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COMBINING ABILITY IN THE F_1 AND F_2 GENERATIONS OF DIALLES CROSS IN MACARONI WHEAT (*TRITICUM DURUM* DESF.)

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ABSTRACT

Combining ability analysis in macaroni wheat (*Triticum durum* Desf.) involving 10 diverse parents and their 45 F_1 and F_2 progenies indicated significant differences for gca among the parents, and for sca in crosses for all the characters studied, except for sca for straw yield in F_2. Additive variance (σ^2A) was higher than the dominance (σ^2 D) for all the characters, except for tillers/plant and grain yield, indicating the predominance of additive gene action for the traits studied. Among the parents, JNK-4W-184, A-9-30-1 and Storck's' were good general combiners for grain yield and also high to average combiners for most of the yield components. The cross Cocorit 71 x A-9-30-1 was consistently good specific combiner for grain yield in both generations. Most of the good specific crosses for grain yield involved Indian and exotic genotypes. Such crosses could be explored further for improvement in the grain yield of *durum* wheat through the combinations of desirable yield components. Biparental mating and/or multiple crosses are recommended in view of significance of both additive and nonadditive gene effects to get tangible advancements.

Key words: Dialles cross, combining ability, macaroni wheat, gene action.

Macaroni wheat (*Triticum durum* Desf.) is the second most important wheat species grown in India. Any improvement in this group of wheat would have a direct bearing not only in varietal diversification but also in augmenting total wheat production of the country. Therefore, the investigation was carried out to elicit information on the nature of gene action and to identify desirable parents for yield and important yield traits by combining ability analysis in 10 x 10 diallel progenies (F_1, F_2). Since, limited information is available on these aspects in macaroni wheat, the information so generated will be helpful in formulating an efficient breeding methodology in this important group of wheat.

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MATERIALS AND METHODS

Ten varieties of macaroni wheat, viz., Raj 1516, HD 4530, NP 401, Cocorit 71, Flamingo's', Storck's', Raj 911, A-9-30-1, Raj 2061, and JNK-4W-184 of diverse genetic origin, were crossed in all possible combinations, excluding reciprocals. Forty five F_1 hybrids so obtained were selfed to produce F_2. Ten parents along with their 45 F_1 and F_2 progenies were grown in randomized block design with three replications under normal sown environment at Agricultural Research Station, Sriganganagar, Rajasthan. The parents and F_1s were grown in single rows and F_2s in four rows. Each row was 5 m long, 30 cm apart rows, 10 cm spacing between plants. The usual cultural practices were followed to raise the crop. Five competitive plants of the parents and F_1s and 20 plants in each F_2 family were selected randomly to record observations on ten quantitative traits (Table 1). Analysis for combining ability was carried out following Method 2, Model 1 of Griffing [1]. Components of variances were translated into genetic components (σ^2A & σ^2D) as suggested by Singh and Choudhary [2].

RESULTS AND DISCUSSION

Significant value of variances (Table 1) due to general combining ability (gca) and specific combining ability (sca) in both F_1 and F_2 revealed that both additive and dominance gene effects are important in the inheritance of all the characters studied. However, the

Table 1. Analysis of variance (M.S.) for combining ability for grain yield and its components in macaroni wheat

Source	Generation	d.f.	Days to heading	Days to maturity	Plant height	Tillers per plants	Spike length	Spikelets per spike	Grains per spike	1000-grain weight	Straw yield	Grain yield per plant
Gca	F_1	9	117.62**	18.79**	1297.66**	5.87**	1.64**	5.78**	231.41**	132.80**	2893.4**	95.5**
	F_2	9	97.71**	17.31**	1182.62**	3.55**	1.08**	4.70**	202.0**	125.28**	1242.6**	44.4**
Sca	F_1	45	2.80**	1.08**	49.27**	3.47**	0.12**	0.26**	18.5**	15.04**	404.9**	52.5**
	F_2	45	2.93**	1.13**	15.09**	1.59**	0.07**	0.22**	8.3**	5.69**	74.0	8.6**
Error	F_1	108	0.51	0.38	2.03	1.89	0.03	0.07	5.8	1.67	167.6	17.8
	F_2	108	0.72	0.41	3.60	0.99	0.01	0.07	3.8	2.05	53.4	4.6
σ^2A	F_1		9.57	1.47	104.03	0.20	0.13	0.46	17.8	9.81	207.4	3.6
	F_2		7.89	1.34	97.29	0.16	0.08	0.37	16.1	9.96	97.4	3.0
σ^2D	F_1		2.29	0.70	47.24	1.58	0.09	0.19	12.7	13.37	237.3	34.7
	F_2		2.21	0.72	11.49	0.60	0.06	0.15	4.5	3.64	20.6	4.0

