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INHERITANCE AND GRAIN WEIGHT TRANSGRESSIVE VARIABILITY PER PLANT IN HYBRID WINTER *WHEAT (T. AESTIVUM L.)*, OBTAINED FROM THE HYBRIDIZATION OF VARIOUS ECOTYPES

Висвітлено особливості успадкування маси зерна з рослини у гібридів F_1 пшениці м’якої озимої. Встановлено, що успадкування маси зерна з рослини гібридами першого покоління в переважній більшості комбінацій проходило за типом позитивного наддомінування. Ступінь фенотипового домінування (h_p) становив 1,4-64,0. Істинний гетерозис за масою зерна з рослини спостерігався у дев’яти з десяти гібридів F_1 з показником 41,1-68,9 %. Частота позитивних трансгресивних рекомбінантів за масою зерна з рослини у гібридів F_2, отриманих від схрещування степового екотипу з лісостеповим становила 36,0-80,2 %. У гібридних популяцій, отриманих від схрещування віддалених еколого-географічних форм, найбільша кількість позитивних трансгресій спостерігалась в популяціях Гайтун / Олеся і Гайтун / Білоцерківська напівкарликова – 68,8 і 57,1 % відповідно.

Ключові слова: пшениця м’яка озима, маса зерна з рослини, екотипи, комбінації схрещування, гібриди, успадкування, гетерозис, ступінь домінування, ступінь і частота трансгресій.

Introduction. One of the priorities of agriculture of Ukraine is a significant increase and stabilization of grain production. Soft wheat winter is the basic and the most important food crop in the world. It is grown in most countries.

The main objective in wheat breeding is to create a soft winter varieties with high productivity. In recent years, due to global climate change, much attention is paid to breeding varieties with enhanced adaptive capacity [1, 2, 3].

Analysis of domestic and international breeding results reveals that broad scientific and reasonable use in breeding programs of different source material is crucial in breeding new modern varieties. Therefore, the study of winter wheat sort samples collection for economically valuable traits provides establishing their breeding value creation for further selecting the varieties with high productivity, grain quality and adaptability to specific soil and climatic cultivation conditions.

Of particular urgency is the experimental verification of the properties of new winter wheat sort samples of various ecological-geographical and genetic origin. Their involvement in hybridization contributes to identifying their breeding value under certain soil and climatic conditions for breeding varieties with agronomic traits complex.

Analysis of recent research and publications. The weight of grain per plant is the main feature of the structure of individual grain productivity of wheat and, according to most scholars, it is one of the most effective means to improve the crop performance [4, 5, 6]. The level of the manifestation of the symptoms depends on many elements, each of them has its own inheritance character and variation range. Number of plants per area unit and their performance determine the level of productivity.

The most effective method of winter wheat selection is intraspecific genetic recombination characteristics with applying different types of crossbreeding with the following single and multiple selection [7]. Gene D, which provided hexaploid wheat tetraploid two-genome transition from level to three-genome in combination with the first two genomes Au and B resulted in large intraspecific polymorphism and diversity of *T. aestivum L* ecotypes, which makes it possible for its improvement [4, 8]. As a result of crossing varieties that differ in morphological, biological and physiological characteristics, with different levels of genetic potential productivity and resistance to biotic and abiotic adverse environmental factors, large quantities of genetically modified form of several parents united in a single genotype. This diversity of recombinant is a starting material for the subsequent creation of a new genotype closely related to environmental conditions [9]. Successful selection of the crossbread pairs requires determining the direction of selection and studying the agri-environmental conditions for the planned cultivation areas, taking into account factors that may limit the potential yield of the variety.

Varieties of different ecotypes are adapted to the conditions of ecological and climatic zones for which they are derived. They differ in terms of duration of the growing season, plant height, morphological features, endurance to adverse environmental conditions. Ye.M. Sins’ka launched the doctrine of the development of the ecological system of selection [10]. The current ecological and geographical differentiation of plant genetic resources provides limitless opportunities of their use in producing varieties with desirable biological properties.

The probability of positive breeding in respect of transgressions increases in crossing the varieties which belong to different ecological types of development. The essence of this phenomenon is not geographical distance and differences in genetic hybridization components which are caused by the results of selection in different natural and historical conditions. The presence of genetic differences in the components of hybridization is the main condition for the recombinant alleles system, which provides the best possible expression of quantitative traits of wheat productivity [4].

