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SPRING SOFT WHEAT HYBRIDS INHERITANCE OF QUANTITATIVE CHARACTERISTICS

Zotova L.P., *PhD, Senior Lecturer*
Jatayev S. A.,*Candidate of Sciences in Biology, Senior Lecturer*
Shamambayeva N. Y.*, Master Student*
S.Seifullin Kazakh Agro Technical University, Kazakhstan 010011, Nur-Sultan Zhenis avenue, 62, lupezo_83@mail.ru

Abstract

The article presents the results of research on the selection of spring wheat in the conditions of Northern Kazakhstan. Field trials have been carried out and an assessment has been made for the F_1 and F_2 generation hybrids obtained by crossing. Evaluation was carried out on 29 hybrid combinations, the parental forms of which were local varieties allowed for cultivation and foreign genotypes.The quantitative assessment included indicators of productive bushiness, graininess, grain weight per ear and 1000 seeds weight.Selection based on genetic information was carried out using the KATU W-51 marker developed for the *TaDr1* gene of a transcription repressor involved in the adaptation mechanism in response to drought. The most successful hybrid combinations of interest in terms of drought tolerance and productivity in contrasting moisture conditions in Northern Kazakhstan have been identified.These hybrids were distinguished by over-dominance and positive transgression over the parental forms when inheriting traits. The combinations ♀H749-4×♂Akmola 2, ♀Br.Line-Z2×♂Saratovskaya 60, ♀Br.Line-Z2 × ♂Karagandinskaya 31, ♀Altayskaya zhnitsa × ♂Br.line Z2, ♀MMF177 × ♂Altayskaya zhnitsa were identified as the best F_1 hybrids in terms of the degree of dominance over parental forms. Hybrids F_2♀ Karabalykskaya 92 × ♂Br.Line - S27, ♀Karagandinskaya 70 × ♂Line-20 were distinguished by positive transgression for a weakly inherited trait of productive bushiness. According to the indicator of the mass of 1000 seeds positive transgression was shown by the combinations ♀Shortandinskaya 95 × ♂Omskaya 30, ♀Karabalykskaya 92 × ♂Br.Line-S27, ♀Akmola 2 × ♂Omskaya 30, ♀Aktyubinka × ♂H1142, ♀Erythrospermum × ♂Br.Line-S45. As a result of genotyping, hybrids were identified that showed good division into alleles: Tertsiya× Br.Line-Z3, Karabalykskaya92 × Br.Line-S27, Shortandinskaya 95 ul. × Br.Line-F45, Shortandinskaya 95ul. × H1142-1.

Key words: Breeding, spring wheat, gene, hybrid, drought, over-dominance, transgressive splitting, genotyping, selection

Introduction

The creation of unique source material correlates as much as possible

with the correct selection of parental pairs to involve them in hybridization. Now in the world of breeding, the problem of genetic similarity of varieties is being solved. One of the most effective approaches to solving this problem is the expansion of genetic diversity through the use of geographically distant material [1].

As a result, the goal of plant breeding is reduced to collecting more desirable combinations of genes in one genotype.

At the present stage, according to the experience of leading scientists from foreign countries, in plant breeding, an effective method for selection is marker assisted selection, in which the trait that interests the researcher is selected on the basis of a marker associated with the gene of interest [2].

The success of the intervarietal hybridization used in this case is directly related to the combining ability and the effect of heterosis of the hybrids obtained as a result of crossing. Due to the recombination of the dominant genes of the parental forms inherited by the first generation hybrids, the indicators of valuable economic traits increase in the new starting material [3].

The inheritance of traits in the F_1 generation or the effect of heterosis is traced using hybridological analysis and calculating the dominance or depression of hybrids relative to the parental forms. In this case, the main investigated features should be easily identifiable indicators of the productivity of the culture [4].

This article presents the results of the main elements of productivity of the F_1 and F_2 generation obtained as a result of hybridization with genotypes of distant geographic origin, and the indicators of inheritance of traits from their parental forms are calculated.

As a result, based on the results of field trials and genetic studies at an early stage of the breeding process, it is possible to select the most successful hybrid combinations.

Materials and research methods

The study of the source material was carried out in the direction of resistance to a lack of moisture and the formation of economic characteristics due to the biological potential of the variety, line and hybrid.

Structural analysis and biometrics of plants were carried out according to the following quantitative characteristics: plant height; productive bushiness; ear length; grains number per ear; the mass of grains from the ear; weight per plant, weight 1000 seeds.

The inheritance of traits in its phenotypic manifestation in F_1 hybrids was calculated using the formula of A. Gustafsson and I. Dormling [5]. The degree of transgressive splitting in F_2 hybrids was determined by the method of G.S. Voskresenskaya, V.I. Shpot [6]. DNA extraction was carried out by the method of phenol-chloroform extraction with the changes introduced [7,8].

