Indian J. Genet., 55 (3): 228–232 (1995)

DIALLEL ANALYSIS FOR COMBINING ABILITY FOR GRAIN YIELD AND ITS COMPONENTS IN BARLEY

V. K. BHATNAGAR AND S. N. SHARMA

Department of Genetics and Plant Breeding, Agricultural Research Station Durgapura, Jaipur 302018

(Received: January 24, 1994; accepted: June 3, 1994)

ABSTRACT

Combining ability analysis was undertaken in 10 x 10 half diallel progenies of barley for grain yield and its component characters in both F_1 and F_2 generations. Both additive and nonadditive gene actions were important in controlling the inheritance of all the traits. However, additive gene action was predominant. The parents BG 105, DL 88, and DL 165 were the best general combiners for grain yield and average to high combiners for other important traits. The best specific crosses for grain yield were BG 105 x RD 728, BL 2 x BG 105, DL 100 x DL 88 and DL 165 x DL 88, involving parents with medium x high and high x high general combiners. Exploitation of additive and nonadditive gene actions through biparental mating and/or diallel selective mating systems is suggested.

Key words: Barley, combining ability, gene action, quantitative traits, heterosis.

The success of any breeding programme depends mainly on the selection of parents which, when crossed, will result in higher proportion of transgressive segregants. This necessitates the investigation of combining ability before initiating any varietal improvement programme. 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.

Therefore, the present investigation was undertaken to get information on the nature of combining ability operative in the inheritance of grain yield and its components in barley to accelerate the pace of its genetic improvement for grain yield.

MATERIALS AND METHODS

Ten barley cultivars, viz., RD 103, BL 2, RD 728, DL 88, DL 100, DL 165, BH 28, BG 25, BG 105 and K 125 of diverse origin were crossed in all possible combinations excluding reciprocals. The parents, their 45 F_1 and F_2 progenies were grown in randomized block design with three replications under normal sown condition at Research Farm, Agricultural Research Station, Durgapura, Jaipur, Rajasthan. The parents and F_1 were grown in single-row and F_2 in four-row plots, 4 m long, with the spacing of 30 cm between rows and 10 cm between plants. Observations were recorded on ten competitive plants in parents and F_1 and 25 plants in each F_2 progeny for nine quantitative characters (Table 1).

The character means for each plot was used for statistical analysis. The combining ability estimates were calculated as proposed in Griffing's Method II, Model I [1].

RESULTS AND DISCUSSION

Analysis of variance showed significant differences among parents as well as progenies for all the characters under study indicating the presence of considerable amount of variability. Analysis of variance for combining ability (Table 1) revealed that the mean squares due to general (gca) and specific combining ability (sca) were highly significant for

Table 1. Analysis of variance (mean squares) for combining ability for yield and its component characters in six-rowed barley

Source	Generation	d.f.	Days to flower	Days to maturity	Plant height	Tiller number	Ear length	Grains per ear	1000-grain weight	Harvest index	Grain yield
Gca	F_1	9	59.1**	15.8**	368.3**	33.7**	2.0**	68.9**	184.9**	205.8**	370.0**
	F_2	9	33.5**	16.5**	615.3**	11.9**	4.7**	89.1**	56.0**	191.1**	132.2**
Sca	F_1	45	9.5**	3.9**	73.8**	12.5**	0.7**	40.5**	17.4**	36.9**	60.7**
	F_2	45	13.5**	5.6**	70.7**	5.6*	0.3**	18.8**	9.4**	35.3**	30.2**
Error	F_1	54	0.6	0.2	2.1	0.7	0.1	1.6	1.7	1.9	1.0
	F_2	108	0.7	0.2	3.1	0.6	0.1	2.4	1.1	2.1	1.5

*P = 0.05, **P = 0.01.

all the traits studied in both F_1 and F_2 generations, indicating the importance of both additive and nonadditive gene actions in controlling the inheritance of yield and its component characters. However, additive gene effects were predominant in both generations except for harvest index in F_2. These findings confirm the earlier reports [2–4], which clearly indicated additive genetic variance as the main component of genetic variance for various economic traits in barley. However, preponderance of nonadditive effects [5–7] and role of both additive and nonadditive effects were also reported for grain yield and its component characters [8–9].