Knowledge on the genetic nature of quantitative traits determining plants productivity are of great importance for breeding work [11, 12]. M.I. Vavilov explained insufficient study of quantitative traits by their complexity, the presence of transitional forms, genetic determination of traits ignorance [13].

The aim of research was to establish the nature of inheritance of grain weight per plant by F1 hybrids and the extent and frequency of positive transgressions in F2 hybrid populations of soft winter wheat, obtained by crossing parent forms belonging to different ecological groups.

Research material and methods. The study was conducted in Bila Tserkva experimental breeding station (BTEBS) of the Institute of crops bioenergy and sugar beet in 2011-2013.

Parental forms were the varieties of breeding establishments located in different ecological and geographical areas, namely: Missia Odes’ka (Miss. Od.) (Plant Breeding and Genetics Institute), Vidrada, Lybid’, Olesya, Rostavytsya, Bilotserkivska semi-dwarf (BTEBS), Dryada 1 (ETE "Dryada a"), Polis’ka 90 (Institute of agriculture), NAZ (Kazakhstan), Haytun and Pekin (China), belonging to various environmental groups. We have studied 10 hybrid combinations: Miss. Od. / Vidrada, Miss. Od. / Lybid, Dryada a 1 / Olesya, Dryada 1 / Rostavytsya, NAZ / Olesya, NAZ / Polis’ka 90 Haytun / Olesya, Haytun / B.TS. s /d, Pekin / Olesya, Pekin / B.TS. s / d. Seeds F1-2 were sown with breeding drill SSKF-7M on the scheme: parent form, hybrid, parent form. Hybrid generation was worked by pedihri method. During the growing season we conducted phenological observations and structural analysis of sheaves was done after the complete ripeness [14-15].

The degree of phenotypic dominance (h_p) of grain weight per plant in the hybrids, was determined according to the formula by G.M. Bailey and R.I. Atkins [16], the degree and frequency of positive transgressions – according to the formulas suggested by H.S. Voskresenckaya, V.I. Shpot [17], A.P. Orlyuk and V.V. Bazaliy [18], true heterosis according to the formula proposed by Kh. Daskalev [19].

Biometric analyzes was carried out on an average sample of 25 plants in triple repetition. The results of the experimental data were treated statistically by the "Statistica" program, version 5.0.

Results and discussion. It has been found out that the inheritance of grain mass per plant hybrids of the first generation of winter wheat soft in most combinations held by the type of positive overdominance. In crossing the steppe and forest-steppe ecotypes the degree of dominance was within 1.4-64.0. In five of the six hybrids obtained by hybridization of remote ecological and geographical forms the rate of phenotypic forms of domination was within 5.9-64.0. Only in the combination of crossing NAZ / Polis’ka 90 the determination of the trait "grain weight per plant" developed on the negative dominance type (Fig. 1).

