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Role of Removing Correlations in Combining Ability Analysis

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Six exotic and six indigenous strains of barley were used to produce four partial diallel and two diallel sets. Original and transformed data were analysed following Griffing's method (1956) for diallel sets and Kempthorne and Curnow's approach (1961) for partial diallel sets. The results were interpreted by rank correlations. In general, significant effect of transformation was recorded. Rank correlations between original and transformed data for mean squares due to gca, sca, error and sca/gca ratio indicated considerable effect of transformation in each analysis. When the statistical parameters were translated into genetical components, the effect of transformation became more evident.

Stress an internal, inter-trait correlations between sequential characters effect the characters in terms of genetic control. This is more influenced in complex traits like grain yield which are under the control of various component traits. In general, observed values are used for the interpretation of the data without giving any consideration to correlations present between the ultimate and component characters. Some studies have already proved the substancial role of removing correlations (Thomas *et al*., 1971 a, b; Lee and Kaltsikes, 1972).

The application of diallel analysis in plant breeding for screening good combiners for the purpose of heterosis dates back to the work of Sprague and Tatum (1942). Diallel crosses involving all possible combinations with a set of inbred lines become unmangeable as the number of parents increase. If only a small number of inbreds are tested, the estimates of combining ability may have a large sampling error. For this reason, the concept of partial diallel analysis was put forward by Kempthorne and Curnow (1961). The present investigation was planned to study (i) the effect of transformation on various genetic analyses and (ii) to compare the efficiency of diallel analysis with some of its modifications.

MATERIALS AND METHODS

Four exotic (AB 12/59, EB 1556, PTS 57 and A 59) and four indigenous (BG 1, K 572/10, IB 226 and C 164) strains of barley were used to prepare a diallel set of 56 crosses including reciprocals. Two exotic (Numer and EC 24882) and two indigenous (RD 42, and BP 3) strains were added for a partial diallel set of 30 crosses with five samples per parental veriety. These F_1 hybrids inculding parents were sown

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in a randomized block design with four replications under similar agronomic practices. Data on five competitive plants were recorded for plant height, ear length, effective tillers, grain yield, ear weight and grains per ear. The data were transformed to uncorrelated values by pivotal condensation method of multivariate analysis (Rao, 1952).

Six experiments conducted were (a) Full diallel set of 56 hybrids along with eight parents, (b) Half diallel set of 28 hybrids along witd eight parents, (c) Partial diallel (PD) - I with twelve parents and five samples per parental variety, (d) PD-II with twelve parents and three samples per parental variety, (e) PD-III with eight parents and five samples per parental variety and (f) PD-IV with eight parents and three samples per parental variety. Data on full and half diallel were analysed following Griffing (1956). Similarly, all the four variants of PD were analysed following Kempthorne and Curnow (1961). For comparing the orginal and transformed data, rank correlations were computed (Snedecor, 1946) giving rank I to the highest value.

RESULTS AND DISCUSSION

Mean squares for gca and sca obtained from the original data were significant in case of full as well as half diallel for all the six characters. In transformed data both gca and sca mean squares were significant for all the characters except effective tillers in full diallel (Chaudhary and Singh, 1977) as well as half diallel. However, mean squares due to gca was also non significant for grain yield, the only complex character, in half diallel. Thus, transformation had more effects on gca mean squares than on sca mean squares. Hence additive variance is more influenced by the removal of correlations. Thomas *et al.* (1971 a, b) also reported deviation from additivity by transformation.

Mean squares due to gca and sca were significant in both original and transformed data for all the four kinds of partial diallel for all the characters except sca mean squares in PD-I for effective tillers (Chaudhary, 1977). Further, reciprocal effects in full diallel, plant height, effective tillers and grain yield were significant in original data, whereas, in transformed data these were non significant.

For a better understanding, rate of sca/gca mean squares was calculated. In general, both the sets of data indicated partial dominance or overdominance for all the characters and all the variants of diallel and partial diallel. However, deviation was recorded in some cases. For example, regarding grain yield in PD-I, III and IV the original data indicated partial dominance, whereas, transformed data showed over dominance. Alternatively, in number of grains per ear in PD-III and IV the original data showed overdominance, whereas, transformed data showed partial dominance. Thus, deviation from dominance and overdominance were observed particularly for these two characters. Further, the ratio of sca/gca mean squares for the transformed data was divided by the ratio of sca/gca mean squares for the original data.

TABLE I. Rank correlations between original and transformed data for mean squares and degree of dominance.

Source	Full diallal	Half diallel	PD-I	PD-II	PD-III	PD-IV
gca	−0.167	0.000	−0.186	−0.119	−0.476	−0.333
sca	−0.095	−0.381	−0.214	−0.119	0.595*	−0.429
error	0.476	0.667	−0.667*	0.119	0.595*	−0.429
reciprocal	0.238					
sca/gca	0.857	0.976*	0.595*	0.333	−0.393	0.429
σ^2_D	0.214	0.143	−0.214	0.524	−0.381	0.095
σ^2_A	0.484	0.429	−0.119	−0.809*	−0.095	−0.809*
σ^2_D / σ^2_A	−0.071	0.226	0.000	0.309	0.524	0.190

PD = Partial diallel * Significant at 5 per cent

This ratio was at par for all the characters in each of the variants of diallel and partial diallel except for grain yield followed by grains per ear.