The gca estimates (Table 2) showed that the parents BG 105, DL 88, DL 165, BG 25 were the best general combiners for grain yield and good to medium combiner for most of the important yield component characters. However, the other parents were poor combiners for grain yield and medium to poor general combiners for yield contributing traits. The parents RD 103 and RD 728 were good general combiners for dwarfness and DL 88 for early flowering. Almost similar trends for gca of parents were observed for yield and its

Table 2. Estimates of general combining ability effects for yield and its component characters in six-rowed barley

Parent variety	Generation	Days to flower	Days to maturity	Plant height	Tiller number	Ear length	Grains per ear	1000-grain weight	Harvest index	Grain yield
RD 103	F_1	1.5^{**}	0.1	-6.8^{**}	1.9^{**}	-0.2^{*}	-3.7^{**}	-4.7^{**}	-6.2^{**}	-2.4^{**}
	F_2	-1.3^{**}	-0.9^{**}	-4.9^{**}	0.4	-0.2^{*}	-1.0^{*}	-4.4^{**}	-6.5^{**}	-4.0^{**}
BL 2	F_1	0.4	0.5^{**}	-2.1^{**}	-1.0^{**}	0.3^{**}	-0.1	-3.1^{**}	-2.1^{**}	-4.6^{**}
	F_2	-2.6^{**}	-1.0^{**}	1.4^{**}	0.6^{*}	-0.1	-1.3^{**}	-3.2^{**}	-3.0^{**}	-1.8^{**}
DL 100	F_1	1.2^{**}	0.9^{**}	0.1	-1.2^{**}	0.2^{*}	1.3^{**}	-0.7^{*}	-4.0^{**}	-4.2^{**}
	F_2	0.4	0.0	1.3^{*}	0.4	0.8^{**}	2.0^{**}	1.2^{**}	-4.0^{**}	-0.2
BG 25	F_1	0.8^{**}	0.7^{**}	4.3^{**}	0.6	-0.7^{**}	-2.2^{**}	-0.5	0.5	0.6^{*}
	F_2	1.6^{**}	1.9^{**}	2.1^{**}	0.7^{**}	-0.1	-1.7^{**}	0.6^{*}	1.5^{**}	1.5^{**}
DL 165	F_1	0.8^{**}	0.4^{**}	4.1^{**}	1.4^{**}	0.2^{*}	1.6^{**}	-2.1^{**}	-1.5^{**}	1.6^{**}
	F_2	0.6^{*}	1.1^{**}	7.4^{**}	0.6^{*}	0.4^{**}	3.7^{**}	-1.2^{**}	1.3^{**}	2.6^{**}
K 125	F_1	0.7^{**}	-0.1	1.3^{**}	-2.2^{**}	0.8^{**}	1.9^{**}	0.1	-2.0^{**}	-4.2^{**}
	F_2	0.0	0.1	1.0^{*}	-1.9^{**}	1.0^{**}	3.4^{**}	-0.2	-3.6^{**}	-4.9^{**}
BG 105	F_1	-0.6^{*}	0.4^{**}	8.5^{**}	2.0^{**}	-0.2^{*}	4.2^{**}	5.8^{**}	1.9^{**}	10.9^{**}
	F_2	0.2	0.5^{**}	7.6^{**}	0.6^{**}	-0.8^{**}	0.8^{*}	4.4^{**}	3.4^{**}	5.9^{**}
BH 28	F_1	1.3^{**}	0.4^{**}	-1.9^{**}	-1.4^{**}	-0.0	-2.8^{**}	2.9^{**}	4.7^{**}	-2.6^{**}
	F_2	2.3^{**}	0.6^{**}	2.2^{**}	-0.6^{**}	0.0	-3.4^{**}	1.7^{**}	3.3^{**}	-0.8^{*}
DL 88	F_1	-6.1^{**}	0.8^{**}	2.6^{**}	2.3^{**}	-0.0	0.3	6.6^{**}	7.9^{**}	8.8^{**}
	F_2	-2.5^{**}	1.0^{**}	-0.5	0.7^{**}	-0.0	1.4^{**}	2.4^{**}	5.9^{**}	3.0^{**}
RD 728	F_1	0.5^{*}	3.2^{**}	-10.3^{**}	-1.6^{**}	-0.7^{**}	-0.6	-0.4	0.8^{*}	-3.9^{**}
	F_2	1.2^{**}	-2.6^{**}	-17.6^{**}	-1.5^{**}	-1.0^{**}	-4.3^{**}	-1.9^{**}	1.7^{**}	-1.5^{**}
SE (±)	F_1	0.2	0.1	0.4	0.2	0.1	0.3	0.3	0.4	0.3
	F_2	0.2	0.1	0.5	0.2	0.1	0.4	0.3	0.4	0.3
C.D	F_1	0.6	0.4	1.2	0.7	0.3	1.0	0.8	1.3	0.8
	F_2	0.7	0.4	1.4	0.6	0.2	1.1	0.8	1.2	1.0

$^{*}P = 0.05$, $^{**}P = 0.01$.

component traits on the basis of F_1 and F_2 analysis except for the parent BG 25. Parents BG 105 and DL 88 were also high combiners for tiller number, grains/ear, 1000-grain weight and harvest index, but low combiners for early maturity, dwarfness and ear length. The parent DL 165 was a good combiner for tiller number, ear length and grains/ear but poor for remaining the traits. Interestingly, BG 25 exhibited significant positive gca effects only in F_2 for tiller number, 1000-grain weight and harvest index, which indicates that this variety is a general combiner only for important yield components, but poor for yield itself.