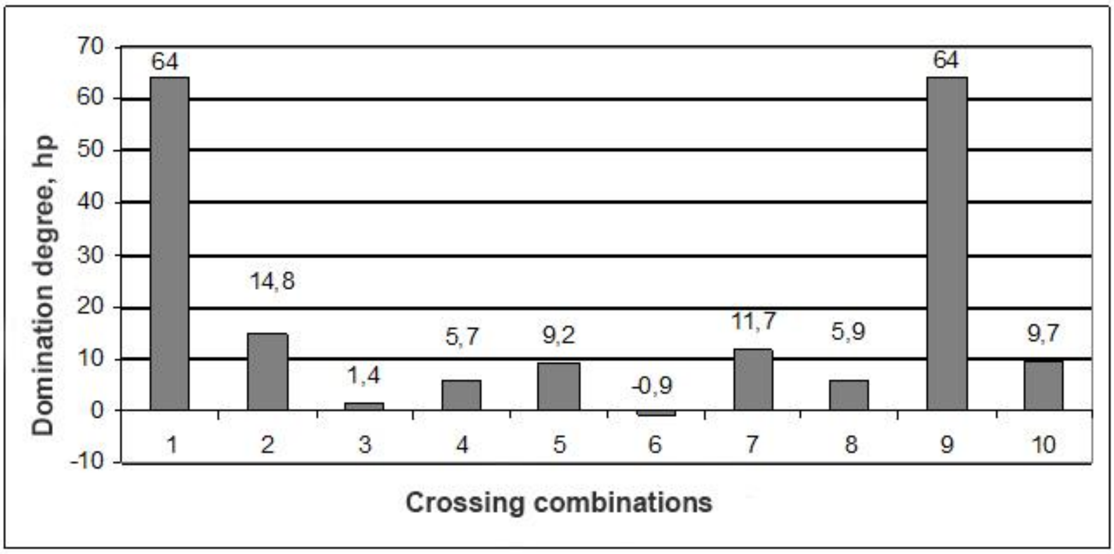

Fig. 1. **The degree of phenotypic domination of grain weight in soft winter wheat F1 hybrids** (2012). **Crossing combinations:** 1 – Miss. Od. / Vidrada; 2 – Miss. Od. / Lybid’; 3 – Dryada 1 / Olesya; 4 – Dryada 1 / Rostavytsya; 5 – NAZ / Olesya; 6 – NAZ / Polis’ka 90; 7 – Haytun / Olesya; 8 – Haytun / B.TS. s/d; 9 – Pekin / Olesya; 10 – Pekin / B.TS. s/d.

The index of phenotypic dominance does not give grounds to judge the value of heterosis effect – it only determines the nature of the manifestation of the trait studied: its values are essential only within 1.1 – (1.1). A more objective assessment of trait inheritance characteristics can be obtained by calculating the degree of heterosis [20].

The degree of heterosis (H%) was determined by comparing the rate of grain weight in F1 hybrid plants with this indicator in a better parent form.

True heterosis for grain weight per plant was marked in nine of the ten first-generation hybrids.

In hybrids Dryada 1 / Rostavytsya (crossing steppe and forest steppe ecotypes) and the NAZ / Olesya (crossing remote eco-geographical forms) we observed the highest heterosis rates of 68.9 and 60.9 %, respectively (Fig. 2).

It has been found out that nine out of the ten first-generation hybrids with a grain weigh per plant of 5.85-9.06 g exceeded the rates of the parental forms with a bigger display by 0.46-3.28 g (Table. 1).

Hybrids F2 exceeded the parental forms with bigger trait display by 0.19-2.68 g for grain weight per plant, except for Miss. Od. / Lybid. The maximum weight of grain per plants in the F2 hybrid populations goexceeded the parental forms and reached 4.82-8.30 g. Variation of trait in F1-2 hybrids and parental forms (except for Haytun, 2013) is significant.

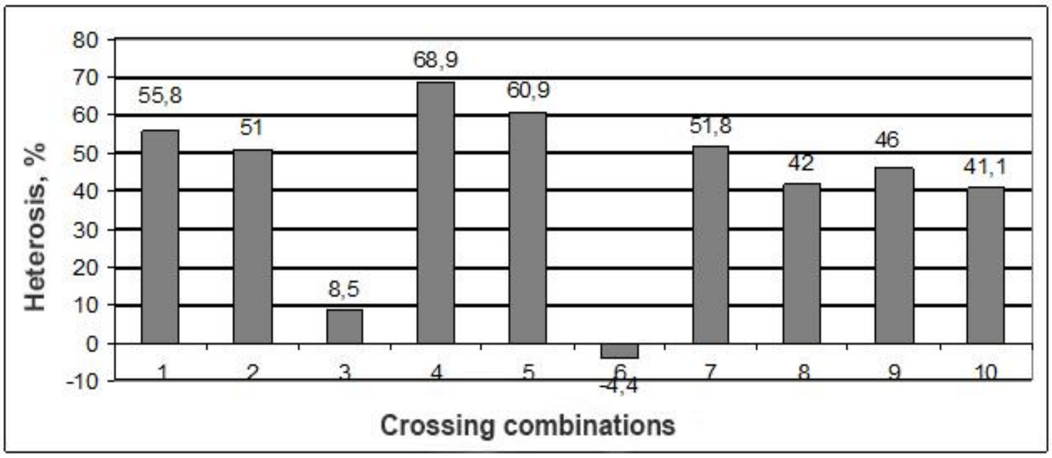

Fig. 2. **Heterosis for grain weight per plant in the F1 soft winter wheat hybrids** (2012).
Crossing combinations: 1 – Miss. Od. / Vidrada; 2 – Miss. Od. / Lybid’; 3 – Dryada 1 / Olesya; 4 – Dryada 1 / Rostavytsya; 5 – NAZ / Olesya; 6 – NAZ / Polis’ka 90; 7 – Haytun / Olesya; 8 – Haytun / B.TS. s/d; 9 – Pekin / Olesya; 10 – Pekin / B.TS. s/d.

An integral part of studying soft winter wheat breeding is the selection of transgressive recombinants in hybrid populations both by the elements of the crop structure in the complex of traits that make up the adaptive potential of modern varieties.