A specially developed SNP Amplifluor marker KATU-W51, specific for the analysis of the *TaDr1* gene, involved in the adaptation mechanism of wheat plants in response to drought, was used for the work.

TaDr1 is a transcriptional repressor originally found and

described in *Arabidopsis thaliana*. The function of a gene is to inhibit the expression of other genes. In other words, the *TaDr1* gene can block the production and inactivate the work of proteins produced by other genes, which are no longer required by the plant or may lead to negative consequences. Depending on the state, plants regulate the activity of the *TaDr1* gene, increasing or decreasing its activity [9].

Table 1 - Characteristics of F_1 hybrids of spring wheat and parental forms by the main elements of productivity, 2018-2019

Hybridcombination	Productive bushiness, piece			D, %	Ear graininess, piece			D, %	1000 grains weight, g			D, %
	♀	♂	F1		♀	♂	F1		♀	♂	F1	
1	2	3	4	5	6	7	8	9	10	11	12	13
♀Shortandinskaya 95ul. ×♂Omskaya 30	1.4	1.8	1.4	CDL	24	28	25	PDL	39	38	41	OD
♀Shortandinskaya95ul. ×♂Br.Line-F45	1.4	2.1	1.4	CDL	24	35	37	OD	39	37	40	OD
♀Karabalykskaya92 ×♂Br.Line-S27	1.4	1.5	1.4	CDL	32	30	34	OD	36	30	38	OD
♀Akmola 2 × ♂Omskaya 30	1.5	1.8	1.7	PDG	23	28	29	OD	36	38	38	OD
♀Aktyubinka × ♂ H1142	1.5	2.2	1.4	D	29	24	26	PDL	36	21	28	PDL
♀Tertsiya × ♂Br.Line-Z3	1.7	1.8	1.8	CDG	27	25	27	IDG	37	40	41	OD
♀Karagandinskaya 70×♂ Line-20	1.4	1.9	1.8	IDG	35	23	30	PDG	33	38	39	OD
♀Erythrosper 81-09 × ♂ Br.Line-S45	1.2	1.7	1.5	PDG	43	22	31	PDL	33	31	38	OD
♀Jans× ♂Akmola 2	3.0	1.3	1.3	CDL	30	25	28	PDG	29	33	35	OD
♀H749-4×♂Akmola2	2.6	1.3	2.0	PDG	23	20	26	OD	31	33	34	OD
♀EGA Bonnie Rock× ♂Erythrospermum81-09	1.6	1.6	1.7	CDL	13	20	22	OD	28	31	31	OD
♀Shortandinskaya95ul. ×♂H 749-4	1.3	2.6	1.5	IDL	21	23	27	OD	35	31	33	PDG

♀Karabalykskaya 25× ♂Gladius	1.2	1.2	1.3	CDL	21	16	25	OD	32	31	36	OD
♀Br.Line-Z2× ♂Saratovskaya 60	1.2	1.4	1.5	OD	21	17	25	OD	36	32	37	OD
♀Br.Line-Z2× ♂Karagandinskaya 31	1.2	1.3	1.3	CDG	21	22	22	IDG	36	35	37	OD
♀Br.Line-Z2× ♂Karabalykskaya 90	1.2	2.0	1.3	IDL	21	20	23	OD	36	30	38	OD
♀Gladius× ♂Aktyubinka	1.2	2.4	1.3	IDL	16	26	26	IDG	31	32	32	IDG
♀Gladius× ♂Altayskaya 60	1.2	1.5	1.3	PDL	16	22	22	OD	31	32	32	OD
♀Spitfire× ♂Altayskaya 60	2.0	1.5	1.5	CDL	23	22	22	IDL	31	32	33	OD
♀Altayskaya zhnitsa×♂Br.Line-Z2	2.0	1.2	1.8	PDG	25	21	26	OD	35	36	38	OD
♀Karabalykskaya 90×♂VIR 16015	2.0	2.4	2.1	IDL	20	18	22	OD	30	34	35	OD
♀Karagandinskaya 31×♂VIR 16015	1.3	2.4	1.7	PDL	22	18	24	OD	35	35	34	D
♀Astana × ♂H749-4	1.6	2.6	1.6	CDL	20	23	24	OD	33	31	36	OD
♀Erythrospermum 35×♂Br.Line-Z2	1.6	1.2	1.5	PDG	17	21	24	OD	43	36	37	IDL
♀RAC1221× ♂Albidum 188	1.8	1.2	1.3	IDL	16	18	23	OD	31	32	32	OD
♀Jans ×♂Ekada113	3.0	1.6	1.8	IDL	30	20	26	PDG	29	32	32	OD
♀MMF177× ♂Altayskaya zhnitsa	1.2	2.0	1.8	PDG	26	25	26	OD	24	35	35	OD

