UDC 633.111.1: 58.02 DOI: 10.36814/pgr.2020.26.01

DOKUKINA K. I., BOHUSLAVSKYI R. L.
Plant Production Institute nd. a. V. Ya. Yuriev of NAAS
National Center for Plant Genetic Resources of Ukraine
142 Moskovskyi Ave., Kharkiv , 61060, Ukraine
E-mail:ncpgru@gmail.com

TRAIT INHERITANCE IN BREAD SPRING WHEAT HYBRIDS WITH SYNTHETICS WITH ABD GENOMIC STRUCTURE

There are prezented results of a study of early hybrid generations of bread spring wheat with synthetics (ABD genomic structure) combining the genomes of *Triticum durum* Desf. and *Aegilops tauschii* Coss. for inheritance of plants height, ear productivity elements: length, spikelet and grain number, grain weight; 1000 grain weight. In all five combinations, transgressive forms were found out on different traits with a frequency of 6% to 8% and a transgression degree of 6 to 17%. In the hybrid Kharkivska 26 / AD 68.112 / Ward // *Ae.squarrosa* (369), such plants are distinguished on five traits: plant height and parameters of the main ear – length, spikelet and grain number, grain weight. The presence of transgressions indicates an increase in the manifestation level of these traits in bread wheat.

Key words: *wheat, synthetics, hybrids, productivity elements, dominance, heritability*.

INTRODUCTION

Amphidiploids with the genomic structure of ABD, which combine the genomes of durum wheat (Triticum durum Desf., A^uB) and goatgrass (*Aegilops tauschii* Coss., synonym *Ae. squarrosa* L., D) and are referred in the world literature to as "synthetics", are genetic stocks of a number of valuable economic traits: disease resistance, high protein and gluten content in the grain, adaptability to abiotic environmental factors etc. [1]. Due to the homology of the synthetics genome to the bread wheat genome, it is quite easy to improve this crop by transferring valuable genes using hybridization. The involvement of synthetics to breeding programmes has created more than 60 high-yielding and highly adaptable wheat varieties in different countries on four continents: China, India, Pakistan, Afghanistan, Tajikistan, Turkmenistan, Syria, Ethiopia, Kenya, Mexico, Uruguay, and Argentina. The breeding value of synthetics in the conditions of Russia - Western Siberia [3], Non-Chernozem Zone [4] is proved.

The International Center for Maize and Wheat Improvement (CIMMYT, Mexico) is the most active in creating synthetics, providing Ukraine with the AB x D Elite Synthetics nursery of these forms for study and use. Success in the use of synthetics for the bread wheat breeding involves the transfer of genes that control the characteristics of yield and its components, adaptability, grain quality in the genotypes of domestic varieties. Our previous studies proved the possibility to transfer from synthetics to spring bread wheat of hereditary basis of quantitative traits plasticity and stability [5], qualitative characteristics of grain [6]. However, it is important to determine the nature of the inheritance of productivity elements and other quantitative traits in hybrids.

The purpose of this research is to establish the inheritance of plant height, ear productivity elements: length, spikelet and grain number in the ear, grain weight; 1000 grains weight in early generations of hybrids of bread spring wheat variety Kharkivska 26 with synthetics *Triticum durum* Desf./*Aegilops tauschii* Coss. of *ABD* genomic structure.

MATERIAL, METHODS AND CONDITIONS

The material for the research were hybrids of five synthetics (genome *ABD*, 2n = 42, male forms) having the introduction numbers of the National Plant Gene Bank of Ukraine and pedigrees: IU13931 (D67.2/P66.270//*Ae.tauschii* (217)); IU13933 (D67.2/P66.270//*Ae.squarrosa* (218)); IU13937 (Dverd_2/*Ae. squarrosa* (221)); IU13948 (68.112/Ward//*Ae.squarrosa* (369)); IU13974 (D67.2/P66.270// *Ae.squarrosa* (257)). The maternal form for all was the spring bread wheat cultivar Kharkivska 26.

In our research, when hybridizing synthetics as the parent form with bread wheat, F1 seed set was reduced by 4-8%. This may be due to the effect of cytoplasm inherited from durum wheat, as well as incomplete homology of the genomes of synthetics and bread wheat. Therefore, one-sided crosses were carried out, where the maternal form was Kharkivska 26, a variety of bread spring wheat, and the male form was synthetic. To prevent uncontrolled cross-pollination, 20 ears of each F1 hybrid were isolated. Sowing of F2 was carried out by seeds from self-pollination.

