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WHEAT F_1 AND F_2 POPULATIONS ASSESSMENT FOR ECONOMIC TRAITS OBTAINED FROM THE LANDRACES GROWN IN DIVERSE ECOLOGICAL ZONES OF UZBEKISTAN

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SUMMARY

Wheat (*Triticum aestivum* L.) is an important staple food crop with agronomic significance and a leading crop in terms of area planted and production worldwide. Therefore, its sustainable production is crucial, requiring greater attention due to its increasing global consumption. The following study aimed to assess the genetic potential of the soft wheat F_1-F_2 populations for economic traits obtained through crossing valuable landraces grown in diverse ecological zones of Uzbekistan. Crossing eight wheat genotypes obtained four hybrids that underwent further evaluation along with their parental forms in 2021–2024 at the Chirchik State Pedagogical University, Tashkent, Uzbekistan. Among the parental genotypes, the recorded trait of average maximum spike length resulted in the wheat cultivar Khivit (11.8 ± 0.25 cm), followed by Kzyl-bugday (11.4 ± 0.48 cm) and Tyuya-tish (11.4 ± 0.27 cm). In the investigated F_1 hybrids, the spike length varied from 10.7 to 12.6 cm. However, nonsignificant differences were notable between the ancient local cultivars Tyuya-tish and Khivit for the average number of spikelets per spike. The highest number of spikelets per spike appeared in the cultivar Ak-bashak (18.7 ± 0.44). In F_2 populations, negative transgression was evident, expressed as a shift by 2–3 classes to the left.

Keywords: Wheat (*T. aestivum* L.) landraces, F_1 and F_2 hybrids, inheritance, genetic variability, coefficient of variation, spike length, spikelets, grains per spike, grain yield

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Key findings: Genetic analysis revealed grains per spike were dependent on the genetic potential of the wheat (*T. aestivum* L.) cultivars. The grains per spike occurred to be transmitted by the negative incomplete dominance. In F_2 populations, for grain weight per spike, the coefficient of variation was twice as high compared with the parental genotypes, indicating medium and high genetic variability.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most important cereal crops according to production and consumption worldwide. Wheat substantially contributes to food security, poverty reduction, raw materials for food industries, and employment generation for the local community. The national demand for wheat grains and their products is growing faster than other food crops. Soft wheat with high nutritional value is one of the main food crops and holds adaptability to various climatic conditions. Wheat ranks third after maize and rice in ensuring food security (Gupta *et al*., 2021).

Landraces are locally adapted and domesticated species offering genetic resources for agricultural challenges (Dwivedi *et al.,* 2016). Along with the crop's wild relatives, landraces also provide extensive genetic variation for traits like yield potential, stability, and nutritional quality, especially when experiencing stress conditions with climate change. Despite their potential in developing and improving modern cultivars, landraces and crops' wild relatives remain underutilized in modern breeding programs (Guzmán and Alvarez, 2021; Adhikari *et al.,* 2022).

Spike and grain traits unreliably distinguish among the quality types of many common wheat cultivars, such as animal feed versus milling to flour for the production of bread, cakes, and noodles, and for gluten–starch manufacture and motor fuel production. Around a century ago, flour millers had to accept nonsegregated common wheat grain as a commodity to serve the specific needs of various flour customers (Ruiz *et al*., 2002; Caballero *et al.*, 2010).

Heritability of various traits is an influential parameter for determining the magnitude of genetic variation and how much succeeded in transferring from generation to generation, obtained through breeding in crop plants. In wheat for grain yield and its contributing components, low, medium, and high degrees of heritability in a narrow sense have been reported (Toklu and Yagbasanlar, 2007). The selection and heritability studies established to analyze the patterns of variability of the traits, genotypic features of cultivars, as well as their interrelationships (Karshiyev *et al.,* 2013).

Determining the grain yield in hybrids evaluated the compatibility of the parental cultivars used in the crossing programs, which manifested by the appearance of the desired genes for various traits in subsequent generations (Topal *et al.,* 2004). Genetic potential is rarely evident in the phenotype of the parental genotypes, requiring its study through progeny analysis. If the parental genotypes produce the promising offspring, this eventually indicates the better compatibility with each other's crossing (Bao *et al.,* 2009).