Notes:

1 D – degree of dominance, %;

2 D> 100% - OD-over-dominance;

3 D=100% CDG - complete dominance of the parent's trait with a greaterexpression of the trait;

4 D= от 76 до 99% IDG -incomplete dominance of the parent with a greater expression of the trait;

5 D = от 51 до 75% PDG - partial dominance of the parent with a greater expression of the trait;

6 D=от 0 до 25% IDL - incomplete dominance of the parent with less expressed trait;

7 D = 0% CDL - complete dominance of the parent with less expressed trait;

8 D < 0% D – depression.

The meteorological conditions of 2019 were characterized by a sharp lack of moisture during the grain filling period (hydrothermal coefficient-0.1), therefore, the obtained productivity indicators more accurately reflect the actual potential of the hybrid for breeding for drought tolerance.

Discussion of the obtained data and conclusion

So, the most valuable are F_1 hybrids, in which the inheritance of traits with over-dominance over the parental forms is observed. Of the 8 hybrids obtained in 2017, a weak character of the inheritance of productivity traits was revealed in the combination Aktyubinka × H1142, in the remaining hybrids over-dominance in the weight of 1000 seeds is observed.

In the generation of F_1 hybrids crossed in 2018, the combinations ♀H749-4 × ♂Akmola 2, ♀Br.Line-Z2 × ♂Saratovskaya 60, ♀Br.Line-Z2 × ♂Karagandinskaya 31,♀Altayskaya zhnitsa× ♂Br.Line-Z2, ♀MMF 177 × ♂Altayskaya zhnitsa can be distinguished as the best in terms of the degree of dominance over the parental forms. These hybrids, with the exception of incomplete dominance in the combination ♀Br.Line-Z2 × ♂Karagandinskaya 31, showed 100% over-dominance in the mass of 1000 grains and the number of grains per ear (table 1).

In the 2019 spring wheat hybrid nursery, 8 hybrids of the F_2 generation were tested (table 2). In breeding for drought tolerance, productivity indicators under the influence of drought are of great importance. According to the results of the correlation analysis of F_2 hybrids, a weak correlation was revealed with such indicators as the weight of grain per ear (R 0.21) and the weight of 1000 seeds (R 0.41). A high value of grain weight per ear (1.37 g) is observed in hybrids (♀Karagandinskaya 70 × ♂Line-20), (♀Shortandinskaya 95 × ♂Br.Line-F45). A hybrid combination (♀Shortandinskaya 95 × ♂Omskaya 30) was distinguished by its coarse grain size (37.9 g) under drought conditions.

Table 2 - Characteristics of F_2 spring wheat hybrids and parental forms by yield and productivity elements, 2019

Number (code) of hybridcombination	Parent,hybrid	Plants number, pc/m^2	Productive bushiness, pc	Grains number per plant, pc	Grain harvest per plant, g	Ear length, cm	Grains number per ear,pc	Grain weight per ear, g	1000 seeds weight,g	Grain harvest per plot, g/m^2
1	2	3	4	5	6	7	8	9	10	11
1	Shortandinskaya 95	200	1.3	27.7	1.28	8.9	21.2	1.01	34.7	257.7
	♀Shortandinskaya 95 × ♂Omskaya 30	276	1.2	26.6	1.24	9.2	22.2	1.03	37.9	292.1
	Omskaya 30	228	2.0	36.2	1.40	9.6	18.1	0.89	32.1	218.7

3	Shortandinskaya 95	200	1.3	27.7	1.28	8.9	21.2	1.01	34.7	257.7
	♀Shortandinskaya95× ♂Br.Line–F45	210	1.2	35.5	1.60	8.8	29.6	1.37	33.8	308.2
	Br. line-F45	123	1.8	49.5	1.70	9.0	27.5	1.04	30.1	128.3
5	Karabalykskaya 92	167	1.2	19.8	0.86	8.8	16.5	0.73	32.8	239.5
	♀Karabalykskaya 92× ♂Br.Line-S27	166	2.4	60.5	1.97	11.0	25.2	1.06	33.6	243.3
	Br.Line-S27	193	1.2	17.7	0.57	6.6	14.7	0.54	27.8	228.0
6	Akmola 2	190	1.3	26.0	0.94	8.8	20.3	0.79	33.0	234.1
	♀Akmola 2 ×♂Omskaya 30	157	1.6	32.0	1.18	8.2	20.0	0.94	34.4	228.6
	Omskaya 30	228	2.0	36.2	1.40	9.6	18.1	0.89	32.1	218.7
10	Aktyubinka	146	2.4	63.4	2.05	9.6	26.4	1.14	32.4	275.5
	♀Aktyubinka ×♂ H1142	168	1.0	21.0	0.90	8.8	21.0	0.90	35.1	200.7
	H1142	203	1.6	43.5	0.83	9.0	27.2	0.78	25.4	182.8
13	Tertsiya	158	2.2	50.0	1.58	7.6	22.7	0.96	32.6	288.0
	♀Tertsiya × ♂Br.Line-Z3	162	1.8	40.7	1.72	7.2	22.6	1.02	31.2	249.3
	Br.line-Z3	203	1.0	19.5	0.97	7.0	19.5	0.97	34.7	170.5
16	Karagandinskaya 70	186	1.6	33.0	0.88	7.8	20.6	0.75	30.7	269.4
	♀Karagandinskaya70 × ♂ Line-20	122	1.8	52.2	2.61	9.4	29.0	1.37	20.7	210.0
	Line-20	181	1.2	25.9	0.88	9.0	21.6	0.81	27.8	180.1
20	Erythrospermum 81-09	220	1.6	25.6	1.32	6.2	20.0	0.87	30.6	230.7
	♀Erythrosper × ♂ Br. Line-S45	155	1.6	36.8	1.58	7.8	23.0	0.96	33.4	331.4
	Br.Line-S45	177	2.4	37.2	1.27	7.2	19.4	0.66	31.4	238.5
	R (correlation)	0.18	0.12	0.08	0.19	0.01	0.05	0.21	0.41	

