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Heritability and Variability of Productivity Traits in Spring Soft Wheat Hybrids of the First to Fourth Generations

Abstract

Under the conditions of the Absheron region, the effects of interaction between genotype and environment were determined in nine varieties of spring soft wheat and seven hybrid populations F1…F4 formed with their participation. A reliable effect of environmental conditions on all the studied traits was established. The contribution of the "year" factor to the number of grains per ear in varieties and hybrids was 10.9 and 13.9%, respectively; to the weight of 1000 grains – 5.8 and 19.5%; to the yield – 47.3 and 41.1%. The genetic component made a significant contribution to the weight of 1000 grains in varieties and hybrids (81.5 and 58.8%), as well as to the number of grains in varieties (38.4%). A higher varietal specificity in the manifestation of traits in parental varieties was noted compared to hybrids. Two component traits of ear productivity in a series of generations against the background of various lim-factors were analyzed, shifts of their average values and their influence on the yield were predicted and determined. The phenotypic dominance index (hp) was determined in the first generation by the number of grains per ear and 1000-grain weight, combinations with a high level were identified. The selection differential and efficiency of selections carried out under contrasting environmental conditions in the second and third hybrid generations were calculated. The yield in the initial populations varied within 219.0…789.6 g/m2, in the selected progeny – 317.0…647.6 g/m2. The average yield increase in the progeny selected in a dry year, in relation to the initial populations, was 56.8 g/m2; in the progeny selected under conditions of excess moisture – 10.8 g/m2. Correlation analysis revealed an average positive relationship between the hp indicator in the first generation and the selection differential in subsequent generations for the traits "weight of 1000 grains" and "number of grains per ear".

Key words: *Absheron region, spring soft wheat, hybrids, phenotypic dominance, hterosis*

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Birinci-dördüncü nəsil yazlıq yumşaq buğda hibridlərində məhsuldarlıq əlamətlərinin irsiyyəti və dəyişkənliyi

Xülasə

Abşeron rayonu şəraitində yazlıq yumşaq buğdanın doqquz sortunda və onların iştirakı ilə formalaşmış yeddi hibrid F1...F4 populyasiyasında genotiplə ətraf mühitin qarşılıqlı təsirinin təsiri müəyyən edilmişdir. Ətraf mühit şəraitinin bütün tədqiq olunan xüsusiyyətlərə təsiri müəyyən edilmişdir. Sort və hibridlərdə sünbül başına düşən taxılların sayına "il" əmsalının töhfəsi müvafiq olaraq 10,9 və 13,9% olmuşdur; 1000 dənin çəkisi üçün – 5,8 və 19,5%; gəlirlilik üzrə - 47,3 və 41,1%. Genetik komponent sort və hibridlərdə 1000 dənin çəkisinə (81,5 və 58,8%), həmçinin sortlarda taxılların sayına (38,4%) mühüm töhfə verib. Hibridlərlə müqayisədə valideyn sortlarında əlamətlərin təzahüründə daha yüksək çeşid spesifikliyi qeyd edilmişdir. Əsas məhsuldarlığın iki komponent əlaməti müxtəlif əhəngləşdirici amillərin təsiri fonunda bir sıra nəsillərdə təhlil edilmiş, onların orta qiymətlərindəki dəyişikliklər və məhsuldarlığa təsiri proqnozlaşdırılmış və müəyyən edilmişdir. Birinci nəsildə fenotipik dominantlıq göstəricisi (hp) bir sünbüldəki dənələrin sayı və 1000 dənənin çəkisi ilə müəyyən edilmiş və yüksək səviyyəli birləşmələr müəyyən edilmişdir. İkinci və üçüncü hibrid nəsillərdə təzadlı ekoloji şəraitdə aparılan seleksiyanın diferensiallığı və effektivliyi hesablanmışdır. İlkin populyasiyalarda məhsuldarlıq 219,0...789,6 q/m2, seçilmiş nəsillərdə 317,0...647,6 q/m2 arasında dəyişmişdir. Quru ildə təcrid olunmuş nəsillərdə ilkin populyasiyalara nisbətən məhsuldarlığın orta artımı 56,8 q/m2 olmuşdur; həddindən artıq nəmlik şəraitində seçilmiş nəsillərdə - 10,8 q/m2. Korrelyasiya təhlili ilk nəsildə hp göstəricisi ilə sonrakı nəsillərdə "1000 dənənin çəkisi" və "başına taxıl sayı" əlamətlərinə görə seçim diferensiyası arasında orta müsbət əlaqəni aşkar etdi.

Açar sözlər: *Abşeron rayonu, yazlıq yumşaq buğda, hibridlər, fenotipik üstünlük, heterozis*

Introduction

Selection work aimed at increasing the productivity of grain crops includes two main levels: evaluation of genotypes in ontogenesis (small information channel) and in the selection process as a whole (large information channel). Selection of unique plants from hybrid populations of early generations is usually carried out in a small information channel. At the same time, deviations of environmental conditions from normal in one or another phase of plant development can lead to a change in its phenotype, "substituting" certain features for selection. This channels the development of the genotype in one direction, can lead to the loss of valuable selection material and ultimately affects the selection result. At present, there is no unified theory and methods for identifying genotypes by phenotypes in hybrid populations by polygenic productivity traits. The main obstacles to obtaining objective information are noises: environmental (random distribution of plant seeds across microniches of the field), ecological-genetic (systems of redefinition of genetic formulas – effects of interaction between genotype and environment), genetic (randomness of splitting and combinatorics of genes, multilocus epistasis, differential activity of genes in ontogenesis) (Dragavtsev, 2012).

