Hybrid vigour of wheat crosses

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Among edible cereals, wheat is known for its variable adaptability to a wide range of environment around the globe. In recent years wheat cultivation has been extended even into less favourable environments including marginal areas and tropical regions.

Average per acre yield in Pakistan varies from 2725 to 1142 kg ha1 for irrigated and drought stress conditions, respectively which shows a big yield gap between the two production situations. Due to environmental changes, lesser rains and shortage of canal water supply for high-yielding irrigated wheat plantings have contributed in the decline in wheat production.

Development of wheat varieties with low moisture requirements and able to withstand moisture stress may well be an answer to combat these problems. Wheat genotypes well adapted to ecologies characterised by various types of environmental stresses should be an important target that our wheat breeding programmes should focus upon.

Increased harvest index has been identified as the major factor responsible for the yield increase attributed to the semi-dwarf wheat in dry and wet environment and it seems that genotype has a greater direct influence on assimilate allocation than it has on either water use efficiency or the amount of water used. Improving the harvest index must result in yield improvement in all drought affected environment, provided that total dry matter does not decrease.

In spite of the greatly improved genetic as well as physical environment of the wheat plant, productivity of the cropped area has not been fully realised. This may be attributed partly to the fact that the drought stress acreage which constitutes nearly one-fifth of the total wheat acreage is not planted to varieties bred specifically to uncertain and erratic moisture supply conditions of these areas. In recent years, however, the problem of arid zone research has come in sharp focus and efforts are now being made to plan and organise arid zone research in a proper manner.

The present study was planned to ascertain the effects of different environments on the various economic characters reflecting yield potential by making a comparative assessment of their performance under irrigated and drought stress conditions, in terms of the type of gene action, combining abilities and heterosis, etc. The study comprising eight wheat genotypes that is Parula, Crow, 87094, 85205, Chakwal 97, Kohistan 97, Punjab 96 and MH.97 indicating measurable differences in agro-economic traits were crossed in a diallel fashion to evaluate their genetic performance and were planted under irrigated as well as drought stress conditions. The characters studied include days to heading, flag leaf area, specific flag leaf weight, plant height, number of tillers per plant, spike length, spikelets per spike, grains per spike, 1000-grain weight, biomass per plant, grain yield per plant and harvest index. The objective of the study was to identify potential parental genotypes or crosses that can be used in future breeding programmes for developing promising genotypes for irrigated as well as drought areas.

Significant differences were found among genotypes for all the characters studied under both irrigated and drought stress conditions. All of the parental genotypes exhibited a reduction in all traits in response to drought. This reduction was much severe in case of important yield components like flag leaf area, specific flag leaf weight, number of tillers per plant, grains per spike and 1000-grain weight which showed a reduction of 32.23, 22.90, 32.45, 25.05 and 30.05 per cent, respectively. Due to reduction in these characters grain yield per plant also registered a marked reduction of 46.49 per cent under drought.

Under irrigated conditions, Parula, Pb.96 and MH.97 were the best genotypes in respect of grain yield with desirable values of yield components. MH.97 was the lowest performer under drought with marked reduction in grain yield and its components showed lowest values of flag leaf area, specific flag leaf weight, spike length, 1000-grain weight and biomass per plant. The genotypes like Parula, Crow, 87094 and Pb.96 were the best performers under drought on the basis of grain yield and its components.

Similarly, the hybrids performing best under irrigated conditions include Parula x MH.97, Crow x Kohis.97, 85205 x MH.97, Pb.96 x MH.97, MH.97 x Parula, MH.97 x

85205 and MH.97 x Pb.96. The hybrids showing best performance under drought were Parula x 87094, Crow x MH.97, Chak.97 x Crow, Kohis.97 x Chak.97, MH.97 x Chak.97 and MH.97 x Pb 96.

Formal diallel analysis of variance displayed that both additive (a) and dominant (b) genetic effects were significant for all the characters under both sowing conditions Scaling tests further provided the adequacy of most of the characters for additive-dominance model.