*P = 0.05, **P = 0.01.

relative magnitude of additive (σ^2A) and dominance (σ^2D) variance revealed that grain yield and number of tillers were mainly controlled by nonadditive genes, while the remaining characters were controlled by additive genes, in both generations except for straw yield which was influenced by both dominance (F_1) and additive components (F_2). These results are in agreement with the earlier reports on a wide range of durum materials [3–11].

The gca estimates (Table 2) revealed that the parents JNK-4W-184, A-9-30-1 and Stork's' were good general combiners for grain yield, whereas parents Raj 2061 and HD 4530 were

Table 2. General combining ability effects for grain yield and its components in macaroni wheat

Parent	generation	Days to heading	Days to maturity	Plant height	Tillers per length	Spike	Spikelets per spike	Grains per spike	1000-grain weight	Straw yield	Grain yield per plant
Raj 1516	F_1	–1.53**	0.18	–11.48**	–0.11	–0.45**	–0.01	2.87**	–2.04**	–12.42**	0.28
	F_2	–1.40**	0.21	–10.76**	0.27	–0.39**	–0.11	2.12**	–1.30**	–7.96**	0.25
HD 4530	F_1	–1.95**	–0.76**	–11.11**	–0.14	–0.01	–0.92**	–0.36	–4.14**	–25.40**	–3.70**
	F_2	–2.93	–1.50**	–9.44**	0.23	–0.06	–0.48**	–0.26	–3.37**	–18.09**	–2.13**
NP 401	F_1	4.79**	1.38**	18.14**	–0.79*	0.69**	0.79**	–0.36	3.67**	32.79**	1.74
	F_2	3.31**	1.25**	15.80**	–0.55*	0.35**	0.29**	–1.32*	2.97**	19.07**	0.38
Cocorit 71	F_1	0.20	–0.56**	–2.50**	1.03**	–0.20**	–0.17*	2.73**	–2.56**	–1.73	1.57
	F_2	0.26	–0.19	–0.31**	0.78**	–0.14**	–0.09	1.04*	–2.67**	–4.23*	1.12
Flamingo's'	F_1	1.90**	1.07**	–5.83**	0.61	0.31**	0.67**	1.30*	–1.06**	–3.51	0.19
	F_2	2.44**	1.19**	–6.90**	0.61**	0.35**	0.77**	–0.56	–1.56**	–0.99	–0.46
Storck's'	F_1	–2.30**	–1.76**	–1.81**	0.29	–0.47**	–0.91**	1.41*	1.04**	–0.36	1.15
	F_2	–2.17**	–1.76**	–2.23**	–0.07	–0.41**	–0.87**	2.21**	1.44**	–5.41**	1.40*
Raj 911	F_1	3.75**	1.72**	–5.13**	0.01	0.10*	0.13	–2.56**	1.22**	6.84	–1.22
	F_2	3.54**	1.49**	–4.65**	–0.35	–0.18**	0.14	2.44**	1.06**	5.27**	–1.26*
A-9-30-1	F_1	2.71**	0.47**	15.44**	–0.47	0.28**	0.60**	2.87**	–2.32**	0.40	–0.05
	F_2	3.06**	0.64**	17.08**	–0.02	0.36**	0.84**	4.62**	–2.87**	5.04*	2.19**
Raj 2061	F_1	–3.73**	0.18	–3.79**	–1.18**	–0.26**	–0.84**	–10.55**	6.95**	–5.94	–4.49**
	F_2	–3.42**	0.01	–3.51**	–1.03**	–0.20**	–0.93**	–9.66*	7.09**	–1.30	–3.71**
JNK-4w-184	F_1	–3.83**	–1.92**	8.08**	0.75*	0.02	0.66**	5.26**	–0.76*	13.34**	4.99**
	F_2	–2.69**	–1.35**	6.94**	0.12	–0.04	0.45**	4.24**	–0.80*	8.60**	2.21**
S.E.(gi)	F_1	0.19	0.16	0.39	0.37	0.05	0.07	0.66	0.35	3.54	1.15
	F_2	0.23	0.17	0.51	0.27	0.03	0.07	0.53	0.39	2.00	0.58
S.E. (gi-gj)	F_1	0.29	0.25	0.58	0.56	0.07	0.11	0.98	0.52	5.28	1.27
	F_2	0.34	0.26	0.77	0.40	0.04	0.11	0.79	0.58	2.98	0.87