The wheat landraces and cultivars in Uzbekistan are valuable genetic resources that can be desirable for use to develop new, promising cultivars enriched with nutritional microelements and other beneficial components essential for human health. As a result of the presented wheat research, for the first time, 31 local wheat landraces entailed preservation in their natural state in the remote regions of Uzbekistan (Buronov and Xamroev, 2022; Buronov *et al.,* 2023; Juraev *et al.,* 2024). The promising study aimed to evaluate the genetic potential of the soft wheat F_1-F_2 populations for economic traits obtained through crossing the crucial landraces grown in diverse regions of Uzbekistan.

MATERIALS AND METHODS

In the following study, eight soft spring wheat (*T. aestivum* L.) landraces, such as Surkhak, Kzyl-Shark, Tyuya-Tish, Khivit, Ak-bashak, Muslimka, Kzyl-bugday, and Pashmak, were specimens undergoing crossing to develop the four hybrids. The parental genotypes and their F_1 and F_2 populations attained evaluation in 2021–2024 at the Chirchik State Pedagogical University, Tashkent, Uzbekistan. Parental cultivars used became standard checks, which were planted on both sides of the F_1 and F_2 hybrids.

In hybridization works, castration proceeded according to the generally accepted method of V.Y. Yuryev and co-authors, and pollination was according to the Twell method developed at the International Maize and Wheat Improvement Center, or CIMMYT (Merezhko *et al*., 1973). The results obtained during the experiments underwent statistical processing according to the methodology of Dospekhov (1985). The indices for each trait sustained analysis of variance. The ratio of genotypic variance to total phenotypic variance, as an index of trait heritability (h^2), succeeded in its determination using the formula of Allard (1956).

RESULTS AND DISCUSSION

In wheat (*Triticum aestivum* L.), spike length is one of the most important and economically valuable traits. The inheritance of spike length was successful from the evaluation in the F_1 populations and their parental cultivars. Among the wheat parental cultivars, on average, the recorded highest spikelet length index resulted in the wheat cultivar Khivit (11.8 ± 0.25 cm), followed by the landraces Kzyl-bugday (11.4 ± 0.48 cm) and Tyuya-tish (11.4 ± 0.27 cm). In F_1 populations, spike length varied from 10.7 to 12.6 cm. Inheritance of spike length in the F_1 cross combinations, such as Surkhak × Kzyl-Shark (hp = 0.2) and Ak-bashak × Muslimka (hp = 0.8), had the control of positive incomplete dominance. However, in wheat F_1 hybrids Tyuya-tish × Khivit (hp = 3.0) and Kzyl-bugday × Pashmak (hp = 2.5), the spike length's inheritance was by complete dominance with a high index of the parental cultivars. During the selection of initial forms, along with the heritability of the studied traits, the process established to analyze the patterns of variability of economically valuable traits, genotypic features of the cultivars, as well as their interrelationships (Karshiyev *et al.,* 2013).

In the F_2 generation, by analyzing the variability of spike length in wheat cultivars and its inheritance, the results revealed parental genotypes Surkhak, Tyuya-Tish, Khivit, Ak-bashak, Muslimka, Kzyl-bugday, and Pashmak had their locations within three classes. Meanwhile, the cultivar Kzyl-Shark appeared within four classes. In the parental genotypes, the spike length was polymorphic, and variability ranged from 9 to 12.9 cm for all wheat cultivars. On analyzing this variability by class, it revealed spikes with 10–10.9 cm length were existing in all cultivars. In wheat cultivar Surkhak, 25.6% of plants had spikes with 10 to 10.9 cm of length, 30.4% had spikes with 11 to 11.9 cm, and 44% of plants had longer ears (12 to 12.9 cm) (Table 1). Moreover, the production of a wide range of regional products with higher nutritional value and suitability for processing resulted in different studies (Konvalina *et al.,* 2012).

In the wheat cultivar Kzyl-Shark, the spike length ranged from 9 to 9.9 cm, which constituted 11.4%. Spikes with lengths of 10 to 10.9 cm were 56.6%, and the average spike length was 10.3 ± 0.30 cm. In the cultivar Tyuya-tish, as well as in two other cultivars, Hivit and Kzyl-bugday, the average spike length was at par (11.5 ± 0.27, 11.8 ± 0.25, and 11.4 ± 0.48 cm, respectively). In the wheat cultivar Muslimka, the average spike length was 10.7 ± 0.2 cm. The lowest spike length resulted in the cultivar Ak-bashak (9.6 ± 0.22 cm), while 60.5% of plants had the spike length of 9 to 9.9 cm. For cultivar Pashmak, the average spike length was 9.9 ± 0.18 cm, while 55% of plants had spike lengths of 10–10.9 cm.

