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COMBINING ABILITY OVER ENVIRONMENTS IN DURUM WHEAT

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ABSTRACT

The comibing ability studies made over environments (sowing dates) for eight characters in durum wheat using 15 × 4 line–tester set revealed that both general combining ability (gca) and specific combining ability (sca) components of variance were significant for all the evaluated characters, viz., grain yield/plant, spikes/plant, spikelets/spike, grains/spike, 100-grain weight, plant height and days to flowering. Both gca and sca were influenced by environments. The parents JU 85, HDM 22550-3, Bansi, Jori C 69 and MACS 1269, having been observed as good combiners for grain yield and certain component traits also, offer the best possibilities of exploitation for the development of improved lines. The cross combinations A206 × Jori C 69, HDM 22550-3 × JU 12, and JU 85 × MACS 9 involving good × average general combiners and exhibiting significant positive specific effects for grain yield are expected to throw transgressive segregants and need exploitation in breeding programmes. As both additive and nonadditive gene effects played role in the inheritance of different attributes, their simultaneous exploitation through adoption of biparental approach in early generation mating is advocated.

Key words: Combining ability, transgressive segregant, durum wheat.

Combining ability studies are frequently used by the plant breeders to evaluate newly developed cultures for their parental usefulness and to assess the gene action involved in various characters so as to design an efficient breeding plan for further genetic upgrading of the existing material. The combining ability studies in a single environment may not provide precise information as environmental effects play an important role and greatly influence the combining ability estimates. There are very few reports available on environmental effects on combining ability estimates and information on these aspects is extremely lacking in durum wheat. The present investigation was, therefore, undertaken to derive information on the nature of combining ability operative in the inheritance of different economic traits and detect the role of environmental components on the combining ability estimates.

MATERIALS AND METHODS

Fifteen genetically diverse lines of durum wheat (*Triticum durum* Desf.) originating from different agroclimatic zones of country used as females were crossed with four males (A206, JU 85, Raj 1555 and HDM 22550-3) and thus 60 F_1 were obtained. The 79 entries including 19 parents and 60 F_1 were sown during winter 1982-83 in randomized block design providing three replications in three dates of sowing, i.e., 25 October, 15 November and 2 December. The plant-to-plant and row-to-row spacings were 10 cm and 30 cm, respectively. Recommended cultural practices were followed uniformly to raise the normal crop. The data were collected on five randomly selected competitive plants for eight characters (Table 1). The combining ability analysis using entry means was done over three dates of sowing (environments) on the basis of Kempthorne's model [1].

RESULTS AND DISCUSSION

The analysis of variance showed significant differences among parents as well as progenies in all three sowings for all the evaluated characters, viz., grain yield/plant, spikes/plant, spikelets/spike, grains/spike, grain weight/spike, 100-grain weight, plant height, and days to flowering. The analysis of variance for combining ability for the data pooled over environments revealed that mean squares due to males, females and males × females were significant for all the characters studied indicating the importance of both additive and nonadditive gene effects. However, additive gene effects were predominant except for grain yield/plant and grains/spike.

The mean squares due to environments were highly significant for all the characters indicating sufficient diversity among environments. The mean squares due to males × environments interaction were significant for all the characters, whereas females × environments mean squares were significant for grain yield/plant, grains/spike, 100-grain weight, plant height, and days to flowering. This indicated that general combining ability (gca) effects of parents were influenced by environment. Further, the mean squares due to crosses × environments interaction showed that the specific combining ability (sca) effects of crosses for majority of characters were not consistent over environments except for spikelets/spike and spikes/plant. It may, therefore, be suggested that for unbiased estimates of combining ability, the studies must be carried out over a range of environments.

The pooled general combining ability effects obtained for various evaluated characters (Table 1) revealed that male parents JU 85 and HDM 22550-3 and female parents Bansi, Jori C 69, and MACS 1269 were the best having high gca effects for not only grain yield but also for a majority of yield components. Bansi, MACS 1269 and JU 85 had high per se performance also for all the characters. High gca effects mostly contribute to additive gene effects or additive × additive interaction effects and represent fixable portion of genetic variation. Thus it would be worthwhile to exploit these varieties/lines for development of improved varieties of durum wheat. It is suggested that population involving these lines in a multiple crossing programme may be developed for isolating high yielding varieties. Further, the varieties showing good gca for particular component may be utilized in component breeding for effective improvement in a particular component, thereby seeking improvement in yield.