For confirming the effect of transformation, rank correlations (rs) were calculated between original and transformed data. These correlations for mean squares due to gca, sca, error and reciprocal are given in Table I. Non significant values indicated the clear cut effect of removal of character correlations. The ratio of mean squares (sca/gca) was significant only in case of full and half diallel. These statistical components (σ^2_s and σ^2_g) were translated to genetical components (σ^2_D and σ^2_A) for calculating the degree of dominance. Non significant rank correlations for σ^2_A, σ^2_D and σ^2_D / σ^2_A (Table I) confirmed the significant effect of transformation. The significant but negative rank correlation for σ^2_A in PD-II (rs = −0.809) and PD-IV (rs = −0.809) indicated that transformation has considerably affected the results.

Rank correlations for gca effects (Table IIa) as well as sca effects (Table IIb) indicated that grains per ear is the maximum affected character followed by grain yield and effective tillers. However, ear weight was also affected in two cases. Remaining characters were not affected by transformation.

Finally, various designs were compared with each other. For this purpose rank correlations were calculated

TABLE II(a). Rank correlation for gca effects.

Characters	Array mean	Full diallel	Half diallel	PD-I	PD-II	PD-III	PD-IV
Plant height	0.976*	1.000*	1.000*	1.000*	1.000*	1.000*	1.000*
Ear length	1.000*	1.000*	1.000*	0.951*	0.972*	1.000*	0.857*
Effective tillers	0.143	0.357	0.214	0.657*	0.594*	0.369	0.786*
Grain yield	0.690	0.762	0.810	0.749*	0.769*	0.214	0.071
Ear weight	0.690	0.690	−0.690	0.895*	0.846*	0.810*	−0.071
Grains per ear	0.286	0.286	0.690	−0.214	0.399	−0.405	−0.762*
Pooled	0.786	0.714	0.786	0.788	0.986	0.661	0.449

* Significant at 5 per cent

TABLE II(b). Rank correlation for sca effects.

Charactets	per se	Full diallel	Half diallel
Plant height	1.000*	1.000*	0.999*
Ear length	0.875*	0.990*	0.987*
Effective tillers	0.816*	0.872*	0.865*
Grain yield	0.360	0.299	0.399*
Ear weight	0.719*	0.829*	0.865*
Grain per ear	−0.238	0.090	0.105
Pooled	0.789	0.807	0.745

* Significant at 5 per cent.

over all the characters in both sets of data. Information is furnished in Table III. It was evident from the table that array means and gca effects in full and half diallel were similar. It showed that array means themselves are a reliable estimates (Chaudhary *et al.*, 1974). Similar results were obtained in transformed data. Contrarily, it was not true in partial diallel analysis. In partial diallel sets, more deviations were recorded by decreasing the number of samples. In original data, bias in the estimation was more common when 's' (samples per parent) was less than n/2, where n was number of parents (Chaudhary *et al.*, 1977, 1978). Contrarily, in partial diallel sets with transformed data more bias was recorded when 's' was more than n/2. Similarly, rank correlation showed a positive relationship between sca effects and *per se* performances as far as original data were concerned, but in case of transformed data this relationship did not exist. When statistical parameters were translated into genetical parameters, no

TABLE III. Rank correlations between variants of diallel and partial diallel

Components	Rank correlations between		Rnnk correlations (rs)	
			Original	Transformed
gca effects	Array mean and	Full diallel	1.000*	0.976*
		Half diallel	0.952*	0.952*
		PD-I	0.262	0.494
		PD-II	0.187	0.643
		PD-III	0.542	0.004
		PD-IV	0.363	0.738
	Full diallel and	Half diallel	0.952*	0.976*
		PD-I	0.262	0.446
		PD-II	0.187	0.690
		PD-III	0.542	0.011
		PD-IV	0.363	0.762
sca effects	*per se* and	Full diallel	0.890*	0.654*
		Half diallel	0.910*	0.579*
	Full diallel and	Half diallel	0.970*	0.980*
σ^2_D/σ^2_A	Full diallel and	Half diallel	0.952*	0.143
		PD-I	—0.556	—0.202
		PD-II	—0.333	0.083
		PD-III	0.230	—0.634
		PD-IV	0.188	0.285

* Significant at 5 percent

clear relationship such as mentioned above could be observed. However, transformation provided a different picture.

Thus, it could be concluded from this study that transformation changes the picture of genetic analysis. Complex characters such as yield and number of grains per ear (components being ear length, spikelets per ear density etc. etc.) are more affected by transformation (Chaudhary and Singh, 1977). Secondly, in the light of similar results in full and half diallel the later should be preferred as it involves less labour, time and cost.

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