Using transgressive fission, a breeder can extend the existing limits and intensity of desirable traits display in wheat. Obtaining these forms of winter wheat by certain economically valuable traits and their complex is an urgent and one of the most difficult problems of the crop breeding. By transgressive splitting it is possible to create new features or, more commonly, a new level of intensity of manifestation of existing signs [4].

Table 1 – **Display of statistical indicators of weight variation in grain plants F1-2 hybrids and their parental forms**

Crossing combinations and parental forms	F_1 hybrids, 2012				F_2 hybrids, 2013			
	($\tilde{o}$ ± S $\tilde{o}$), г	Lim (г)		V,%	($\tilde{o}$ ± S $\tilde{o}$), г	Lim (г)		V,%
		min	max			min	max	
Steppe ecotype / Forest-Steppe ecotype								
♀ Miss. Od.	4,52 ± 0,31	2,07	6,29	27,7	3,33 ± 0,23	2,28	4,42	21,7
Miss. Od. / Vidrada	7,04 ± 0,47	4,42	11,03	24,3	4,93 ± 0,37	2,24	8,30	31,4
♂ Vidrada	4,43 ± 0,46	1,84	9,01	36,6	2,70 ± 0,26	1,58	3,85	30,1
Miss. Od. / Lybid’	7,37 ± 0,52	2,59	12,02	23,8	2,96 ± 0,44	1,90	6,80	55,5
♂ Lybid’	4,88 ± 0,45	2,11	7,18	32,9	2,09 ± 0,15	1,37	2,72	22,9
♀ Driada 1	3,08 ± 0,34	1,46	5,79	42,7	1,14 ± 0,10	0,62	1,85	35,1
Driada 1 / Olesya	5,85 ± 0,43	2,97	7,83	26,9	4,44 ± 0,42	2,04	7,40	31,1
♂ Olesya	5,39 ± 0,49	2,31	8,85	32,0	2,95 ± 0,26	1,42	4,15	27,5
Driada 1 / Rostavytsya	7,38 ± 0,50	3,93	12,22	23,6	5,33 ± 0,43	3,51	7,59	25,4
♂ Rostavytsya	4,37 ± 0,44	2,23	6,73	37,7	2,65 ± 0,36	1,00	4,24	42,9
Remote ecological geographical forms crossing								
♀ NAZ	4,59 ± 0,49	2,08	9,02	37,8	3,75 ± 0,37	2,13	5,97	31,1
NAZ / Olesya	8,67 ± 0,67	4,12	17,09	23,4	3,94 ± 0,44	2,18	6,94	38,7
NAZ / Polis’ka 90	4,60 ± 0,26	2,75	6,32	25,0	4,80 ± 0,45	2,20	7,25	32,1
♂ Polis’ka 90	4,81 ± 0,42	2,19	8,34	35,1	2,65 ± 0,26	1,41	3,58	31,1
♀ Haytun	5,97 ± 0,43	2,91	9,39	28,7	3,01 ± 0,16	2,26	3,82	17,3
Haytun / Олеся	9,06 ± 0,69	4,60	17,42	22,1	4,87 ± 0,28	3,06	6,92	23,2
Haytun / B.Ts. s/d	8,48 ± 0,53	4,64	14,0	20,9	4,85 ± 0,47	2,48	7,17	31,9
♂ B.Ts. s/d	4,95 ± 0,41	2,32	8,56	34,0	2,86 ± 0,28	1,47	4,54	31,3
♀ Pekin	5,48 ± 0,39	2,87	8,78	30,1	3,13 ± 0,26	2,12	4,45	26,2
Pekin / Olesya	8,00 ± 0,49	4,70	13,43	21,8	3,37 ± 0,33	1,52	5,77	37,9
Pekin / B.Ts. s/d	7,73 ± 0,47	4,15	10,95	21,8	3,37 ± 0,30	1,96	4,82	29,4
Podolyanka (St)	5,77 ± 0,52	2,14	10,62	30,6	2,53 ± 0,23	1,63	4,16	28,2

The degree of positive transgressions by grain weight per plant in the studied populations of the second generation hybrid was in the range of 8.3 % (Pekin x B.Ts. s/d) to 87.8 % (Miss. Od. / Vidrada) (Table 2).

Frequency of transgressive recombinants by weight of corn plants in hybrids derived from crossing steppe and forest steppe ecotypes was 36.0-80.2 %. In hybrid populations obtained by crossing remote eco-geographical forms, the highest number of transgressions was obtained in populations Haytun / Olesya and Haytun x B.TS. s / d – 68.8 and 57.1 % respectively.