Crossings were performed in 2015 and 2016. In 2017 and in 2018, the F_1 and F_2 hybrids were sown along with the parent forms. Sowing was carried out in rows 1 m long with a row spacing of 15 cm, 40 grains were sown in one row.

In 2015, the temperature was close to the perennial average. The spring was excessively humid and warm. The amount of precipitation in May was higher than the perennial average by 2.8 mm or 6%, respectively, and the average daily air temperature exceeded the perennial average by 1.2 ^{o}C. The amount of precipitation in June was 104.5 mm, which is 39.4% more than the perennial average. In July, during the period of grain filling and ripening, 42.6 mm fell, which is 40.6% less than the perennial average, so this period was arid. In 2016, the temperature was close to the long-term average. Spring was characterized by excessive humidity and heat: the amount of precipitation in May exceeded the perennial by 48.0 mm; the average daily temperature in May exceeded the perennial by 0.9ºC, and the sum of effective temperatures in May was by 67.6ºC higher than the average perennial level –143.0ºC. In June, the amount of precipitation was 43.3 mm, which is 31.6% less than for many years. In July, during the period of grain filling and ripening, 106.4 mm of precipitation fell, which is by 48.4% higher than the perennial value and contributed to higher productivity of wheat plants. May 2017 was excessively wet: precipitation was 107.9 mm (perennial average – 43.7 mm); the average daily temperature was 15.5^{o}C (long-term – 16.1^{o}C). In June and July, the amount of precipitation was less than the perennial average by 44.7 mm and 40.1 mm, respectively, or by 70.6% and 55.9%, i.e. the summer months were dry. 2018 was a dry year. In May, the average daily temperature was 19.9^{o}C, which exceeded the norm by 3.8^{o}C; the amount of precipitation was 15.9 mm, which was almost three times lower than the perennial average level. The average daily temperature in June was 21.8°C, the amount of precipitation was 43.5 mm, which is by 58% less than for many years; in July, the amount of precipitation was 28.7 mm, ie 39% less than the average perennial, so the year was also dry.

In general, the conditions of research years allowed to obtain viable hybrid grains, grow hybrid plants and assess the traits of plant height and productivity.

The degree of traits dominance in F1 was determined by the method of GM Beil and RE Atkins [7]. Dominance with a degree in absolute value greater than 0.0 and up to 0.33 was considered weak, from 0.34 to 0.66 – medium, from 0.67 to 1.0 – strong.

Assessment of the trait heritability in a broad and narrow sense was performed in accordance with the method of PF Rokytsky [8] using a set of computer programs Excel. Coefficients of trait heritability in the broad sense (H^2) were determined through variances of parents and hybrids [9], in the narrow sense (h^2) – as regression coefficients between the trait values of parents and offspring [10]. Heritability coefficients, like the dominance degree, were classified as low, medium and high. The frequency (Tf) and degree (Td) of transgression were determined according to the method of GS Voskresenska and VI Spota [11].

The threshing was evaluated by passing the ears through a grain thresher model MKS-1MA. The scale of the trait manifestation was used: heavy threshing – threshes up to 10% of the total grains number, heavier than medium – from 11 to 30%, medium — from 32 to 50%, lighter than average – from 51 to 70%, light – from 71 to 100% grains.

RESULTS AND DISCUSSION

A manifestation levels of plant height, characteristics of the main ear and 1000 grains weight of synthetics as parental forms are lower as compared with the maternal variety Kharkivska 26 (Table 1). Approximate to the last variety are the samples IU13937 and IU13948 by ear length, IU13931 – by 1000 grains weight.

Table 1. **The traits manifestation in the parental forms of hybrids between bread spring wheat and synthetics, the average for 2016-2018**

Parental form	Plant height, cm	Main ear				
		length, cm	number of		weight of	
			spikelets, pcs	grains, pcs	grains, g	1000 grains, g
♀ bread wheat Kharkivska 26	85	8.0	17.4	35	1.3	35.0
♂ synthetic						
IU13931	58	5.5	10.2	17	0.6	32.3
IU13933	52	6.0	12.4	26	0.8	29.4
IU13937	60	7.5	11,3	18	0.5	28.0
IU13948	72	7.7	13.1	28	0.8	30.2
IU13974	60	6.4	10.5	21	0.7	31.1
LSD_{05}	4.4	1.2	3.4	2.7	0.1	2.3