*P = 0.05, **P = 0.01.

consistently poor combiners for grain yield but good combiners for earliness. None of the parents was a good general combiner for all the traits. However, all the three good general combiner for all the traits. However, all the three good combiners for grain yield also appeared to be the best general combiners for most of the component traits. The parent JNK-4w-184 was also a good combiner for earliness, number of tillers, spikelets and grains/spike, and straw yield; A-9-30-1 for spike length, spikelets and grains/spike, and straw yield; and Stork's' for earliness, dwarfness, grains per spike, 1000-grain weight. Cocorit 71 and Flamingo's' were the other promising parents showing high gca effects for important yield traits. The gca effects represent the fixable components of genetic variance [12]. Thus, the parents, especially JNK-4W-184, A-9-30-1 and Stork's', may be useful in hybridization programmes for the improvement of grain yield of macaroni wheat.

The specific combining ability (sca) effect represents nonfixable components of genetic variance, related with heterosis. Among the 45 crosses, seven crosses in F_1 and five crosses in F_2 were found to be good specific combiners for grain yield. However, the highest positive and significant sca effect was exhibited by the cross NP 401 x Raj 911 for grain yield which also gave highest per se performance in F_1. The other promising crosses which showed significant positive sca effects for grain yield were Cocorit 71 x A-9-30-1, HD 4530 x Raj 2061, Flamingo's' x A-9-30-1, Cocorit 71 x JNK-4w-184, HD 4530 x Stock's', and NP 401 x Flamingo's' in F_2 generation, the crosses HD 4530 x A-9-30-1 followed by Stock's' x Raj 2061, Stock's' x Raj 911, Stock's' x A-9-30-1 and Cocorit 71 x A-9-30-1 showed significant positive sca effects for grain yield. These crosses also exhibited average to high sca effects for some of the yield components. However, the sca effects in different generations did not have much similarity except the cross Cocorit 71 x A-9-30-1. This indicates the occurrence of sca x generation interaction as also reported by [13–15].

An examination of the sca effects of different crosses revealed that the crosses showing higher sca effects did not necessarily involve good general combiners as their parents as observed by [7, 8, 13–15] .The crosses with significant positive sca have potential for further improvement in grain yield through its component traits. It is therefore suggested that such crosses should be exploited vigorously in the future breeding programmes to obtain good segregates which will lead to build up a population with high genetic yield potential.

It is noteworthy that most of the crosses showing high sca effects for grain yield in both F_1 and F_2 generations were combinations of Indian x exotic types. This emphasises the need for combining two diverse germplasms to create maximum genetic variability which is the prime requirement and this alone would help in raising yield levels through selection in any successful breeding programme [16].

The study revealed that the additive component (σ^2A) was predominant and played a more important role than the dominance component (σ^2D) in the genetic control of all the traits studied except tillers/plant and grain yield/plant. Hence pedigree method of selection can be used for the improvement of the characters. On the contrary, characters like tillers/plant and grain yield were mainly under the control of nonadditive gene action, though they also showed considerable amount of additive genetic variance. Improvement of such characters needs a breeding methodology which can capitalize on additive as well as nonadditive genetic variances. In this situation biparental mating offers good promise to increase the frequency of genetic recombination and hasten the rate of genetic improvement. Inclusion of high sca F_1s and high gca parents in multiple crosses could also prove a rewarding approach.

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