,9), та лінію 206, що поєднує високу врожайність (5,11 т/га) з високим гомеостазом (Hom=182,3) та селекційною цінністю (Sc=3,9). В результаті інтрогресивної гібридизації з *Triticum compactum* Host. виявлено нові генетичні джерела, які характеризуються наявністю дефіцитних для селекції ознак і мають велике практичне значення для подальшої селекції та генетичного поліпшення спельти, оскільки вони можуть збагатити існуючий генофонд культури

Ключові слова: пшениця спельта; успадкування; розщеплення; трансгресія; урожайність; адаптивність