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COMBINING ABILITY STUDIES FOR YIELD AND ITS COMPONENTS IN GROUNDNUT

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ABSTRACT

Nine lines were mated to three testers in a line x tester design. Among the lines, ICGV-86125 proved to be a good general combiner for pod and kernel yield and unit pod weight. Majority of the best specific combinations for different characters resulted from the crosses among the parents with high x low or low x low gca effects. Non-additive effects were predominant for pod and kernel yield and shelling outturn, but appreciable additive effects were noted for pod number, pod weight, and primary branches. The breeding method which can exploit both nonadditive as well as additive types of gene action is suggested for groundnut improvement.

Key words: Groundnut, combining ability.

In autogamous crops like groundnut (*Arachis hypogaea* L.), recombination breeding has been extensively used to develop the variability reservoir for exploitation in breeding programme. In a systematic breeding programme, it is essential to identify the elite parents for hybridization, and superior crosses to expand the variability reservoir for selection of superior genotypes. Combining ability studies help in such endeavour. In the present investigation, line x tester design with well adapted and widely grown varieties of groundnut (tester) was used to obtain information on combining ability of elite lines for six characters of economic importance in groundnut.

MATERIALS AND METHODS

Twelve genotypes were selected on the basis of their geographical adaptation and morphological diversity. Out of them, three were used as testers (males), each crossed with nine genotypes used as lines (females). Among the testers, two (KRG-1 and S-206) were local varieties grown extensively in the districts of Raichur, Bidar and Gulbarga, and one (JL-24)

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was a high yielding kharif cultivar grown in Maharashtra, Karnataka and other groundnut growing regions in the southern, central and western parts of the country.

All the nine lines were recently developed cultures, of which six (ICGV-86031, ICGV-86029, ICGV-86010, ICGV-86125, ICGS-11, ICGS- 44-1) have small, dark green leaf and semispreading plant type, and three (RSHY-4, RSHY-13, DORG-18-10) are erect bunch types with broad, light green leaves.

Twenty seven F_1s along with 12 parents were planted in randomized complete block design with two replications during summer 1989-90 at the Regional Research Station, Raichur. The parents were randomized among themselves [1]. Each treatment in a replication had single row of 5 m length at 45 x 15 cm spacing. The mean data recorded on ten random plants for six quantitative characters were used for statistical analysis. The combining ability analysis was done following Kempthorne [2]. The total variance among F_1 hybrids was further partitioned into variance due to lines, testers and interaction component, which was used to estimate the additive and nonadditive components of variance. Also, the contributions of lines, testers and their interaction towards total variability for each character was computed for assessing their relative importance.

RESULTS AND DISCUSSION

Analysis of variance indicated the presence of significant differences among treatments for all the six characters studied (Table 1). The parents differed significantly for all the characters except kernel yield, however, mean squares due to lines were significant only for pods per plant and pod weight. The testers differed significantly for pod and kernel yield, and shelling outturn. The hybrids showed significant differences only for shelling outturn and pod weight. Further partitioning of variance among the hybrids revealed that the mean squares due to lines were significant for pod number and pod weight, due to tester for pod and kernel yield, and pod number, and for shelling outturn in case of line x tester interactions. This was also clearly illustrated when the proportional contribution of each character was studied. Lines and their interactions with testers contributed more than 70% of total variance for all the characters. Except for pod yield (21.2%), kernel yield (22.4%), and pod number (28.8%), the contribution of testers was very little. The contribution of lines varied from 32.5% for kernel yield to 63.7% for pod weight (Table 1). Similarly, Line x tester interactions contributed up to 64.5% for shelling outturn.

The estimates of variance components (gca and sca) indicated that nonadditive components were predominant for most of the characters, though appreciable additive effects were noted for pod number, unit pod weight and primary branches, as was also reported earlier [3, 4]. These observations suggest that in groundnut breeding, the

Table 1. Analysis of variance (ms) for six characters in groundnut

Source	d.f.	Pod yield	Kernel yield	Shelling outturn	Pods per plant	Pod weight	No. of primary branches
Replications	1	239.0**	63.3*	81.2*	693.9**	0.05	41.1**
Treatments	38	71.7**	26.2*	67.5**	127.0**	0.04**	3.3**
Parents	11	110.1**	24.4	79,3**	307.1**	0.05**	8.0**
Parents vs crosses	1	190.4**	157.3**	88.7**	0.3	0.1	0.1
Crosses	26	50.8	21.9	61.7**	55.6	0.03*	1.4
Lines	8	59.1	23.1	65.8	83.7*	0.07**	1.9
Testers	2	140.4*	63.6*	21.3	208.1**	0.02	1.1
Lines x testers	16	35.5	16.1	64.7**	22.5	0.02	1.1
Error	38	29.3	15.1	16.3	43.6	0.02	1.7
			Estimates of variance components				
Gca		0.48	0.18	@	1.02	0.0001	0.08
Sca		3.07	0.47	24.2	@	0.0001	@
Gca/sca		0.15	0.38	@	@	1.000	@
			Proportional contribution (%) to total variance				
Lines		35.8	32.5	32.8	46.3	63.7	43.6
Testers		21.3	22.4	2.7	28.8	5.6	6.1
Lines x testers		42.9	45.1	64.5	24.9	30.7	50.3

*,**Significant at 5% and 1% levels, respectively. @ Estimates negative.

methodology that can exploit both additive as well as nonadditive effects would be of immense value. Diallel selective mating [5], which provides better opportunity for recombination, accumulation of desirable genes and selection would help in concentrating most of such genes in a pure line. A judicious integration of the classical approaches (pedigree and bulk) with diallel selective mating may be of great help in achieving the quantum jump in groundnut improvement.