In the F_2 generation, the expanded range of variability in the spike length displayed an association with the wheat genotypes. Hybrids of the cultivars Surkhak

Table 1. Genetic variability and inheritance in wheat F_2 populations for spike length.

Parental cultivars and F_2 populations	Number of plants	Spike length (cm %)										
		9.0-9.9	10.0-10.9	11.0-11.9	12.0-12.9	13.0-13.9	14.0-14.9	15.0-15.9	16.0-16.9	x±Sx	V%	h^2
Surkhak	30		25.6	44.0	30.4					11.3±0.3	7.3	
Kzyl-Shark	30	11.4	56.6	22.0	10.0					10.3±0.3	9.2	
Tyuya-Tish	30		10.0	60.0	30.0					11.5±0.3	6.1	
Khivit	30		25.0	55.6	19.4					11.8±0.2	12.5	
Ak-bashak	30	60.5	35.5	4.0						9.6±0.2	7.3	
Muslimka	30		53.0	30.0	17.0					10.7±0.2	7.7	
Kzyl-bugday	30		20.0	30.0	50.0					11.4±0.5	7.4	
Pashmak	30	35.0	55.0	10.0						9.9±0.2	7.5	
F_2 populations												
Surkhak × Kzyl-Shark	160	10.0	11.3	28.7	12.5	16.9	6.2	9.4	5.0	12.1±0.9	24.8	0.84
Tyuya-Tish × Khivit	160	1.9	9.4	11.3	20.0	30.0	18.8	3.8	5.0	14.3±0.3	7.4	0.29
Ak-bashak × Muslimka	160	18.1	23.2	21.8	16.9	10.0	3.1	3.1	3.8	9.7±0.4	13.8	0.82
Kzyl-bugday × Pashmak	160	14.4	28.1	20.6	17.5	9.4	3.1	1.9	5.0	11.8±0.5	13.7	0.73

and Kizil Shark showed transgression to the right side. In these hybrids, 16.9% of plants had longer spikes (13.0 to 13.9 cm), and about 5% of plants had spike lengths of 16.0–16.9 cm, which exceeds the spike length in parental forms. In hybrids with participation of the cultivars Tyuya-tish and Khivit, 30% of the plants had longer spikes (13 cm), and about 18.8% of plants had a spike length of 14 cm, which exceeds the said trait in wheat parental genotypes (Table 1). However, these hybrids also showed plants with lower values than the parental forms, and negative transgression was evident in 1.9% of plants. In hybridological analysis, the results revealed that cleavage by intermediate classes occurred within heterozygous states of genes and their additive gene action.

In hybrids involving the wheat cultivars Ak-bashak and Muslimka, 18.1% of plants showed a shift in the spike length toward the parental form (cultivar Ak-bashak), which participated as the maternal genotype. For wheat hybrids with participation of the cultivar Kzyl-bugday, it owned the highest value for the trait, and the cultivar Pashmak, with relatively low indices, expressed a shift to the right, where the genotypes with longer spikes amounted to 19.4%. For spike length, the coefficient of variation ranged from 7.4% (Tyuya-tish × Hivit) to 24.8% (Surkhak × Kzyl-Shark). This indicates the topmost degree of variability of this trait in the F_2 populations.

For the spike length, the coefficient of inheritance ranged from 0.29 to 0.84. In cross combinations Surkhak × Kzyl-Shark (0.84) and Ak-bashak × Muslimka (0.82), the ultimate heritability (h^2) values indicate a significant contribution of the genotype to the transmission of the trait to the next generation, and its low variability was under the influence of environmental conditions. Past studies emphasized that epistatic effects on the traits, such as spikelets per spike, flowers per spike, the number of seeds per flower, and the number of seeds per spike, were more distinct than additive effects (Fethi and Mohammed, 2010).