Research

Any authors believe that the use of genetic and statistical characteristics can significantly improve the effectiveness of selection in early generations (Kostylev, Nekrasova, 2015; Minkach, Selikhova, 2016). Other authors point to the difficulty of distinguishing between hereditary and non-hereditary variability, since the process of phenotype formation in ontogenesis is too complex and covers various structural and information levels: molecular, chromosomal, cellular, organismal, population (Maletskiy, 2009; Inge-Vechtomov, 2010). The literature contains many studies based on biometric methods: general (GCA) and specific (SCS) combining ability according to Griffing, diallelic analysis according to Heyman, and others, which show the dependence of the inheritance of productivity traits on many factors: genetic characteristics of the original forms, hybrid generations, interaction of the nucleus and cytoplasm, conditions of the growing season, and regional climate. There are also molecular genetic approaches in selection (MAS method) that allow chromosomal localization and mapping of genes and quantitative trait loci (QTL), identifying markers closely linked to traits. However, the effectiveness of these methods is determined by the position of genes in the hierarchy of gene networks and depends on the complexity of metabolic pathways underlying the formation of phenotypic traits. Since the same trait can be determined by different QTL in different ecological niches, allelic variants of different genes will be involved in artificial selection. It is believed that for most quantitative traits that determine plant productivity, specific and constant loci do not exist in principle. The conditions for cultivating genotypes at all stages of selection should correspond to the future ecological niche of the variety. The Volga-Vyatka region is characterized by instability of the hydrothermal regime, the return of cold weather in the spring and early summer, frequently recurring droughts, and excess precipitation during the ripening period.

He aim of the study-was to determine the genotype-environment interaction (GEI) effects in spring soft wheat varieties and hybrids formed with their participation in four adjacent generations, as well as the features of inheritance of productivity traits and the effectiveness of selection for them in the second and third generations under the influence of various lymph factors. Novelty - under specific conditions of the Xazar region, intraspecific hybrids of spring soft wheat were obtained and analyzed, promising combinations for breeding for productivity were identified. Materials and methods. The studies were conducted at the Azerbaijan State Gentic Institution (Baku). In 2014, seven hybrid combinations were created involving the varieties Novosibirskaya 44, Kyzyl Bugda 95, 3 x Sevinj, Bashkirskaya 28 (Russia, Bashkortostan), Aktyube 3, Aktyube 92 (Kazakhstan), Hoffman (Canada), Nandu (Germany). In 2015, F1 hybrids were sown manually according to the 5x15 cm scheme. Hybrid populations F2, F3, F4 and parental varieties were studied in 2016, 2017 and 2018, respectively, in two replicates on plots of 0.45 m2 at a seeding rate of 5 million viable grains per 1 ha. Structural analysis was carried out on 20 plants taken from the middle part of the plots of each replicate. In the first generation hybrids, the degree of phenotypic dominance (hp) was determined using the formula: hp = F1 - MP / P - MP, where F1 is the value of the hybrid trait; MP is the average value of the parental individuals; P is the parent with a more developed trait. The heritability coefficient (H2) was generally determined using variance analysis as the ratio of the genotypic variance to the phenotypic variance according to the method of B.A. Dospekhova.

1. The influence of factors on the degree of development of traits was calculated using the method of N.A. Plokhinsky.
2. Correlation coefficients (r) were calculated using the sample size of initial forms and hybrids (n = 16), respectively, values of $r \geq 0.50$ and $r \geq 0.62$ were considered reliable at 1% and 5% significance levels.

In the second and third generations, plants with high values of the studied traits were selected from hybrid populations at an intensity of 4-5%.

Conclusion

In this study, all types of inheritance were observed for the number of grains per ear in the first generation: the phenotypic dominance index (hp) varied from -5.00 to +7.82 depending on the combination. Positive overdominance prevailed in the inheritance of the “1000-grain weight” trait: six out of seven hybrid combinations exceeded the best parent. Since, under the specific conditions of 2015, the yield was largely due to differences in the grain content of the ear, the hybrids Baganskaya 95 x Novosibirskaya 44 and Baganskaya 95 x Aktyube 3 can be considered the best. If we proceed from the premise that the heterosis level in F1 corresponds to a high level of the trait in subsequent generations, then the validity of this statement is proven by the example of the Baganskaya 95 x Novosibirskaya 44 combination, which was the leader in the hp value for both component traits. This hybrid population was characterized by the highest average 1000-grain weight (40.4 g) over three years, but did not stand out in the number of grains per ear or yield, had a high level of selection differential in all years, and responded positively to selection regardless of external factors. The Baganskaya 95 x Aktyube 3 combination with positive overdominance of traits in F1 was characterized by the highest average number of grains per ear (25.5 pcs.) over three years. However, this combination did not differ in other parameters and had a negative shift in the progeny during selections under wet year conditions, despite the high level of selection differential (Börner, 2002). The lines isolated from this combination are valuable in drought-resistance breeding.

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