For the splitting generation F_2, the values of transgression for the main elements of productivity are important in selection.

The index of transgressive splitting indicates the action of genes, leading to an increase or decrease in the manifestation of a trait or characteristic of hybrids. Thus, transgressive forms selected in the F_2 generation are of great importance in breeding for productivity [10].

As a result of studying the transgressive splitting of F_2 hybrids, various manifestations of the inheritance of valuable economic traits were revealed. In terms of productive bushiness, the degree of transgression ranged from -40 to + 100%.

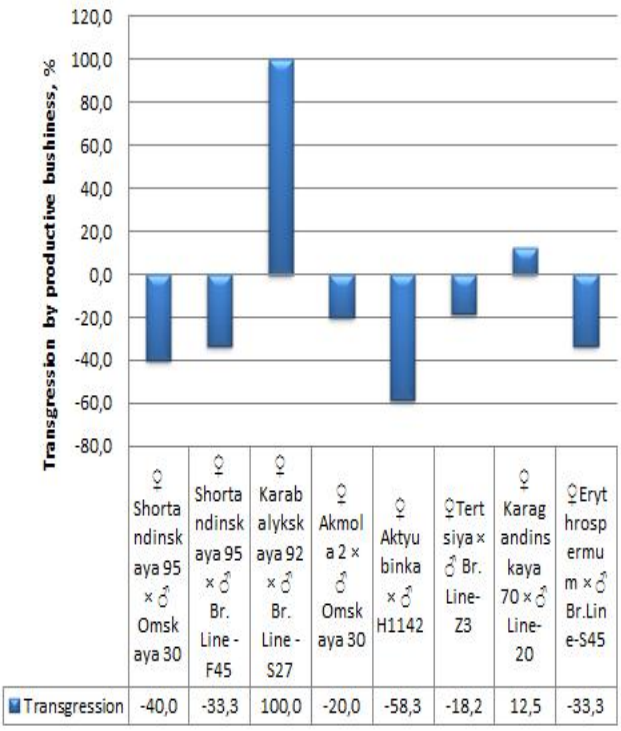
In this case, only two combinations of F_2 hybrids showed positive transgression. The positive transgression of ♀Karagandinskaya 70 × ♂Line-20 combination over the parental forms is 12.5%. The highest values of transgressive

splitting were observed in the hybrid ♀Karabalykskaya 92 × ♂Br.Line-S27. The remaining 6 combinations of hybrids of the F_2 generation showed negative transgression in productive bushiness and, therefore, poor inheritance of this trait (figure 1a).

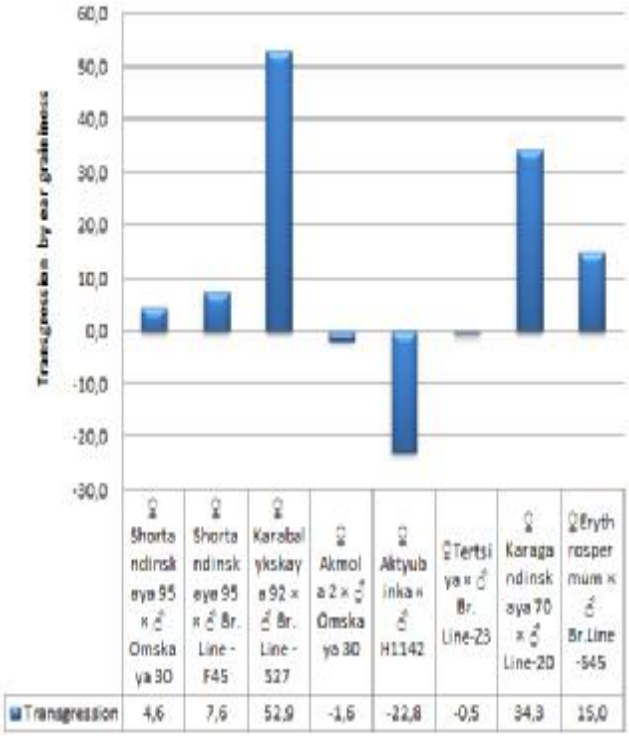
The transgression in terms of grain content and grain weight per ear was almost identical in all combinations. In both cases, a negative transgression was shown by the combination ♀Aktyubinka × ♂H1142.