Inheritance of plant height and grain weight per ear was mostly intermediate (*D* weak, from −0.2 to 0.2), only in the hybrid with IU13948 the plant height was moderately dominated by wheat (*D* = 0.4) (Table 2,3). Kharkivska 26 wheat dominated (*D* = 0.6-1), and in the hybrids with the participation of synthetics IU13937 and IU13948, it over-dominated (*D* 4.6 and 8.3, respectively) in ear length. In terms of the spikelet number per ear, the wheat dominated in the degree from weak (IU13933) to strong (IU13931); in terms of the grain number in the ear – from weak to medium. The degree of wheat dominance by 1000 grain weight ranged from weak (IU13948) to full (IU13974). In general, a weak dominance of the wheat by the studied traits manifestation levels occurred in 16 cases, medium – in eight, strong – in four cases; in two cases there was overdominance.

Table 2. **The traits manifestation in the F1 of hybrids between bread spring wheat and synthetics, the average for 2016-2018**

Hybrids with the synthetic	Plant height, cm	Main ear				
		length, cm	number of		weight of	
			spikelets, pcs	grains, pcs	grains, g	1000 grains, g
IU13931	73.3	7.5	16.5	27	0.92	34
IU13933	69.8	7.9	15.6	32	1.09	34
IU13937	69.4	8.9	16	28	0.92	33
IU13948	81.2	9.1	16	33	1.09	33
IU13974	71.1	8	15.2	30	1.05	35
LSD_{05}	5.1	1.1	2.6	3.3	0.71	2.8

Table 3. **Trait dominance degree in F1 of hybrids between bread spring wheat and synthetics, the average for 2016-2018**

Hybrids with the synthetic	Plant height, cm	Main ear				
		length, cm	number of		weight of	
			spikelets, pcs	grains, pcs	grains, g	1000 grains, g
IU13931	0.13	0.60	0.75	0.11	−0.09	0.26
IU13933	0.08	0.90	0.28	0.33	0.15	0.64
IU13937	−0.25	4.60	0.54	0.18	0.06	0.43
IU13948	0.42	8.33	0.35	0.43	0.16	0.17
IU13974	−0.11	1.00	0.36	0.29	0.17	1.00

The determined heritability coefficients in the broad sense H^2 were high in the vast majority of cases – 25 out of 30, medium – in four, weak – in one (Table 4).

Table 4. **Trait heritability coefficients in the hybrids between bread spring wheat and synthetics, the average for 2016-2018**

Hybrids with the synthetic	Plant height, cm	Main ear				
		length, cm	number of		weight of	
			spikelets, pcs	grains, pcs	spikelets, g	grains, g
Heritability in a broad sense H^2						
IU13931	0.98	0.54	0.84	0.96	0.78	0.14
IU13933	0.99	0.65	0.78	0.87	0.91	0.88
IU13937	0.98	0.98	0.81	0.96	0.63	0.89
IU13948	0.93	0.99	0.79	0.73	0.89	0.85
IU13974	0.98	0.78	0.91	0.93	0.87	0.59
Heritability in a narrow sense h^2						
Загальне	0.58	0.095	0.03	0.52	0.62	0.29

Heritability coefficients in the narrow sense h^2 were determined in relation to parent synthetics. By all traits, they are much smaller than the heritability coefficients in the broadest sense. A significant excess of H^2 over h^2 indicates the predominance of not additive but dominant or epistatic effects of genes, and selection for these traits should begin in later generations. Some convergence of both coefficients occurs in the grain weight per ear in hybrids with the participation of the synthetics IU13931 and IU13937. Therefore, in these hybrids it is advisable to start selection in the early generations by grain weight per ear.

The selection of transgressive forms from the segregating population is of practical importance. Such forms appeared in all five combinations in terms of different traits with a frequency from 6% to 8% and a transgression degree from 6 to 17% (Table 5).

In the combination Kharkivska 26 / IU13948, transgressive plants are found by five traits: plant height and parameters of the main ear: length, number of spikelets and grains, grain weight. In the offspring of the hybrid with the participation of synthetic IU13933, transgressions were observed by the grains number per ear and the grain weight per ear; in the hybrid with IU13937 – by the ear length and the grain weight per ear. Transgressions by a 1000 grain weight were observed in hybrids with the participation of synthetics IU13931 and IU13974. Small transgression frequencies and degrees are consistent with the predominance of trait control by genes with non-additive effects. However, the presence of transgressions suggests that such genetic control may increase the trait manifestation level in bread wheat.