Twelve out of 60 crosses showed significant positive sca effects for grain yield/plant. Specific combining ability effects represent dominance and epistatic

Table 1. General combining ability effects pooled over the environments

Parent	Grain yield per plant	Spikes per plant	Spikelets per spike	Grains per spike	Grain weight per spike	100-grain weight	Plant height	Days to flowering
Males:								
A206	−0.21	0.77**	−0.55**	0.22	−0.20**	−0.07*	8.02**	−0.59**
JU 85	2.05**	0.92**	0.14*	0.64**	−0.09*	−0.26**	−6.05**	−0.17**
Raj 1555	−2.31**	−1.63**	−0.54**	−0.26	0.19**	0.26**	−2.66**	−3.22**
HDM 22550-3	0.46*	−0.05	0.92**	−0.59**	0.11**	0.07*	0.70**	3.98**
SE ±	0.23	0.17	0.06	0.20	0.04	0.03	0.24	0.05
Females:								
A 9-30-1	−1.30**	0.18	0.51**	2.05**	−0.09	−0.13*	7.52**	3.11**
Anhinga	0.42	−0.51	−0.12	2.48**	0.24**	−0.05	−1.30**	−1.71**
Bansi	2.41**	0.39	0.77**	1.12**	0.15	0.65**	13.16**	0.34*
Bijaga yellow	0.74	0.56	0.17	0.60	−0.07	0.00	12.06**	0.67**
Flamingo	−2.25**	−0.71*	−0.01	−0.37	−0.10	−0.24**	−10.75**	−1.14**
Jairaj	−0.43	−0.51	−0.29*	−0.46	0.15	−0.04	−2.05**	−1.91**
Jori C 69	1.19**	0.41	0.38**	−0.73	−0.02	0.16**	−5.21**	2.75**
JU 12	0.84	0.63	−0.27*	−1.04**	−0.01	−0.19**	8.83**	3.23**
JU 91	0.77	0.35	0.14	0.19	0.06	−0.23**	−6.62**	2.42**
JU 109	−0.19	−0.11	−0.55**	0.27	−0.09	−0.03	−11.25**	−1.47**
JU 129	−3.21**	−0.87*	−0.31**	2.05**	−0.05	−0.45**	−13.48**	−1.97**
Kiwis	−1.00*	−0.36	−0.79**	−2.17**	−0.10	−0.20**	−17.46**	−1.89**
MACS 9	0.48	0.25	−0.20	0.87*	0.03	0.15**	9.22**	−0.50*
MACS 1269	1.36**	0.19	−0.13	−2.55**	0.05	0.47**	8.16**	−1.72**
N 59	−0.13	0.18	0.10	−2.82**	0.09	0.32**	9.19**	−0.19
SE ±	0.46	0.34	0.11	0.39	0.08	0.06	0.46	0.10

Significant at *P=0.05, **P=0.01.

component of variation which are nonfixable in nature. However, when high sca effects are observed in crosses involving either both or one good general combiner parent, they could be successfully exploited for varietal improvement. In the present study, such crosses for grain yield were A206 × Jori C 69, HDM 22550-3 × JU 12, and JU 85 × MACS 9. These could be expected to yield transgressive and stable performing segregants in the advanced generations and, thus, need exploitation in breeding programmes.

The present study has revealed the importance of both additive and non-additive gene effects in the inheritance of the characters studied in durum wheat. Under such situations, where both additive and nonadditive gene effects are important, maximum yield gain may be attainable with a system that can exploit both additive and nonadditive gene effects simultaneously. Winder and Lebsock [2] and Singh et al. [3] also suggested that maximum grain production in durum wheat may be attainable with a system that exploits both additive and nonadditive gene effects simultaneously. As such in certain populations, biparental matings as well as mating of selected plants in early segregating generations could help in developing potential population having optimum levels of homozygosity and heterozygosity. Further exploitation of such populations would lead to the development of high yielding lines.

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