Merely in the graph of the splitting of the transgression by the grain content of the ear, the maximum value is observed in the hybrid ♀Karabalykskaya 92 × ♂Br. Line-S27, the transgression was 52.9%, and in terms of grain weight per ear, this position is occupied by the combination ♀Karagandinskaya 70 × ♂ Line-20 with a transgression of 69.3% (figure 1 b, c).

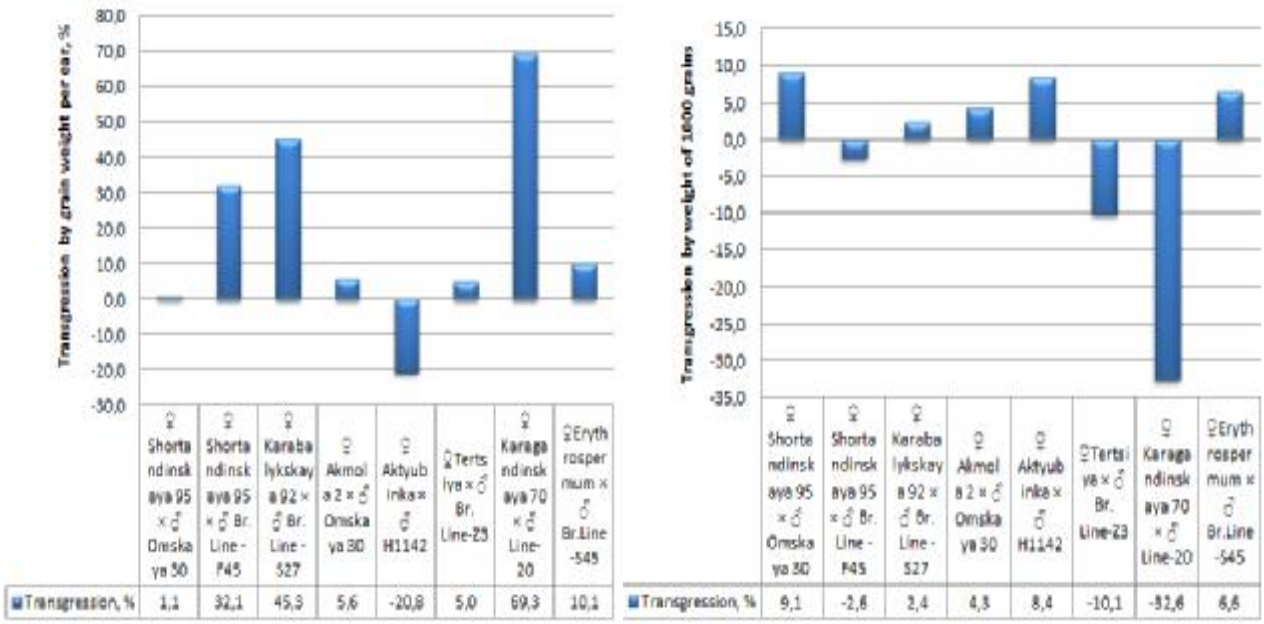
A positive transgression in the mass of 1000 seeds (2.4-9.1%) was shown by the combinations ♀Shortandinskaya 95 × ♂Omskaya 30, ♀Karabalykskaya 92 × ♂Br.Line-S27, ♀Akmola 2 × ♂Omskaya 30, ♀Aktyubinka × ♂H1142, ♀Erythrospermum × ♂ Br.Line-S45 (figure 1 d).



