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Estimation of epistatic components and order effects for pod number in groundnut - A triallel analysis

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Abstract : Three way hybrids numbering sixty involving six parents were tested in randomized block design with three replications. The mean data on number of mature pods per plant were analyzed as per a triallel analysis model. The character showed predominantly epistatic genetic variance. The magnitude of additive x dominance types of epistasis was maximum followed by dominance x dominance and additive gene effects respectively. The dominance and additive x additive type of gene effects were negative. The combining ability analysis revealed that ALR 2 was a good grand parent as well as third parent and GG 2 good third parent in three-way crosses. The cross combination (JL 24 x Co 2) x GG 2 gave the highest three line specific effect. Whereas, the other combinations of the same three parents (JL 24 x GG2) x Co 2 and (GG 2 x Co 2) x JL 24 exhibited negative estimates. As the epistatic gene action predominated, attempting multiple crosses or intermating of early generation segregants besides postponing the selection to later generation may yield fruitful results for the improvement of pod number in groundnut. ***(Key words : Groundnut, Triallel, Order effects, Epistasis)***

Groundnut (*Arachis hypogaea* L.) is one of the important oil seed crops known for its wider adaptability. Number of mature pods is one of the important yield attribute in this crop (Nigam *et al.* 1984 and Deshmuk *et al.* 1986). A thorough knowledge on the genetic architecture of the parents and the nature of gene action for yield components is a prerequisite for crop improvement programme. The genetic investigations on number of mature pods have given contradictory results with regards to the relative importance of additive and non-additive effects. The importance of additive gene effect for this trait has been reported by Basu *et al.* (1987). Predominance of non-additive gene action was reported by Wynne *et al.* (1970) and Dwivedi *et al.*(1989). The importance of epistatic gene effect in the expression of number of mature pods was reported by Sandu and Khehra (1976), Seshadri (1990) and Vindhiyavarman *et al.* (1990).

The present attempt therefore, was made to further analyse the gene action of number of mature pods through the triallel analysis developed by Rawling and Cockerham (1962), Hinkelmann (1965) and Ponnuswamy et al. (1974), which provides information not only on additive, dominance and epistasis type of gene action but also about the order effects of the parents in three way crosses. No such information on order effects in groundnut is however available.

Materials and Methods

All possible sixty, three-way crosses involving six groundnut strains *viz.* ICGS 44, Girnar 1, ALR 2, JL 24, GG 2 and Co 2 were planted in randomize block design with three replications during the rain season (June-September) of 1994 at the Regional Research Station in Vridhachalam. Each cros consisted of 12 rows in a plot with row length of m. The rows and plants with in the row spaced a 30 cm and 15 cm apart respectively. At full maturit, the harvest was carried out on individual plant basis. Number of mature pods in each plant were recorded on fifteen randomly selected plants. Mean data were subject to triallel analysis according to Ponnuswamy *et al.* (1974). The following model was used.

$Y_{ij}k_l$ = $m+h_l+G(i_j)k = e_{ij}kl$ were,

$Y_{ij}k_l$ = The pehnotypic value in the l^{th} replication by ij^{th} cross (Grand parents) mated to k^{th} parent;

m = Gencal mean ;

b_l = Effect of l^{th} replication:

$G(ij)^k$ = The cumulative effect of the triallel cross (ij)k:
Where i and j are grand = parents and k is the parent

$G(ij)^k$ = $g_{ij}+g_k+F_{(ij)}^k$;

g_{ij} = Averae effect of F_1 hybrid:

g_{ij} = $h_i+h_j+d_{ij}$;

h_i = The general line effect of i^{th} parent as grand parent (the first kind general line effect)

d_{ij} = Two line (i x j) specific effect of first kind (grand parent);

g_k = General line effect of k as parent (the second kind effect);

$F_{(ij)}^k$ = Non-additive effect of Fi hybrid (i x j) with both parents;

Table 1. Estimates of General-line and two-line specific effects for number of mature pods

Strains	General-line effects		Two-line specific effects S_{ij}(Upper half and S_{ji} lower half(Figures in the bracket corresponds to d_{ij})					
	First kind (h_i)	Second kind (g_i)	1	2	3	4	5	6
1	-1.30**	-0.54	-	0.03 (-0.42)	-1.98** (-0.02)	1.23*(0.36)	2.50** (-0.10)	0.68 (0.19)
2	0.55	0.39	-0.38	-	0.13 (0.77)	1.14 (0.39)	-0.45 (-2.11)**	-0.17 (1.37)*
3	1.16**	2.09**	-0.08	-0.11	-	-1.43* (-1.49)**	1.51* (2.00)**	0.11 (-1.24)
4	-0.37	-0.31	-0.44	-2.61**	3.86**	-	0.71 (0.63)	-1.52* (0.10)
5	0.87**	0.11	-2.66**	-0.06	0.29	1.53**	-	0.89 (-0.41)
6	-1.92**	-1.73**	3.56**	2.76**	-2.04**	-0.02	-4.27**	-

SE (h_i) = 0.38 SE (g_i) = 0.48 SE (S_{ij}) = 0.59 SE (d_{ij}) = 0.68

* $P < 0.05$ ** $P < 0.01$

1. ICGS 44, 2. Girnar 1 3. ALR 2 4. JL 24 5. GG 2 6. Co.2

$F(ij)k$ = $S_{ik} + S_{ij} + T_{ijk}$;
S_{ik} = Two-line specific effect where i is half-parent and k is the parent. Hence specific effect of second kind;
T_{ijk} = Three line specific effect;
e_{ijkl} = Error effect.