Table 5. **Transgression frequency (*Tf*) and degree (*Td*) in F2 of hybrids between bread spring wheat Kharkivska 26 and synthetics, %, the average for 2016-2018**

Hybrids with the synthetic	Plant height		Main ear								1000 grain weight	
			length		number of				grain weight			
					spikelets		grains					
	Tf	*Td*	*Tf*	*Td*	*Tf*	*Td*	*Tf*	*Td*	*Tf*	*Td*	*Tf*	*Td*
IU13931	0	0	0	0	0	0	0	0	0	0	6	14-17
IU13933	0	0	0	0	0	0	10	11-14	7	7-14	0	0
IU13937	0	0	6	6-	0	0	0	0	6	10-14	0	0
IU13948	7	8-12	7	6-	6	7-9	12	13-15	8	10-15	0	0
IU13974	0	0	0	0	0	0	0	0	0	0	7	12-16

Synthetics are characterized by heavy grain threshability due to the *Tg* gene located in the D genome of *Ae. tauschii* [12]. In the synthetics IU13931, IU13933, IU13937, IU13974 used in the experiment, the threshability was difficult; the synthetic IU13948 has the average threshability level.

Hybrids with the participation of these synthetics were dominated by a characteristic feature of synthetics – difficult grain threshability. Segregation on this trait in F2 is shown in the table 6. In our experiment, threshing of grains in the ranges of 11-39% and 61-79% was not observed. In the hybrids with participation of synthetics IU13931, IU13933, IU13937, IU13974, segregation corresponds to a monogenic scheme with incomplete dominance of difficult threshing: 1: 2: 1, $\chi^2 < 5.99$, P = 0.95.

In the hybrid with the participation of IU13948, segregation was 168 with medium threshing: 62 with light threshing. This corresponded to a monogenic scheme 3:1 with a dominance of average threshing, $\chi2 = 0.58 < 3.84$ for n = 1. Thus, genetic control of threshing difficulty in IU13948 (68.112 / Ward // Ae.squarrosa (369) is weaker than in other synthetics. This may be due to genes – modifiers of the A^u and *B* subgenomes.

*Table 6***. Segregation by threshability level in F2 of hybrids between bread spring wheat Kharkivska 26 and synthetics, %, the average for 2016-2018**

Hybrids with the synthetic	Number of F_2 plants	Including with threshability			χ^2 , P=0,95	
		difficult	medium	light	actual	theoretical
IU13931	248	62	124	62	1,58	5,99
IU13933	260	65	130	65	1,05	5,99
IU13937	195	49	98	49	2,75	5,99
IU13948	230	58	115	58	82,36	5,99
IU13974	226	57	113	57	2,41	5,99

CONCLUSIONS

Synthetics are inferior to the bread spring wheat variety Kharkivska 26 in plant height, ear length and productivity elements. In F1 hybrids of synthetics with bread wheat Kharkivska 26, the wheat is dominated in weak and medium degree. Weak dominance in plant height occurs in hybrids with synthetics Dverd_2 / *Ae.squarrosa* (221) and D67.2 / P66.270 // *Ae.squarrosa* (257), positive overdominance – by ear length in hybrids with Dverd_2 / *Ae.squarrosa* (221) and 68.112 / Ward // *Ae.squarrosa* (369). The heritability coefficients in the broad sense were high in the vast majority of cases – 25 out of 30, medium – in four, weak – in one.

The heritability coefficients in the narrow sense on all traits are much lower than the heritability coefficients in the broad sense, which gives grounds to start selection for these traits in later generations. The convergence of both coefficients takes place by the grain weight per ear in hybrids with the participation of synthetics D67.2 / P66.270 // *Ae.tauschii* (217) and Dverd_2 / *Ae. squarrosa* (221), in which it is advisable to start selection in the early generations.

Transgressive forms were observed in all five combinations on different traits with a frequency of 6% to 8% and a transgression degree of 6 to 17%. In the combination Kharkivska 26 / 68.112 / Ward // *Ae.squarrosa* (369) such plants are found on five traits: plant height and parameters of the main ear – length, number of spikelets and grains, grain weight. The presence of transgressions indicates an increase in the level of these traits in soft wheat.

У гібридів з синтетиками IU13931 (D67.2/P66.270//*Ae.tauschii* (217)), IU13933 (D67.2/P66.270//*Ae.squarrosa* (218)), IU13937 (Dverd_2/*Ae.squarrosa* (221)), IU13974 (D67.2/P66.270// Ae.*squarrosa* (257)) домінував важкий вимолот зернівок. Розщеплення за цією ознакою у гібридів за участі синтетиків відповідає моногенній схемі з неповним домінуванням важкого вимолоту. У гібридів за участі IU13948 (68.112/Ward//*Ae.squarrosa* (369)) домінував середній вимолот, розщеплення відповідало схемі повного домінування.