Average degree of dominance displayed additive gene action for days to heading, flag leaf area and spikelets per spike under both sowing conditions while overdominance was operative for specific flag leaf weight, number of tillers per plant, biomass per plant, grain yield per plant and harvest index. It was also found that additive action of genes for plant height and grains per spike under irrigated condition changed to overdominance under drought while overdominance for spike length and 1000-grain weight changed to additive.

Mean squares due to both GCA and SCA were highly significant for all the traits, with a few exceptions where GCA mean squares were only significant or non-significant, under irrigated as well as drought stress conditions. The relative magnitude of variation due to GCA and SCA indicated the importance of additive effects for all the characters under both sowing conditions, except tillers per plant and grain yield under irrigated condition and specific flag leaf weight, grains per spike, biomass per plant, grain yield per plant and harvest index under drought where importance of dominant genetic effects was indicated.

Greater SCA effects obtained in crosses involving both parents with high GCA (high x high) indicated the possibility of genetic improvement for those particular characters through pedigree selection. For example the cross 87094 x 85205 may produce transgressive recombinant for 1000-grain weight under both sowing conditions and Pb.96 x MH.97 for grains per spike under drought.

Similarly crosses showing high SCA and involving both parents as low general combiner (low x low) for a trait indicated the presence of epistasis or non-allelic interaction at the heterozygous loci. This suggested to utilise these crosses through single plant selections in the later generations. These type of crosses under irrigated condition include Parula x MH.97 for grains per spike and 1000-grain weight; 87094 x MH.97 for flag leaf area; Crow MH.97 for plant height, 1000-grain weight and biomass per plant. Chak.97 x Kohis.97 for 1000-grain weight, biomass per plant and grain yield per plant; 87094 x 85205 for grain yield and harvest index. Under drought this situation was found in 85205 x Kohis.97 for flag leaf area and spike length; Parula x MH.97 for plan height, tillers per plant spike len and grain yield per plant; Chak.9 Pb.96 for tillers per plant and gra yield; 87094 x MH.97 for flag lea area, specific flag leaf weight and grains per spike; 85205 x Pb.96 for spikelets per spike, biomass per plan and grain yield; Chak.97 x MH.97 for 1000-grain weight, biomass per plant and grain yield per plant.

Crosses presenting high SCA and involving at least one parent with high GCA (Low x high) indicated the involvement of additive x dominance gene interaction for the expression of that particular trait. This situation under irrigated condition was indicated in Parula x MH.97 for days to heading, biomass and grain yield per plant; Crow x Pb.96 for specific flag leaf weight and tillers per plant; Chak.97 x MH.97 for tillers per plant and spikelets per spike; Chak.97 x Kohis.97 for flag leaf area, grains per spike and spikelets per spike; 85205 x MH.97 for 1000-grain weight and grain yield; Parula x 85205 for spike length and biomass per plant; Pb.96 x MH.97 for grain yield per plant.

This situation under drought was found in crosses like 87094 x Chak.97 for days to heading; Parula x Pb.96 for specific flag leaf weight and grains per spike; Chak.97 x Kohis.97 for grains per spike and spike length; Crow x Kohis.97 for tillers per plant, biomass and grain yield per plant; Parula x Chak.97 for grains per spike; Parula x 87094 for grain yield per plant.

Studies pertaining to heterosis revealed significant mid-parent and better-parent heterosis for all the characters. Number and magnitude of hybrid vigour was generally low under drought condition as compared to that under irrigated condition. Magnitude of hybrids showing significant positive increase for flag leaf area, specific flag leaf weight, plant height, spike length, spikelets per spike, 1000-grain weight and harvest index was greater under irrigated condition while magnitude of hybrid increase for tillers per plant and grains per spike was greater in hybrids under drought stress conditions. The results suggested the exploitation of hybrid vigour of certain crosses like, MH.97 x Chak.97, Parula x MH.97 and Crow x MH.97 for flag leaf area, tillers per plant, spike length, grains per spike, 1000-grain weight and grain yield per plant.The presence of both additive and non-additive variability suggested the utilisation of certain genotypes and crosses to evolve new wheat genotypes for irrigated as well as drought environments. The use of diallel mating with recurrent selection and integration with pedigree selection will yield new combinations with accumulation of desirable genes.■

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