High gca effects are mostly due to additive gene effects or additive x additive interactions as earlier reported by Griffing [1]. In view of this, the parents BG 105, DL 88 and DL 165 offer the best possibilities for the development of improved lines of barley through hybridization programme. It is, therefore, recommended that to improve yield one should breed for superior combining ability for the component traits with an ultimate objective to improve the pace of its genetic improvement.

The sca estimates of 18 crosses in F_1 and 11 crosses in F_2 were significantly positive for grain yield. The high sca for yield was observed only in the crosses BL 2 x BG 105, BG 105 x RD 728, DL 165 x DL 88, BG 25 x K 125 and RD 103 x BH 28 in F_1 generation and BG 105 x DL 88 and DL 100 x DL 88 in F_2 generation. These crosses were the highest yielders, and involved one good combiner parent, which indicated that such combinations are expected to throw desirable transgressive segregants. However, the crosses RD 103 x DL 88, BL 2 x BG 105, DL 100 x DL 88, DL 165 x DL 88, K 125 x BG 28, BG 105 x RD 728, BH 28 x DL 88 and DL 88 x RD 728 showed significant positive sca effects in both F_1 and F_2 generations. It is noteworthy that crosses which exhibited consistently significant positive sca in both the generations also exhibited significant positive heterosis over better parent.

It is, therefore, suggested that sca performance may be considered as a criterion for selecting the promising crosses in barley. It may also be worth while to attempt biparental matings in the segregating generation among selected crosses to permit greater recombinations. The best crosses for grain yield also showed average to high sca effects for most of the yield component characters. All the important crosses involving parents with high x high, high x medium and medium x medium general combiners for yield, indicated that unfixable nonadditive gene actions were involved in the selected crosses.

The results of this study show that high sca for grain yield is generally due to high to medium sca for yield components. In no case, high sca was observed for all the component traits. It is, therefore, necessary to use new materials in future breeding programme to recombine the desirable traits in the existing elite genotypes. The crosses BG 105 x RD 728, BL 2 x BG 105, DL 100 x DL 88 and DL 165 x DL 88 are excellent crosses for grain yield. Therefore, these crosses should be particularly exploited vigorously in future breeding programmes to obtain good segregates which would lead to build up a population with high genetic yield potential.

Since additive as well as nonadditive gene effects control grain yield and its component characters, breeding methods such as biparental matings and/or diallel selective mating are suggested for amelioration of grain yield in barley through its component traits.

REFERENCES

1. B. Griffing. 1956. Concept of general and specific combining ability in relation to diallel crossing system. Aust. J. Biol. Sci., **9**: 463–493.

2. J. D. Hayes and R. S. Paroda. 1974. Parental generation in relation to combining ability analysis in spring barley. Theor. Appl. Genet., **44**(8): 373–377.

3. Z. R. Haung. 1984. Studies on heterosis and combining ability in F_1 hybrid of six-rowed barley. Acta Agron. Sinica, **10**(2): 123–131.

4. Mahabal Ram. 1989. Genes for dwarfness in barley and inter-relationship of plant height with yield and yield components. Indian J. agric. Sci., **59**(1): 27–31.

5. S. K. Sethi, R. S. Paroda and D. Singh. 1986. Genetics of harvest index and its components in barley. Crop Improv., **13**(2): 206–208.

6. B. D. Chaudhary. 1987. Estimation of gene effects for grain yield in barley. Cereal. Res. Comm., **15**(2–3): 195–196.

7. Ishwar Singh. 1992. Generation Mean Analysis in Two Tall x Dwarf High Yielding Crosses of Barley. M. Sc. Thesis. Rajasthan Agril. University, Bikaner.

8. G. F. Nikitenko and V. T. Gorodov. 1981. Results of breeding and genetic study of parental material of spring barley in diallel crosses. Referat. Zh., **7**(65): 224.

9. P. S. Madan and K. S. Bains. 1982. Inheritance of some yield character in barley. Crop Improv., **9**(1): 31–36.