Results and Discussion

The general line effects of first and second kind revealed that ALR 2 was the only parent showing general combining ability effects of both kinds (h_i = 1.16 and g_i = 2.09) GG 2 registered significant value of the first kind only (h_i = 1.87). Co 2 and ICGS 44 had negative estimates for both.

The estimates of two-line specific effect of first kind (d_{ij}) were positive and significant for the crosses ALR 2 x GG 2 and Girnar 1 x Co 2. The two line specific effect of second kind (S_{ij}) was positive in ICGS 44 x GG 2 and ALR 2 X GG 2. Similarly, the reciprocal (S_{ji}) was positive and significant in the combinations JL 24 x ALR 2, Co 2 x ICGS 44, Co 2 @ x Girnar 1 and GG 2 x JL 24 (Table 1)

The three-line specific effect revealed that out of 60 crosses, only 13 combinations exhibited significant positive three-line specific effect (t_{ijk}). The combination (JL 24 x Co 2) x GG 2 registered the maximum value of 5.71 (Table 2).

The epistatic components of additive x dominance and dominance x dominance were more in magnitude than additive type of gene action. The negative estimates were recorded by dominance and additive x additive type of interaction (Table 3).

ALR 2 was the only parent which showed significant general line effects of the first kind (h_i) and second kind (g_i) indicating that it as a good grand parent as well as immediate parent in three-way croses. The significant two-line specific effect of first kind observed in the cross ALR 2 x GG 2 also supports the use of these two genotypes as good grand parents.

GG 2 as a good third parent was evident from the significant two-line specific effects observed in the combinations ALR 2 x GG 2 and ICGS 44 x GG 2. It was also evident from the significant and the highest three-line specific effect observed in the triplet (JL 24 x Co 2) x GG 2. Similarly ALR 2 as a parent was further confirmed by the two-line specific effect (Sji) observed in the combination JL 24 x ALR 2 and

Table 2. Estimates of three-lines specific effects (t_{ijk}) for number of mature pods

Grand Parental Strains		Parental Strains					
		1	2	3	4	5	6
1	2	-	-	-3.25**	-1.57	3.67**	1.15
1	3	-	0.83	-	1.29*	0.09	-2.22*
1	4	-	3.28**	-1.24	-	-2.20*	1.16
1	5	-	-0.34	0.04	-0.60	-	0.90
1	6	-	-3.77**	4.45**	0.88	-1.55	-
2	3	0.90	-	-	-0.78	1.95*	-2.08**
2	4	1.98	-	2.25*	-	-3.26**	-0.98
2	5	-3.50*	-	-0.63	2.22*	-	1.91*
2	6	0.61	-	1.62	0.13	-2.36*	-
3	4	-0.87	-2.84**	-	-	-0.25	3.96**
3	5	0.56	-0.33	-	-0.55	-	0.33
3	6	-0.59	2.33*	-	0.04	-1.79	-
4	5	0.92	-0.60	2.82**	-	-	-3.15**
4	6	-2.04**	0.15	-3.83**	-	5.71**	-
5	6	2.01**	1.28	-2.23*	-1.06	-	-

SE (t_{ijk}) = 0.94 * $P < 0.05$ ** $P < 0.01$

1. ICGS 44, 2. Girnar 1 3. ALR 2 4. JL 24 5. GG 2 6. Co.2

Table 3. Magnitude of components of genetic variance for number of mature pods

Components	Estimates
Additive	799.66
Dominance	-1415.50
Additive x additive	-1319.50
Additive x dominance	6300.95
Dominance x dominance	1480.75

the three-line specific effect recorded in the cross (ICGS 44 x Co 2) x ALR 2. The three-line specific effect was significant for thirteen combination, in which GG 2 or ALR 2 were mostly involved either as grand parent or third parent.

The results indicate that all the crosses with high two line specific effects of second kind had invariably reciprocal differences as they are associated with the order effects in the three-way hybrids as alsc shown by Chaudhary (1987) in barley. Joshi (1983) in wheat and Ram *et al.* (1989) in rice.

Considering the best performing triplet (JL 24 x Co 2) x GG 2, only GG 2 was a good combiner, JL 24 and Co 2 were poor combiners. The other orders of the combination exhibited undesirable effects for this trait. For example the triplet (JL 24 x GG 2) x Co 2 and (GG 2 x Co 2) x JL 24 showed negative estimate indicating the parental order effects for this trait. Such parental order effects may be due to (i) either involvement of at least one parent showing better general combining ability (general life effect), with the restriction that it should be placed in a specific position in the triplet, or (ii) either cross showing better two-line specific effects and/or (iii) rarely due to purely interaction effects among three poor general combiners making the triplet.

The estimates of components of genetic variation (Table 3) revealed that dominance and additive x additive were negative. The magnitude of additive x dominance and dominance x dominance genetic variance were higher than additive type. Similar results were reported by Ram *et al.* (1989) and Shaalan and Aly (1977) in rice and Vindhiyavarman *et al.* (1990) in groundnut. As the epistatic component of genetic variance was predominant, attempting multiple crosses or intermating of early generation segregants besides postponing the selection to later generation may yield fruitful results for the improvement of pod number in groundnut.

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