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Combining Ability Studies for Growth and Yield Traits in Groundnut (*Arachis hypogaea* L.)

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Abstract

Line × Tester analysis involving four lines and three testers in groundnut was carried out to assess the combining ability with respect to ten growth, yield and its related traits. The estimates of gca : sca variance revealed the predominance of non-additive gene action for the characters days to 50 per cent flowering, plant height, number of pods per plant, pod yield per plant, number of kernels per plant, kernel yield per plant, sound mature kernel per cent, shelling percentage and test weight. NRCG 12568, NRCG 11915 and NRCG 12326 were good general combiners for all the characters studied. The crosses NRCG 12568 × NRCG 12326 and NRCG 12899 × NRCG 12965 were good specific combiners for number of pods per plant, pod yield per plant, number of kernels per plant and kernel yield per plant, while NRCG 12899 × ICGV 95454 was good specific combiner for sound mature kernel per cent, shelling percentage and test weight. The study indicated the importance of yield related traits like number of pods per plant, number of kernels per plant, sound mature kernel per cent, shelling percentage, kernel yield and pod yield in breeding programs intended to improve yield levels of groundnut genotypes.
Key words : Combining ability, Non-additive gene action, Groundnut, Growth, Yield.

Groundnut (*Arachis hypogaea* L.) is one of the most important oilseed crops of the world. The groundnut seeds are valued for both its oil and protein contents. The low productivity of groundnut is mainly attributed to the cultivation of the crop in poor and marginal lands under rainfed conditions. Hence identification and improvement of yield related traits that would sustain or even increase productivity under water limited conditions is prerequisite in breeding programs aimed at improving yield levels in groundnut. The first step in the development of hybrid is the selection of parents with good combining

Table 1. ANOVA for parents and hybrids for 10 growth and yield related traits in groundnut. *Significant at P=0.05, **Significant at P=0.01.

Source	df	Days to 50% flowering	Plant height (cm)	No. of primary branches	Number of pods/ plant	Pod yield / plant (g)	No. of kernels/ plant	Sound mature kernel (%)	Kernel yield / plant (g)	Shelling percen-tage	Test weight (g)
Replication	2	0.36	2.49	0.47	6.83	2.61	2.55	3.66	2.15*	62.20**	0.55
Parents	6	15.55**	9.63**	0.21	733.94**	529.10**	1295.02**	164.68**	186.9**	859.16**	253.51**
Lines	3	3.66**	17.67**	0.11	22.04**	582.86**	2058.94**	279.41**	90.46**	514.07**	172.63**
Testers	2	40.77**	0.82	3.44**	1191.05**	688.08**	672.39**	74.64**	399.73**	1237.18**	46.64**
Line vs tester	1	0.77	3.15	0.84*	1355.43**	49.84**	248.51**	0.57	51.14**	1138.41**	909.87**
Hybrids	11	30.99**	70.56**	0.31	937.99**	303.80**	1709.97**	240.03**	147.65**	386.04**	367.41**
Parents vs hybrids	1	9.83**	138.64**	1.62**	377.59**	0.11	144.12**	0.11	2.45*	159.79**	555.71**
Error	36	0.40	1.50	0.15	2.17	1.35	1.78	6.03	0.53	11.61	0.83

Table 2. ANOVA for combining ability for 10 growth and yield related traits in groundnut. *Significant at P=0.05, **Significant at P=0.01.

Source	df	Days to 50% flowe-ring	Plant height (cm)	No. of primary bran-ches	Number of pods	Pod yield per plant (g)	No. of kernels/ plant	Sound mature kernel (%)	Kernel yield/ plant (g)	Shelling percen-tage	Test weight (g)
Replication	2	0.36	1.47	0.28	0.98	2.05	4.23	2.24	1.25	33.05	0.18
Lines	3	49.36	140.50	0.46	1285.45	311.84	2670.17	425.67	94.42	114.36	836.37
Testers	2	17.69	25.11	0.45	512.50	152.16	1934.13	144.34	265.12	226.47	59.18
Line × Tester	6	26.24**	50.74**	0.19	906.10**	350.33**	1155.15**	179.11**	134.86**	575.07**	235.68**
Error	22	0.42	1.07	0.12	1.81	1.50	2.00	7.15	0.56	9.15	0.68

ability. It has been noticed that *per se* performance of parents is not always a true indicator of its potential in hybrid combinations. The information on the combining ability status of the genotypes will give an indication as to how well they combine with a given genotype to produce potential and productive populations. This helps the breeder to decide upon the choice of parents for hybridization and to isolate promising genotypes from the segregating populations. It also provides information on the relative significance of additive and non-additive types of gene action in the expression of the characters under consideration. Therefore, the present investigation was taken up to study the nature of gene action of important growth and yield related traits in groundnut by line × tester analysis.