The analysis further showed the number of flowers per spike in the wheat landraces Tyuya-tish and Khivit have not provided reliable differences. However, the highest indicator resulted in the cultivar Ak-bashak, where the average number of flowers per spike amounted to 18.7 ± 0.44. The mean value of the said trait among the F_1 populations ranged between 16.3 ± 0.30 and 18.1 ± 0.48 seeds (Table 2).

Table 2. The degree of dominance for various traits in parental genotypes and their F_1 populations in wheat.

Parental genotypes and F_1 populations	Spike length	Number of spikelets	Grains spike^{-1}	Grain weight spike^{-1}
Surkhak	11.3±0.3	16.1±0.4	37.7±1.1	1.8±0.2
Kzyl-Shark	10.3±0.3	15.4±0.2	40.3±1.2	2.0±0.4
Tyuya-Tish	11.4±0.3	16.3±0.2	43.8±0.6	2.3±0.3
Khivit	11.8±0.2	16.6±0.3	41.3±1.1	2.2±0.4
Ak-bashak	9.6±0.2	18.7±0.5	40.6±1.2	2.3±0.2
Muslimka	10.7±0.2	14.3±0.1	45.0±1.8	2.5±0.3
Kzyl-bugday	11.4±0.5	16.9±0.3	43.3±1.6	2.2±0.4
Pashmak	9.9±0.2	15.0±0.4	41.5±1.4	2.0±0.3
F_1 populations				
Surkhak × Kzyl-Shark	10.9±0.3	16.3±0.3	43.8±0.6	2.2±0.2
Tyuya-Tish × Khivit	12.2±0.2	17.8±0.4	48.2±1.2	2.5±0.5
Ak-bashak × Muslimka	10.6±0.2	16.6±0.2	42.3±0.7	2.6±0.6
Kzyl-bugday × Pashmak	12.5±0.4	18.1±0.5	40.4±1.5	1.8±0.2

In hybrid combinations, varied dominance (hp=1.6, hp=2.3, and hp=9.0) was evident for the degree of dominance of the trait, depending on the parental genotypes (Table 3). No dominance for the said trait appeared in the hybrid Ak-bashak × Muslimka (hp=0.0). In F_2 populations, a variation in the number of spikelets per spike was noticeable, and 15 to 20.9 spikelets emerged in the parental forms. On analyzing the variability, it was apparent that the cultivar Kzyl-Shark formed two classes; cultivars Surkhak, Tyuya-tish, and Muslimka formed three classes, while cultivars Khivit, Ak-bashak, Kzyl-bugday, and Pashmak occurred with four classes.

Overall, all the wheat cultivars manifested with the number of spikelets per spike ranging from 17.0 to 17.9, except the cultivar Kzyl-Shark. Plants with more than 18 spikelets per spike surfaced in the wheat cultivars Khivit, Ak-bashak, Kzyl-bugday, and Pashmak. The dense spikelets were 27.0% in the cultivar Khivit, 45.5% in Ak-bashak, 10.0% in Kzyl-bugday, and 20.0% in the cultivar Pashmak. The cultivar Ak-bashak was notable with the most spikelets per spike (19–20) compared with other cultivars. The mean values for spikelets per spike in these cultivars were 16.1 ± 0.43, 16.3 ± 0.45, 16.6 ± 0.43, 16.0 ± 0.37, and 16.9 ± 0.41, respectively. The manifestation of inheritance and interaction of genes during hybridization depends on the genotypes, environments, and genotype by environment interactions (Nehe *et al*., 2019). Among the studied cultivars, the maximum spikelet number resulted in the cultivar Ak-bashak (18.7 ± 0.40), while the minimum was in the cultivar Kzyl-Shark (15.4 ± 0.30), and 65.5% of the plants belonged to the class with an index of 15.0–15.9. In F_2 populations, the spikelets per spike ranged from 19.0 to 22.0.