The estimates of gca effects (Table 2) showed that among lines and testers, ICGV-86125 was superior, as it showed positive and significant gca effects for pod and kernel yields, beside pod weight. The lines DORG-18-10 and RSHY-13 were good combiners for shelling outturn and RSHY-4 for pods per plant. None of the testers was found to be a good general combiner. Association between per se performance and gca effects was not evident in the present study. In fact, in many cases, the lines or testers with high mean had low gca effects, indicating the ineffectiveness of choice of parents based on per se performance for hybridization.

Table 2. General combining ability effects of the lines and testers for six economic characters in groundnut

Parent	Pod yield	Kernel yield	Shelling outturn	Pods per plant	Pod weight	Primary branches per plant
Lines:						
ICGV-86031	2.47	0.89	2.93	0.57	0.08	0.41
ICGV-86029	–1.11	–2.59	–5.98	2.87	–0.10	0.13
RSHY-13	–4.43	–1.67	4.27*	–4.25	–0.03	0.93
ICGS-11	1.11	0.48	–1.26	0.55	0.01	0.33
DORG-18-10	–2.98	–0.64	4.29*	–0.27	–0.10*	–1.12*
ICGS-44-1	–2.08	–0.89	1.97	–5.85	0.10	–0.18
ICGV-86010	1.62	0.83	–0.84	–2.10	0.10	–0.12
RSHY-4	–0.49	–0.64	–0.26	6.48*	–0.16*	–0.03
ICGV-86125	5.89*	4.24*	0.74	2.00	0.11*	–0.37
SE±	2.21	1.59	1.65	2.70	0.05	0.53
SE (gi–gj)	3.13	2.25	2.33	3.81	0.07	0.75
Testers:						
KRG-1	1.48	1.30	1.17	3.07	–0.04	–0.24
JL-24	1.74	0.86	–0.98	0.59	0.03	–0.02
S-206	–3.22*	–2.16*	–0.19	–3.66*	0.01	0.26
SE±	1.28	0.92	0.95	1.56	0.03	0.30
SE (gi–gj)	1.80	1.30	1.35	2.20	0.04	0.43

*Significant at 5% level.

Eighteen out of 27 crosses occupied the first five ranks for six characters (Table 3). The four top ranking crosses for kernel yield also figured in the top five for pod yield, indicating a close association between pod yield and kernel yield. Of these 18 crosses, 10 crosses were between low x low, 7 between high x low combiners, and only one cross involved high x high gca parents. The large number of low x low and high x low gca crosses figuring in top ranks for different characters is of great interest, as such combinations could result in desirable transgressive segregates if the additive effects of one parent and complementary epistatic effects (present in the cross) act in the same direction and maximize the expression of plant attributes under selection. Two such crosses, ICGV-86125 x KRG-1 (high x low) and ICGV-86010 x JL-24 (low x low), exhibited high mean values for pod and kernel yield. These crosses may be further exploited for isolating the desirable segregates for pod and kernel yields.

Table 3. Specific combining ability of the best five crosses based on per se performance

Character	Cross	Mean	Sca effect	Gca status of parent	
				P_1	P_2
Pod yield (g)	ICGV-86125 x KRG-1	44.2	6.57	High	Low
	ICGV-86010 x JL-24	39.5	5.92	Low	Low
	ICGV-86125 x JL-24	37.2	–0.69	High	Low
	ICGV-86031 x KRG-1	37.2	2.99	Low	Low
	RSHY-4 x JL-24	34.1	2.59	Low	Low
Kernel yield (g)	ICGV-86125 x KRG-1	30.0	4.82	High	Low
	ICGV-86010 x JL-24	24.5	3.18	Low	Low
	ICGV-86031 x KRG-1	24.3	2.42	Low	Low
	ICGV-86125 x JL-24	22.4	–2.35	High	Low
	ICGS-11 x JL-24	22.3	1.28	Low	Low
Shelling outturn (%)	RSHY-4 x KRG-1	77.0	10.69	Low	Low
	DORG-18-10 x JL-24	72.0	3.22	High	Low
	ICGS-44-1 x S-206	70.4	3.18	Low	Low
	RSHY-13 x JL-24	70.3	1.61	High	Low
	ICGV-86010 x S-206	70.2	5.84	Low	Low
Pod number	ICGV-86029 x KRG-1	44.5	4.48	Low	High
	ICGV-86125 x KRG-1	42.0	2.80	Low	High
	RSHY-4 x KRG-1	41.1	–2.58	High	High
	RSHY-4 x S-206	40.5	3.59	High	Low
	RSHY-4 x JL-24	40.2	–1.12	High	Low
Pod weight (g)	ICGV-86010 x JL-24	1.1	0.07	Low	Low
	ICGV-86125 x KRG-1	1.1	0.09	High	Low
	ICGS-44-1 x S-206	1.0	0.04	Low	Low
	ICGV-86031 x JL-24	1.0	0.03	Low	Low
	ICGS-44-1 x KRG-1	1.0	0.07	Low	Low
Primary branches	ICGV-86010 x KRG-1	7.3	1.32	Low	Low
	RSHY-13 x KRG-1	7.3	0.75	Low	Low
	RSHY-4 x S-206	7.2	1.18	Low	Low
	ICGS-11 x S-206	7.0	0.61	Low	Low
	RSHY-13 x S-206	6.7	–0.34	Low	Low

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