Methods

Twelve F_1s were obtained by crossing four females (lines) (NRCG 12568, NRCG 11915, NRCG 12274 and NRCG 12899) and three males (testers) (NRCG 12965, ICGV 95454 and NRCG 12326). These F_1s along with their parents were sown in a randomized complete block design with three replications in rows of 3 m length with a spacing of 45 × 30 cm. Data were recorded on five randomly chosen plants per replication. Ten characters viz. days to 50% flowering, plant height, number of primary branches per plant, number of pods per plant, pod yield per plant, number of kernels per plant, kernel yield per plant, shelling percentage, sound mature kernel per cent and test weight were recorded following standard procedures. The data were subjected to line × tester analysis according to standard procedure (1).

Results and Discussion

Analysis of variance indicated significant differences for all the characters except number of primary branches per plant among parents and hybrids showing that the parents chosen and their hybrids exhibited considerable variability for almost all the characters (Table 1). Higher magnitude of variance in hybrids as compared to parents was observed for days to 50% flowering, plant height, number of pods per plant, number of kernels per plant and test weight indicating the presence of heterosis for these characters.

However, variance due to lines and testers was not significant for all the characters studied (Table 2). But the line × tester interaction component of variance was significant for all the characters except number of primary branches per plant. The results indi-

Table 3. Variance due to general and specific combining ability effects for 10 growth and yield related traits in groundnut.

Characters	Variance due to gca	Variance due to sca	gca : sca ratio
Days to 50% flowering	0.69	8.61	1:12.47
Plant height (cm)	3.05	16.56	1:5.42
Number of primary branches	0.025	0.025	1:1
Number of pods per plant	0.67	298.73	1:445.86
Pod yield per plant (g)	11.26	116.25	1:10.32
Number of kernels per plant	109.23	384.39	1:3.51
Sound mature kernel (%)	10.08	57.33	1:5.68
Kernel yield per plant (g)	4.30	44.76	1:10.40
Shelling percentage	38.53	188.62	1:4.89
Test weight (g)	20.20	78.33	1:3.87

Table 4. General combining ability effects of parents (lines and testers) for 10 growth and yield related traits in groundnut. *Significant at *P*= 0.05, **Significant at *P*=0.01.

	Days to 50% flowering	Plant height (cm)	No. of primary branches	Number of pods per plant	Pod yield per plant (g)	Number of kernels per plant	Sound mature kernel (%)	Kernel yield / plant (g)	Shelling percen-tage	Test weight (g)
Lines										
NRCG 12568	-1.31**	-1.76**	0.16	14.96**	3.48**	15.68**	6.89**	3.11**	3.56**	-9.42**
NRCG 11915	1.92**	-1.61**	-0.05	4.15**	6.48**	14.08**	-2.14**	1.88**	0.53	-7.05**
NRCG 12274	-2.64**	-2.52**	-0.30**	-11.14**	-4.70**	-16.17**	-8.64**	-4.22**	-4.94**	6.67**
NRCG 12899	2.03**	5.90**	0.19*	-7.97**	-5.26**	-13.58**	3.89**	-0.77**	0.85	9.79**
SE	0.15	0.24	0.08	0.31	0.28	0.33	0.61	0.17	0.69	0.19
Testers										
NRCG 12965	1.14**	0.54**	-0.22**	-6.51**	-3.88**	-10.52**	3.10**	-2.93**	-1.02	-0.59**
IGCV 95454	-0.14	1.10**	0.08	-0.06	0.76**	-3.58**	-3.75**	-2.49**	-3.74**	2.46**
NRCG 12326	-1.28**	-1.64**	0.14	6.56**	3.12**	14.10**	0.64	5.42**	4.76**	-1.87**
SE	0.12	0.19	0.07	0.25	0.23	0.46	0.50	0.14	0.57	0.15

cate the presence of considerable variability among the hybrids rather than among the lines and testers. Hence it is possible to select superior hybrids with high yield.

In general, the variance due to specific combining ability was greater than the variance due to general combining ability for the characters days to 50% flowering, plant height, number of pods per plant, pod yield per plant, number of kernels per plant, kernel yield per plant, shelling percentage, sound mature kernel per cent and test weight (Table 3). This indicates the predominance of non-additive gene action for these traits. Hence improvement of these yield related traits could be accomplished by selection of crosses having high sca effects and advancing progenies to later filial generations. These results were in accordance with the findings of earlier scientists for yield related traits (2—4). For number of primary branches per plant, both gca and sca variances were of equal magnitude indicating that both additive and non-additive gene components of variance were of equal importance.