For spikelets per spike, the variability ranges comprised eight classes. In wheat hybrids Surkhak × Kzyl-Shark and Tuyatish × Khivit, the majority of their plants were in classes with 21.0 to 21.9 spikelets per spike. Concerning F_2 populations, for the spikelets per spike, the plants with low indices compared with the parental forms occupied 1–2 classes. In hybrids for the spikelets per spike, a positive transgression was noteworthy, and among the parental forms, the plants stood out with dense spikelets and with two classes, and the spikelets per spike were more than 21.0 to 22.0. Especially in wheat hybrids Surkhak × Kzyl-Shark and Tyuya-tish × Khivit, the number of spikelets per spike ranged from 21.0 to 22.0, and the accounted dense spikelets were 41.2% and 39.4%, respectively. In both hybrids, the mean values were 18.5 ± 1.20 and 21.5 ± 0.40, respectively. However, in hybrids Ak-bashak × Muslimka and Kzyl-bugday × Pashmak, the mean values were

Table 3. Genetic variability and inheritance in wheat F_2 populations for the number of spikes.

Parental cultivars and F_2 populations	Number of plants	Number of spikes (%)										
		15.0-15.9	16.0-16.9	17.0-17.9	18.0-18.9	19.0-19.9	20.0-20.9	21.0-21.9	22.0-23.0	x±Sx	V%	h^2
Surkhak	30	15.0	70.0	15.0						16.1±0.4	4.6	
Kzyl-Shark	30	65.5	34.5							15.4±0.3	9.2	
Tyuya-Tish	30	25.5	56.2	18.3						16.3±0.4	8.2	
Khivit	30	12.6	50.4	10.0	27.0					16.6±0.4	6.5	
Ak-bashak	30			10.0	45.5	18.2	26.3			18.7±0.4	5.7	
Muslimka	30	18.0	50.0	32.0						16.4±0.4	8.6	
Kzyl-bugday	30	18.4	45.6	26.0	10.0					16.9±0.4	9.1	
Pashmak	30	28.5	41.5	10.0	20.0					16.2±0.2	8.3	
F_2 populations												
Surkhak × Kzyl-Shark	160	3.1	4.4	10.6	6.3	15.6	18.8	22.5	18.7	18.5±1.2	21.2	0.84
Tyuya-Tish × Khivit	160	3.8	5.0	10.6	7.5	15.6	18.1	23.1	16.3	21.5±0.4	5.5	0.69
Ak-bashak × Muslimka	160	18.8	22.5	14.4	18.1	9.3	3.8	3.8	9.3	15.8±0.7	14.9	0.63
Kzyl-bugday × Pashmak	160	9.3	10.0	30.0	15.7	16.9	8.7	4.7	4.7	15.4±0.8	15.7	0.62

15.8 ± 0.70 and 15.4 ± 0.80 pieces, indicating lower values than the wheat parental genotypes. In F_2 populations, the positive transgression confirms the appearance of dense spikelets compared with the parental types. The number of grains per spike is an important breeding trait, directly associated with the plant's productivity (Yu *et al*., 2014).

In ancient local wheat cultivars, the spikelets per spike have the highest variability, and their variation ranges from 5.5% to 21.2%. For grains per spike, the coefficient of inheritance in the hybrid Surkhak × Kzyl-Shark was 0.84, the hybrid Tyuya-tish × Khivit was 0.69, and other hybrids had 0.62 to 0.63. These implied the highest values of such indicators and the proximity of trait values. In the studied combinations of inheritance of the trait of the number of grains in the spike in F_1 hybrids, Surkhak × Kzyl-Shark (hp = 3.7) and Tyuya-tish × Khivit (hp = 4.5), the highest values of dominance were evident in the parental genotypes. In wheat hybrid Ak-bashak × Muslimka (hp = -0.2), the said trait's inheritance was in the form of a negative incomplete dominance, indicating the influence of maternal cytoplasm with the low level of the trait.

The grain number and weight per spike are essential quantitative traits in wheat, and numerous studies have focused on the genetic basis of these traits. By analyzing the range of variability for the grains per spike, the F_2 populations incurred division into eight classes, while parental genotypes covered 2–3 classes. The wheat cultivars Kzyl-Shark and Ak-bashak appeared at par with the number of grains, and 50.0% of their plants had the range of 37.0 to 43.9 grains per spike. In cultivars Tyuya-tish and Kzyl-bugday, 70.0% and 58.2% of plants, respectively, had grains per spike ranging from 44.0 to 50.9. In cultivar Muslimka, only 1.0% of the plants obtained 51.0 to 57.9 grains per spike. For grains per spike, the average values were at par and ranged from 37.7 to 45 grains. However, the highest values for the said trait resulted in wheat cultivars Tyuya-tish, Muslimka, and Kzyl-bugday (43.8 ± 0.63, 45.0 ± 1.77, and 43.3 ± 1.58 grains, respectively).