Для підвищення рівня прояву у ліній пшениці м´якої ярої маси 1000 зерен доцільно використовувати для гібридизації синтетики IU13931 та IU13974; маси зерна з колосу та кількості зерен з колосу – IU13933 та IU13948.

In hybrids with the synthetics IU13931 (D67.2 / P66.270 // *Ae.tauschii* (217)), IU13933 (D67.2 / P66.270 // *Ae.squarrosa* (218)), IU13937 (Dverd_2 / *Ae.squarrosa* (221)), IU13974 (D67.2 / P66.270 // *Ae.squarrosa* (257)), difficult threshability was dominated. Segregation on this trait in the hybrids corresponds to a monogenic scheme with incomplete dominance of difficult threshability. In the hybrids with participation of IU13948 (68.112 / Ward // *Ae.squarrosa* (369)), medium threshability completely dominated, the segregation corresponded to the monogenic scheme.

To increase the manifestation level of 1000 grains weight in bread spring wheat lines, hybridization with the synthetics IU13931 and IU13974 should be used; to increase grain weight per ear and grain number per ear – IU13933 and IU13948.

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Докукіна К. І., Богуславський Р. Л.
Інститут рослинництва ім. В. Я. Юр'єва НААН
Національний центр генетичних ресурсів рослин України
Московський просп., 142, Харків, 61060, Україна
E-mail: ncpgru@gmail.com

УСПАДКУВАННЯ ОЗНАК У ГІБРИДІВ ПШЕНИЦІ М'ЯКОЇ З СИНТЕТИКАМИ ГЕНОМНОЇ СТРУКТУРИ *ABD*

Мета. Встановити успадкування морфологічних ознак і елементів продуктивності в ранніх поколіннях гібридів *Triticum aestivum* L. з амфідиплоїдами-синтетиками геномної структури *ABD* (*T. durum* Desf.-*Aegilops tauschii* Coss.).

Результати та обговорення. Вивчали гібриди, материнською формою яких служила пшениця м'яка яра Харківська 26, а батьківською формою — синтетики. Використання амфідиплоїдів у схрещуваннях дозволяє поліпшити генетичну основу господарсько-цінних ознак пшениці м'якої шляхом интрогресії від пшениці твердої та егілопсу. Дано характеристику F_1 і F_2 гібридів за морфологічними ознаками, елементами продуктивності, важкістю вимолоту зерна; визначено ступінь домінування ознак, їх успадковуваність. Рівень прояву висоти рослин, елементів продуктивності колосу батьківських синтетиків нижче, ніж у материнського сорту Харківська 26. У гібридів F_1 спостерігалося слабке домінування ознак пшениці в 16 випадках, середнє — у восьит, сильне — у чотирьох і наддомінування пшениці — у двох випадках. Коефіцієнти успадковуваності ознак в широкому сенсі (H_2) були високими у більшості випадків (25 з 30), проте коефіцієнти успадковуваності у вузькому сенсі (h_2) за всіма ознаками значно менше, що свідчить про переважання епістатичного ефекту генів і доцільності відборів у більш пізніх поколіннях. У гібридів за участі синтетиків IU13931 і IU13937 відбір за масою зерна з колосу краще проводити в ранніх поколіннях. Виділено трансгресивні форми типу пшениці м'якої, що перевищують за рівнем прояву ознак пшеничну батьківську форму. У гібридів з синтетиками D67.2 / P66.270 // *Ae.squarrosa* (217), D67.2 / P66.270 // *Ae.squarrosa* (218), Dverd_2 / *Ae.squarrosa* (221), D67.2 / P66.270 // *Ae.squarrosa* (257) домінує важкий вимолот, і розщеплення відповідає моногенній схемі з неповним домінуванням. У гібридів з синтетиком 68.112 / Ward // *Ae.squarrosa* (369) середній ступінь вимолочуваності домінував над легкістю вимолоту пшениці м'якої, і розщеплення відповідає моногенній схемі. Для підвищення рівня прояви у ліній пшениці м'якої ярої маси 1000 зерен доцільно використовувати для гібридизації синтетики D67.2 / P66.270 // *Ae.tauschii* (217) і D67.2 / P66.270 // *Ae.squarrosa* (257); маси зерна з колоса і кількості зерен в колосі – Dverd_2 / *Ae.squarrosa* (221) і 68.112 / Ward // *Ae.squarrosa* (369).