The breeding potential of seven parents was ascertained based on gca effects (Table 4). The line NRCG 12274 was a good combine for early flowering and dwarf plant type. NRCG 12568 was found to be promising line for yield related traits like number of pods per plant, number of kernels per plant, sound mature kernel percentage, shelling per cent, kernel yield. Among testers, NRCG 12326 was a good combiner for early flowering, dwarf plant type, number of pods per plant, number of kernels per plant, pod yield, kernel yield, sound mature kernel per cent and shelling percentage. Since high gca effects are due to additive or additive × additive gene action, these genotypes can be readily exploited in breeding programs.

Estimation of specific combining ability effects of hybrids are presented in Table 5 for various traits. NRCG 12568 × NRCG 12326, NRCG 12274 × ICGV 95454, NRCG 12899 × NRCG 12965 were the best superior combinations for early flowering. The best specific crosses for dwarf ness were NRCG 12899 × NRCG 12326, NRCG 12274 × NRCG 12965 and NRCG 12568 × NRCG 12965.

The crosses NRCG 12568 × NRCG 12326, NRCG 11915 × ICGV 95454 and NRCG 12899 × NRCG 12965 were identified as the best superior combinations for number of pods per plant, number of kernels per plant and pod yield. These hybrids involved parents with either high (H × H) or low (L × L) gca effects. This could be attributed to the involvement of non-additive gene action in the inheritance of pod yield.

NRCG 12899 × ICGV 95454, NRCG 12274 × NRCG 12326 and NRCG 11915 × NRCG 12326 were identified as desirable specific combinations for sound mature kernel percentage and test weight. NRCG 12568 × NRCG 12326 and NRCG 12274 × ICGV 95454 topped the list of best performing hybrids for kernel yield per plant. Whereas for shelling percentage, NRCG 12899 × ICGV 95454, NRCG 12274 × ICGV 95454 and NRCG

Table 5. Specific combining ability effects of hybrids for 10 growth and yield related traits in groundnut. *Significant at P=0.05, **Significant at P=0.01.

Hybrids	Days to 50% flowe-ring	Plant height (cm)	No. of primary bran-ches	Number of pods per plant	Pod/ yield plant (g)	Number of kernels/ plant	Sound mature kernel (%)	Kernel yield/ plant (g)	Shelling percen-tage	Test weight (g)
NRCG 12568 × NRCG 12965	0.64**	-1.52**	-0.08	-15.72**	-11.59**	-14.44**	1.58	-4.02**	6.85**	4.69**
NRCG 12568 × ICGV 95454	2.64**	-1.31**	-0.22	-11.89**	-3.15**	-16.31**	3.11**	-7.22*	-17.89**	-6.45**
NRCG 12568 × NRCG 12326	-3.28**	2.84**	0.29**	27.62**	14.74**	30.75**	-4.68**	11.23**	-11.04**	1.77**
NRCG 11915 × NRCG 12965	-1.92**	0.46	0.12	-3.07**	-2.74**	-0.83	2.04*	1.23**	3.07**	-3.06**
NRCG 11915 × ICGV 95454	0.08	-0.28	0.06	14.02**	9.84**	7.69**	-7.61**	1.80**	-8.00**	-5.36**
NRCG 11915 × NRCG 12326	1.83**	-0.18	-0.18	-10.94**	-7.10**	-6.87**	5.57**	-3.03**	4.93**	8.42**
NRCG 12274 × NRCG 12965	3.31**	-3.18**	-0.20	7.25**	4.22**	-2.74**	-2.03*	1.77**	-3.27**	4.94**
NRCG 12274 × ICGV 95454	-2.36**	-0.59	0.31**	-0.86	-0.79	11.78**	-4.95**	4.00*	8.81**	-1.25**
NRCG 12274 × NRCG 12326	-0.94**	3.78**	-0.11	-6.39**	-3.43**	-9.04**	6.98**	-5.77**	-5.53**	-3.69**
NRCG 12899 × NRCG 12965	-2.03**	4.25**	0.16	11.55**	10.10**	18.01**	-1.59	1.02**	-6.64**	-6.57**
NRCG 12899 × ICGV 95454	-0.36	2.19**	-0.15	-1.27**	-5.89**	-3.17**	9.45**	1.42**	17.08**	13.07**
NRCG 12899 × NRCG 12326	2.39**	-6.44**	-0.01	-10.29**	-4.20**	-14.84**	-7.86**	-2.44**	-10.44**	-6.50**
SE	0.21	0.34	0.11	0.44	0.40	0.46	0.87	0.24	0.98	0.27

12568 × NRCG 12965 were found to be promising cross combinations.

Most of the crosses exhibiting desirable sca effects involved parents with good and poor gca effects, indicating the influence of non-additive gene interactions in these crosses. Hence parents of these crosses can be utilized for biparental mating or reciprocal recurrent selection program for developing supperior varieties with high yield. Whereas crosses with higher sca and having both parents with good gca effects could be exploited by pedigree method to yield transgressive segregants.

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