The coefficient of variation for grains per spike in the wheat cultivars varied from 3.3% to 7.4%, indicating a low level of variability for the said trait among the cultivars. Both negative and positive cases of transgression were noticeable in hybrids of the F_2 generation. Negative transgression manifested itself in the form of isolation of plants with fewer grains in the spike versus the parental genotypes. The results further revealed that in wheat hybrids Ak-bashak × Muslimka and Kzyl-bugday × Pashmak, a shift downward occurred by one class. In these hybrids, 48.0%–36.0% of the plants had grains per spike ranging from 30.0 to 36.9.

In F_2 populations, the increase in the range of variability for grains per spike and the isolation of genotypes with the most grains materialized in a shift of 4–5 classes to the right compared with the parental forms. For the wheat hybrid Surkhak × Kzyl-Shark, 38.0% of the plants had the grains per spike ranging from 44.0 to 50.9, while 28.0% of the plants had the grains per spike at a range of 51.0 to 57.9, with an average of 42.0 ± 4.80 grains per spike. In hybrid Tyuya-tish × Khivit, the average number of grains per spike was 57.4 ± 2.5, which was superior among the F_2 populations. The topmost level of this trait confirms the presence of the additive effect of the dominant genes in the transmission of the said trait to subsequent generations. The coefficient of variation for the grains per spike was higher than other traits, i.e., 18.1% (Surkhak × Kzyl-Shark) to 19.7% (Kzyl-bugday × Pashmak). The level of inheritability for the said trait varied from 0.96 to 0.98, which indicates the supreme level of transmission of this trait to the F_2 populations. In F_2 populations, the isolation of genotypes with high indices was notable (Table 4).

In the presented studies, among the F_1 populations, the highest grain weight per spike resulted in cross combinations Tyuya-tish × Khivit (2.5 ± 0.5) and Ak-bashak × Muslimka (2.6 ± 0.6), and the relatively low value for the said trait was evident in the hybrid Kzyl-bugday × Pashmak (1.8 ± 0.2). The hybridological analysis of yield-related traits in F_2 populations of the soft wheat (*T. aestivum* L.) showed the grains per spike generally incurred inheritance as per the dominance type of the better-performing parental genotypes with a higher trait index (Qulmamatova *et al.,* 2022; Kodirova *et al.,* 2024).

By analyzing the degree of dominance for grain weight per spike in the studied hybrids, it was noticeable that in wheat cross combinations Surkhak × Kzyl-Shark (hp=3.0) and Tyuya-tish × Khivit (hp=5.0), the said trait's inheritance was in the form of a pronounced dominance. However, in the cross combination Ak-bashak × Muslimka (hp=0.0), the dominance was non-existent. In the hybrid Kzyl-bugday × Pashmak (hp=-3.0), the inheritance of the trait resulted in the form of a negative incomplete dominance. In analyzing the variability range of the grain weight per spike in F_2 populations, the mean values ranged from 1.8 to 2.5 g among all the cultivars, with the range of variability covering 4–5 classes (Table 5).

For grain weight per spike, the highest values appeared in wheat cultivars Tyuya-tish, Ak-bashak, and Muslimka (2.3 ± 0.3, 2.3 ± 0.2, and 2.5 ± 0.3, respectively), while the lowest value emerged in the cultivar Surkhak (1.8 ± 0.2). In cultivars Kzyl-bugday and Pashmak, 40.4%–35.0% of the plants had grain weights of 2.2 to 2.3 g, which also had a location within the 7th class. The coefficient of variation for the grain weight per spike in the cultivars Ak-bashak and Surkhak ranged from 5.1% to 9.6%, indicating a low variability, while in other wheat cultivars, it was above 10%, signifying a medium variability.

In F_2 populations, the low variability showed an association with the isolation of plants with lower indices than the parental genotypes. In the studied wheat hybrids, the phenomenon of transgression to the left was evident for the grain weight per spike. Regarding F_2 populations, the negative transgression manifested itself in a shift by 2–3 classes to the left. In hybrids Surkhak × Kzyl-Shark, 28.0% of the plants had grain weights of 1.2 to 1.3 g, and in wheat hybrids Tyuya-tish × Khivit, Ak-bashak × Muslimka, and Kzyl-

Table 4. Genetic variability and inheritance in wheat F_2 populations for grains per spike.