a



b



c d

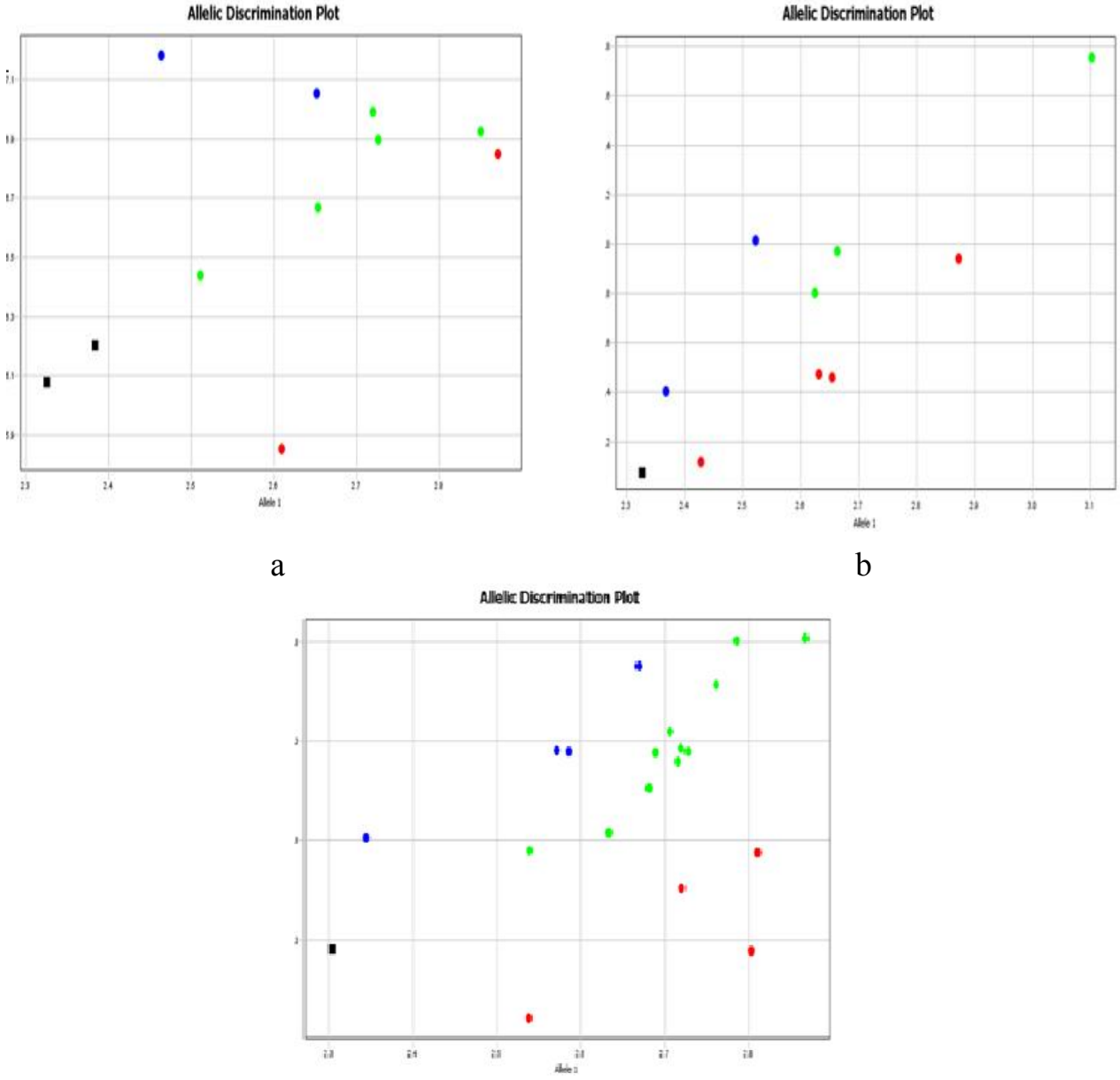
a - Transgression by productive bushiness; b - transgression by ear graininess; c –transgression by grain weight per ear; d -transgression by weight of 1000 grains

Figure 1 - Transgressive splitting of F_2 generation spring wheat hybrids

Hybrids (♀Shortandinskaya 95ul. × ♂Omskaya 30) and (♀Aktyubinka × ♂ H1142) managed to exceed the best parent in terms of the mass of 1000 seeds, Shortandinskaya 95 ul., the degree of transgression was 9.1% and 8.4%, respectively (figure 1d).

The developed marker KATU W-51 was used to screen hybrids by genotype, based on the *TaDr1* gene.

The KATU W-51 marker was used to screen hybrids of the F_2 generation. Genotyping showed good separation in the Tertsiya × Br.Line-Z3, Karabalykskaya 92 × Br.Line-S27, Shortandinskaya 95 ul. × Br.Line-F45,Shortandinskaya 95 × H1142-1 (figure 2).



a - hybrid Tertsiya × Br.Line-Z3; b - hybrid Karabalykskaya 92 × Br.Line-S27; c - ; d - hybrids Shortandinskaya 95 st. × Br. Line-F45, Shortandinskaya 95 × H1142-1

Figure 2 - The results of genotyping F_2 hybrids by the KATU W-51 marker

Note - Homozygous samples 'aa' and 'bb' are marked in red and blue color. Heterozygous 'ab' plants are indicated in green. Control is sterile water instead of DNA, indicated as a black square.

