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Assessment of Genetic Parameters of Agronomic Traits in Bread Wheat using Generation Means Analysis under water-limited Conditions

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Introduction: Wheat is the oldest and most important cultivated crop in the world and has fundamental role in human food security. Drought is one of the most common environmental stresses that affect growth and development of plants. Most parts of Iran's cultivation land are located in arid and semiarid regions and because of water deficiency, plant stress appear and wheat performance reduces severely in these regions. In such circumstances, the production of drought tolerant varieties has special importance. Understand the genetic basis of yield and yield related traits is necessary in breeding programs. One of the best approaches to determine genetic parameters is generation means analysis method, due to it allows breeders to predict epistasis. In order to estimate genetic parameters and evaluation of gene action controlling agronomic traits in bread wheat under moisture stress, F_4 families derived from cross between Roushan and Kavir along with F_2, F_3 and parents, were evaluated under moisture stress.

Materials and Methods: Field experiment was carried out in research field of Shahid Bahonar University of Kerman, during growing season of year 2013-2014 using Augmented design with 5 known check cultivars (Roushan, Falat, Mahdavi, Karchia and Shahpasand). Stress treatment was cut off irrigation at heading stage. Grain yield and some agronomic traits were measured. Generation means analysis method was used to determine genetic parameters including additive effect (d), dominance effect (h), additive × additive [i], and dominance × dominance effect [l] were evaluated for different traits. Generation means analysis was carried out using equation 1.

$$Y= m+\alpha[d]+\beta[h]+\alpha^2[i]+2\alpha\beta[j]+\beta^2[l] \quad (1)$$

Broad and narrow sense heritability of evaluated traits were estimated according to equation 2 and 3.

$$h_b^2 = [\left(\tfrac{1}{2}\right)D + \left(\tfrac{1}{4}\right)H]/[\left(\tfrac{1}{2}\right)D + \left(\tfrac{1}{4}\right)H + E \quad (2)$$

$$h_n^2 = [\left(\tfrac{1}{2}\right)D]/[\left(\tfrac{1}{2}\right)D + \left(\tfrac{1}{4}\right)H + E \quad (3)$$

Results and Discussion: The study revealed a complex genetic control for studied traits. Genetic variation in F_2, F_3 and F_4 was more than parents. Five-parameter model including m, [d], [h], [i] and [l] explained genetic variation for plant height, awn length, grain number per plant, 1000-grains weight, biology and grain yield. While, a four parameter model including m, [h], [i] and [l] were explained genetic diversity of grain filling period and a four-parameter model including m, [d], [h], and [l] was valid for explaining genetic variation of number of spike per plant and harvest index. A three parameter model including m, [d], [i] made the significant contributions to the inheritance of spike length. The additive genetic variance was detected as the most important genetic effect in controlling grain yield, biologic yield, harvest index, 1000-grian weight, awn length, spike length and grain filling

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period. Therefore, selection in early generations is effective for these traits. High narrow sense heritability of these traits proposes that the most part of genetic variance could be fixed in segregating generations. Broad and narrow sense heritability of studied traits in the present population were 0.46 to 0.96 and 0.16 to 0.93, respectively. 1000-grian weight, grain yield, biologic yield, grain filling period and harvest index had the highest narrow sense heritability, respectively. Therefore in the present population, selection based on these traits could result in good genetic gain. While, dominant effect was more important for plant height, number of spike per plant and grain number per plant. Significant differences between broad and narrow sense heritability of these traits has confirmed the fact that the dominance effect is very important. Therefore, selection should be made in later generations until desirable genes are fixed. Low narrow sense heritability was observed for number of spike per plant (0.16). Therefore, selection based on this trait can not have good genetic gain in present population. In this study, environmental variation was less than additive and dominance variance that show accuracy of the estimations and low impact of the environment on evaluated traits. Plant height, number of spike per plant and grain number per plant showed one degree greater than of dominance. These result showed over dominance of genes controlling mentioned traits.

Conclusions: Based on the results obtained in this experiment, it can be concluded that there is a considerable genetic diversity in the population F_2, F_3, F_4 derived of Roushan and Kavir cross which can be used as a high potential population for genetic improvement of evaluated traits. The Results showed that additive variance was more important than dominance in genetic control of evaluated traits. So, selection during early generations is recommended in wheat breeding program of this population.

Keywords: Additive, Cut-off Irrigation, Dominance, Heritability