Parental cultivars and F_2 populations	Number of plants	Grains spike^{-1} (%)										
		30.0-36.9	37.0-43.9	44.0-50.9	51.0-57.9	58.0-64.9	65.0-71.9	72.0-78.9	79.0-85.9	x±Sx	V%	h^2
Surkhak	30	50.0	50.0							37.7±1.1	5.3	
Kzyl-Shark	30	18.5	50.0	31.5						40.3±1.2	6.1	
Tyuya-Tish	30		30.0	70.0						43.8±0.6	3.9	
Khivit	30	22.6	50.4	27.0						41.3±1.1	7.4	
Ak-bashak	30	23.6	50.0	26.4						40.6±1.2	4.2	
Muslimka	30	15.3	24.7	60.0	1					45.0±1.8	3.9	
Kzyl-bugday	30		41.8	58.2						43.3±1.6	6.8	
Pashmak	30	29.4	10.6	60.0						41.5±1.4	3.3	
F_2 populations												
Surkhak × Kzyl-Shark	160	31	35	38	28	8	8	6	6	42.0±4.9	18.1	0.98
Tyuya-Tish × Khivit	160	9	24	32	24	26	15	8	8	57.4±2.5	13.6	0.98
Ak-bashak × Muslimka	160	48	33	31	25	15	8			33.5±5.1	16.1	0.97
Kzyl-bugday × Pashmak	160	36	29	35	25	10	10	7	8	37.3±2.3	19.7	0.96

Table 5. Genetic variability and inheritance in wheat F_2 populations for grain weight per spike.

Parental genotypes and F_2 populations	Number of plants	Grain weight spike^{-1} (g %)										
		1-1.1	1.2-1.3	1.4-1.5	1.6-1.7	1.8-1.9	2-2.1	2.2-2.3	2.4-2.5	x±Sx	V%	h^2
Surkhak	30			19.8	39.2	21.0	20.0			1.8±0.2	9.6	
Kzyl-Shark	30				11.5	23.4	32.1	22.0	22.0	2.0±0.4	12.9	
Tyuya-Tish	30					15.5	22.5	22.0	40.0	2.3±0.3	19.9	
Khivit	30				11.4	21.6	14.5	22.5	30.0	2.2±0.4	12.8	
Ak-bashak	30						20.0	25.8	54.2	2.3±0.2	5.1	
Muslimka	30						21.4	29.6	49.0	2. ±50.3	14.4	
Kzyl-bugday	30				12.3	11.7	24.6	40.4	21.0	2.2±0.4	18.3	
Pashmak	30				11.6	22.4	31.0	35.0		2.0±0.3	17.2	
F_2 populations												
Surkhak × Kzyl-Shark	160	27	28	19	26	30	15	15	10	1.2±0.3	21.2	0.60
Tyuya-Tish × Khivit	160		20	38	40	23	9	10	10	1.5±0.3	20.6	0.82
Ak-bashak × Muslimka	160		18	36	36	30	17	17	6	1.6±0.1	16.8	0.95
Kzyl-bugday × Pashmak	160	14	33	41	23	20	14	8		1.3±0.04	14.3	0.83

bugday × Pashmak, 38.0%, 36.0%, and 41.0%, respectively, had grain weights of the plants at 1.4 to 1.5 g. The coefficient of variation for grain weight per spike in F_2 populations was twice as high compared to the parental cultivars. The coefficient of variation ranged from 14.3% to 21.2%, indicating a medium and high variability for this trait.

CONCLUSIONS

For developing the high-yielding wheat (*T. aestivum* L.) cultivars, selection based on the number of grains per spike will significantly increase the possibility of selecting productive genotypes. Genetic analysis revealed grains per spike primarily depend on the genetic potential of the cultivars. In the cross combinations, the inheritance of grains per spike proved to be managed by the negative incomplete dominance with the influence of maternal cytoplasm and revealed a low variability. In F_2 populations, the coefficient of variation for grain weight per spike was twice as high compared with the parental genotypes, which indicated a medium and high variability for the said trait. Thus, the local landraces of Uzbekistan have various traits useful for selection.

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