Висновки. У гібридів пшениці м'якої з синтетиками геномної структури *ABD* домінують морфологічні ознаки пшениці і важкий вимолот зерна синтетиків. У потомстві цих гібридів доцільно проводити відбори в більш пізніх поколіннях. У всіх комбінаціях виділено трансгресивні форми зі ступенем трансгресії від 6 до 17 %, що свідчить про можливість поліпшення пшениці м'якої за ознаками продуктивності.

Ключові слова: *пшениця, синтетики, гібриди, морфологічні ознаки, елементи продуктивності, домінування, успадковуваність.*

Докукина К. И., Богуславский Р. Л.
Институт растениеводства им. В.Я. Юрьева НААН, Украина
Национальный центр генетических ресурсов растений Украины
Московский просп., 142, Харьков, 61060, Украина
E-mail:ncpgru@gmail.com

НАСЛЕДОВАНИЕ ПРИЗНАКОВ У ГИБРИДОВ ПШЕНИЦЫ МЯГКОЙ С СИНТЕТИКАМИ ГЕНОМНОЙ СТРУКТУРЫ *ABD*

Цель. Установить наследование морфологических признаков и элементов продуктивности в ранних поколениях гибридов *Triticum aestivum* L. с амфидиплоидами-синтетиками геномной структури *ABD (T. durum* Desf.- *Aegilops tauschii* Coss.).

Результаты и обсуждение. Изучали гибриды, материнской формой которых служила пшеница мягкая яровая Харьковская 26, а отцовской формой — синтетики. Использование амфидиплоидов в скрещиваниях позволяет улучшить генетическую основу хозяйственно-ценных признаков мягкой пшеницы путем интрогрессии от пшеницы твердой и эгилопса. Дана характеристика F_1 и F_2 гибридов по морфологическим признакам, элементам продуктивности, трудности вымолота зерна; определены степень доминирования признаков, их наследуемость. Уровень проявления высоты растений, элементов продуктивности колоса у родительских синтетиков ниже, чем у материнского сорта Харьковская 26. У гибридов F_1 наблюдалось слабое доминирование признаков пшеницы в 16 случаях, среднее — в восьит, сильное – в четырех и сверхдоминирование пшеницы — в двух случаях. Коэффициенты наследуемости признаков в широком смысле (H^2) были высокими в большинстве случаев (25 из 30), однако коэффициенты наследуемости в узком смысле (h^2) по всем признакам значительно меньше, что говорит о преобладании эпистатического эффекта генов и целесообразности отборов в более поздних поколениях. У гибридов с участием синтетиков IU13931 и IU13937 отбор по массе зерна с колоса лучше проводить в ранних поколениях. Выделены трансгрессивные формы типа мягкой пшеницы, превышающие по уровню проявления признаков пшеничный родитель. У гибридов с синтетиками D67.2/P66.270//*Ae.squarrosa* (217), D67.2/P66.270//*Ae.squarrosa* (218), Dverd_2/*Ae.squarrosa* (221), D67.2/P66.270// *Ae.squarrosa* (257) доминирует трудный вымолот, и расщепление соответствует моногенной схеме с неполным доминированием. У гибридов с синтетиком 68.112/Ward//*Ae.squarrosa* (369) средняя степень вымолачиваемости доминировала над легкостью вымолота мягкой пшеницы, и расщепление соответствует моногенной схеме. Для повышения уровня проявления у линий пшеницы мягкой яровой массы 1000 зерен целесообразно использовать для гибридизации синтетики D67.2/P66.270//*Ae.tauschii* (217) и D67.2/P66.270// *Ae.squarrosa* (257); массы зерна с колоса и количества зерен в колосе – Dverd_2/*Ae.squarrosa* (221) и 68.112/Ward//*Ae.squarrosa* (369).

Выводы. В гибридах мягкой пшеницы с синтетиками геномной структуры *ABD* доминируют морфологические признаки пшеницы и трудность вымолота зерна синтетиков. В потомстве этих гибридов целесообразно проводить отборы в более поздних поколениях. Во всех комбинациях выделены трансгресивные формы со степенью трансгресии от 6 до 17 %, что говорит о воможности улучшения пшеницы мягкой по признакам продуктивности.

Ключевые слова*: пшеница, синтетики, гибриды, морфологические признаки, элементы продуктивности, доминирование, наследуемость.*