As a result of genotyping of F_2 hybrids, homozygous samples were selected by the KATU W-51 marker, indicated in the figure with blue and red dots, for study at the next stage of the breeding process.

As a result, with the help of hybridological, selection-genetic analysis and molecular screening, it was possible to identify the most successful hybrid, Karabalykskaya 92 × Br.Line-S27, with the positive transgression in terms by key

performance indicators (figures 1 and 2).

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НАСЛЕДОВАНИЕ КОЛИЧЕСТВЕННЫХ ПРИЗНАКОВ ГИБРИДОВ ЯРОВОЙ МЯГКОЙ ПШЕНИЦЫ

Зотова Л.П.,PhD, ст. преподаватель
Джатаев С.А., к.б.н., ст. преподаватель
. Шамамбаева Н.Е, магистрант

Казахский агротехнический университет им. С.Сейфуллина, проспект Жеңіс, 62, г. Нур-Султан, 010011, Казахстан, lupezo_83@mail.ru

Резюме

На основе полевых испытаний, анализа наследования количественных признаков и молекулярно-генетического скрининга выделены наиболее удачные гибридные комбинации. В качестве лучших по степени доминирования над родительскими формами выделены комбинации♀Акмола 2 ×♂Омская 30, ♀Н 749-4× ♂Акмола 2, ♀Br.LineZ2 × ♂Саратовская 60, ♀Br.LineZ2× ♂Карагандинская 31,♀Алтайская жница × ♂Br.LineZ2, ♀MMF 177 × ♂Алтайская жница. У данных гибридов, за исключением неполного доминирования у комбинации ♀Br.Line-Z2 × ♂Карагандинская 31, проявлено 100% сверхдоминирование по массе 1000 зерен и количеству зерен в колосе над родительскими формами.

В результате изучения трансгрессивного расщепления, выявлены гибриды F_2: ♀Карагандинская 70 × ♂ Line-20, ♀Шортандинская 95 × ♂Омская 30.

Положительную трансгрессию по слабо наследуемому показателю продуктивной кустистости проявили две комбинации гибридов F_2: у комбинации ♀Карагандинская 70 × ♂ Line-20 положительная трансгрессия над родительскими формами составила 12,5%, у гибрида ♀Карабалыкская 92 × ♂Br.Line-S27 100%.Слабый характер наследования признаков продуктивности выявлен у комбинации Актюбинка × Н1142.

Трансгрессивное расщепление по показателям озерненности и массы зерна с колоса проходило практически идентично во всех комбинациях. Наиболее удачными гибридными комбинациями в обоих случаях оказались ♀Карабалыкская 92 × ♂Br.Line-S27 с более высокой трансгрессией по озерненности колоса (52,9%), и ♀Карагандинская 70 × ♂Line-20 с трансгрессией по массе зерна с колоса в 69,3%.

В результате скрининга по маркеру KATU W-51, разработанному для гена *TaDr1*, выделены комбинации Терция × Br.Line-Z3, Шортандинская 95 ул. × Br.Line-F45, Шортандинская 95 × Н1142-1.

В ходе комплексного отбора с помощью гибридологического, селекционно-генетического анализа и молекулярного скрининга удалось выявить наиболее удачный гибрид ♀Карабалыкская 92 × ♂Br. Line-S27 с положительной трансгрессией по основным показателям продуктивности.

Ключевые слова: Селекция, яровая пшеница, ген, гибрид, засуха, сверхдоминирование, трансгрессивное расщепление, генотипирование, отбор.

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Л.П. Зотова,PhD, аға оқытушы
С.А. Джатаев, б.ғ.к., аға оқытушы
Н.Е. Шамамбаева, магистрант

С. Сейфуллин атындағы Қазақ агротехникалық университеті, Жеңіс даңғылы, 62 үй, Нұр-Сұлтан қ., 010011, Қазақстан, lupezo_83@mail.ru

Түйін

Танаптық сынақтар, сандық белгілердің тұқымқуалау талдауы және молекулалық-генетикалық скрининг негізінде ең жақсы гибридті комбинациялары анықталды.

Ата-аналық формалардан басымдылық дәрежесі бойынша ең үздік комбинациялар ретінде ♀Акмола 2 × ♂Омская 30, ♀H749-4 × ♂Акмола 2, ♀Br.Line-Z2 × ♂Саратовская 60, ♀Br.Line-Z2 × ♂Карагандинская 31,♀Алтайская жница × ♂Br.Line-Z2, ♀MMF177 × ♂Алтайская жница бөлініп алынды. Берілген гибридтерде, яғни ♀Br.Line-Z2 × ♂Карагандинская 31 комбинациясындағы толық емес басымдылықты қоспағанда, 1000 тұқым массасы және масақтағы дән саны бойынша ата-аналық формалардан 100% аса басымдылық байқалды.