Table 2 – **Degree and frequency of positive transgressions by weight per plant in F2 hybrids** (2013)

Crossing combinations	h_p degree in F_1	Transgression degree, %	Transgression frequency, %
Steppe ecotype / Forest-Steppe ecotype			
Miss. Od. / Vidrada	64	87,8	36,0
Miss. Od. / Lybid’	14,8	53,8	30,8
Dryada 1 / Olesya	1,4	78,3	33,3
Dryada 1 / Rostavytsya	5,7	79,0	80,2
Remote ecological geographical forms crossing			
NAZ / Olesya	9,2	16,2	8,3
NAZ / Polis’ka 90	-0,9	21,4	20,0
Haytun / Olesya	11,7	66,7	68,8
Haytun / B.TS. s/d	5,9	57,9	57,1
Pekin / Olesya	64	29,7	20,0
Pekin / B.TS. s/d	9,7	8,3	5,3

Conclusions and recommendations for further research. 1. F1 hybrids inheritance of soft winter wheat grain weight per plant, obtained by crossing parental ecotypes of different forms, developed, in most combinations, according to the the type of positive overdominance. The degree of phenotypic dominance (h_p) was 1.4-64.0.

2. The highest heterosis rate for the grain weight per plant was observed in hybrids Dryad 1 / Rostavytsya (steppe and forest-steppe ecotypes crossing) and in NAZ / Olesya (Remote ecological geographical forms crossing) – 68.9 and 60.9 % respectively.

3. Frequency of transgressive recombinants by frain weight per plant in F2 hybrid populations, obtained by steppe and forest-steppe ecotypes crossing was 36.0-80.2 %, received. The highest number of transgressions in remote eco-geographical forms crossing was obtained in populations Haytun / Olesya and Haytun B.Ts. s/d – 68.8 and 57.1 % respectively.

4. Engaging local adapted varieties of other ecotypes in hybridization allows creating significant reserve genotypic variability by grain weight per plant.

The prospect of further research is selection and evaluation of the obtained recombinants by a complex of economically valuable traits aimed to create a new source material for breeding varieties with high productivity and adaptability to adverse environmental conditions.

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Наследование и трансгрессивная изменчивость массы зерна с растения в гибридов пшеницы озимой (*T. aestivum L.*), полученых от гибридизации разных экотипов

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Показано особенности наследования массы зерна с растения гибридами F_1 пшеницы мягкой озимой. Степень фенотипического доминирования (h_p) составляла 1,4-64,0. Истинный гетерозис по массе зерна с растения наблюдался в девяти с десяти гибридов F_1 с показателем 41,1-68,9 %. Частота положительных трансгрессивных рекомбинантов по массе зерна с растения у гибридов F_2, полученых от скрещивания степного экотипа с лесостепным составляла 36,0-80,2 %. У гибридных популяций, полученных от скрещивания отдаленных эколого-географических форм, наибольшее количество позитивных трансгрессий наблюдалось в популяциях Гайтун / Олеся и Гайтун / Белоцерковская – полукарликовая 68,8 и 57,1 % соответственно.

Ключевые слова: пшеница мягкая озимая, масса зерна с растения, экотипы, комбинации скрещивания, гибриды, наследование, гетерозис, степень доминирования, степень и частота трансгрессий.

Inheritance and grain weight transgressive variability per plant in hybrid winter wheat *(T. aestivum L.),* obtained from the hybridization of various ecotypes

M. Lozinskyi

The peculiarities of grain weight inheritance per plant in the F1 soft winter wheat hybrids is highlighted. It has been found out that grain weight inheritance per plant in first generation hybrids in most combinations develops on the type of positive overdominance. The degree of phenotypic dominance (h_p) was 1.4-64.0. True heterosis for grain weight per plant was observed in nine of the ten F1 hybrids with the index of 41.1-68.9 %. The frequency of positive transgressive recombinants by crop grain weight in F2 hybrids, obtained by crossing the steppe and forest-steppe ecotypes was 36.0-80.2 %. The highest number of the positive transgressions in hybrid populations obtained with crossing remote eco-geographical forms, was observed in Haytun / Olesya and Haytun / Bilotserkivska, semi-dwarf populations – 68.8 and 57.1 % respectively.

Key words: soft winter wheat, the grain weight per plant, ecotypes, crossbreeding combinations, hybrids, inheritance, heterosis, dominance degree, transgressions degree and frequency.

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