Трансгрессивті бөлінуді зерттеу нәтижесінде F_2 гибридтері анықталды: Карагандинская 70 × Line-20, Шортандинская 95 × Омская 30.

F_2 гибридтерінің екі комбинациясы өнімді түптену көрсеткіші бойынша нашар тұқым қуашылықтың оң трансгрессиясын көрсетті: Карагандинская 70 × ♂ Line-20 комбинациясында ата-аналық формаларға қарағанда оң трансгрессия 12,5%, Карабалыкская 92 × Br.Line-S27 - 100%. Актюбинка × H1142 комбинациясында өнімділік белгілерінің тұқым қуалаушылығы әлсіз белгісі анықталды.

Дәнділік пен масақ дәнінің массасы бойынша трансгрессивті бөліну барлық комбинацияларда бірдей болды.Екі жағдайда да ең сәтті гибридті комбинациялар♀Карабалыкская 92 × ♂Br.Line-S27дәнділік бойынша көбірек трансгрессиясы (52,9%) мен ♀Карагандинская 70 × ♂ Line-20 масақтағы дән массасы бойынша трансгрессиясы болып табылды.

*TaDr1*геніне арналған KATU W-51 маркері бойынша скрининг нәтижесінде Терция × Br.Line-Z3, Шортандинская 95 ул. × Br.Line-F45, Шортандинская 95 × H1142-1 комбинациялар ерекшеленді.

Гибридологиялық, селекциялық-генетикалық анализді және молекулалық скринингті қолдану арқылы кешенді іріктеу барысында өнімділіктің негізгі көрсеткіштері бойынша оң трансгрессиясы бар ең үздік гибридті♀Карабалыкская 92 × ♂Br. Line-S27 анықтауға мүмкіндік берді.

Кілттік сөздер: Селекция, жаздық бидай, ген, гибрид, құрғақшылық, аса басымдылық, трансгрессивті бөліну, генотиптеу, іріктеу.

SPRING SOFT WHEAT HYBRIDS INHERITANCE OF QUANTITATIVE CHARACTERISTICS

L.P. Zotova, PhD, SeniorLecturer
S.A.Jatayev, Candidate of Biological Sciences, Senior Lecturer
N.Y. Shamambayeva, Master Student

S.Seifullin Kazakh Agro Technical University, Kazakhstan 010011, Nur-Sultan Zhenis avenue, 62, lupezo_83@mail.ru

Summary

On the basis of field trials, analysis of the inheritance of quantitative traits and molecular genetic screening, the most successful hybrid combinations have been identified.

The combinations ♀Akmola 2 ×♂Omskaya 30, ♀H749-4 × ♂Akmola 2, ♀Br.Line-Z2 × ♂Saratovskaya 60, ♀Br.Line-Z2 × ♂Karagandinskaya 31, ♀Altayskaya zhnitsa× ♂Br.line-Z2, ♀MMF177 × ♂Altayskaya zhnitsa were identified as the best F_1 hybrids in terms of the degree of dominance over parental forms.In these hybrids, with the exception of incomplete dominance in the combination ♀Br.Line-Z2 × ♂Karagandinskaya 31, 100% over-dominance in the mass of 1000 grains and the ear graininess over the parental forms was expressed.

As a result of the study of transgressive splitting, F_2 hybrids were identified: ♀Karagandinskaya 70 × ♂Line-20, ♀Shortandinskaya 95 × ♂Omskaya 30.

Two combinations of F_2 hybrids showed positive transgression in terms of a poorly inherited productive bushiness indicator: in the combination Karagandinskaya 70 × Line-20, the positive transgression over the parental forms was 12.5%, in the hybrid Karabalykskaya 92 × Br.Line-S27 - 100%. A weak inheritance of productivity traits was revealed in the combination Aktyubinka × H1142.

The transgressive splitting in terms of ear graininess and grain weight per ear was almost identical in all combinations. The most successful hybrid combinations in both cases were ♀Karabalykskaya 92 × ♂Br.Line-S27 with a higher transgression in ear graininess (52.9%), and ♀Karagandinskaya 70 × ♂Line-20 with transgression in grain weight per ear of 69.3%.

Combinations Tertsiya × Br.Line-Z3, Shortandinskaya 95 ul. × Br.Line-F45, Shortandinskaya 95 × H1142-1 were allocated as a result of screening using the KATU W-51 marker developed for the *TaDr1* gene.

In the process of complex selection with the help of hybridological, selection-genetic analysis and molecular screening, it was possible to identify the most successful hybrid - Karabalykskaya 92 × Br.Line-S27 with positive transgression in terms by key productivity indicators.

Keywords: Breeding, spring wheat, gene, hybrid, drought, over-dominance, transgressive splitting, genotyping, selection.

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