

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

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Abstract

Line X tester analysis was carried out involving four lines and three testers in groundnut for assessing the combining ability with respect to 10 growth and yield related traits. The estimates of GCA:SCA variance revealed the predominance of non-additive gene action for all the characters studied namely, 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 except for number of primary branches per plant. The genotypes NRCG 12568, NRCG 11915 and NRCG 12326 were good general combiners for all the characters studied. The crosses NRCG 12568 X NRCG 12326 and NRCG 12899 X 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 X ICGV 95454 was a good specific combiner for sound mature kernel *per cent*, shelling percentage and test weight. The hybrids NRCG 12568 x NRCG 12326, NRCG 11915 x ICGV95454, NRCG 12899 x NRCG 12965, NRCG 12274 x NRCG 12965 exhibiting desirable sca effects involved parents with high and low gca effects indicating the influence of nonadditive gene interactions. Parents of these crosses can be used for biparental mating or reciprocal recurrent selection for developing superior varieties with high yield. Crosses with higher sca having both parents with good gca effects could be exploited by pedigree method of breeding to get transgressive segregants.

Key words: Groundnut, Combining ability, Additive gene action, Non Additive gene action

Introduction

From the past experience in different crops, 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 and also on the nature of gene action involved. This helps the breeder to decide upon the choice of parents for hybridization and to isolate promising genotypes from the segregating populations. An investigation was taken up in groundnut (*Arachis hypogaea* L.) involving a set of four ovule parents and three pollen parents crossed in a line X tester mating design, to study the general and specific combining ability and the gene action determining the important growth and yield traits in this crop.

Material and Methods

The material consisted of four females (lines) having low carbon isotopic discrimination (NRCG 12568, NRCG 11915, NRCG 12274 and NRCG 12899) and three males (testers) having high carbon isotopic discrimination (NRCG 12965, ICGV 95454 and NRCG 12326). The crosses were effected to produce twelve F₁s. These F₁s along with their parents were sown in Randomized Complete Block Design (RCBD) with three replications with a spacing of 45 cm X 30 cm. Data were recorded on five randomly chosen plants per replication from each treatment. Ten characters *viz.*, days to 50 *per cent* 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 percentage and test weight were recorded as per standard procedures. The data were subjected to line X testers analysis according to Kempthorne (1957).

Results and Discussion

The analysis of variance (Table 1) indicated significant differences for all the characters except number of primary branches per plant among parents as well as hybrids indicating that the parents chosen and their hybrids exhibited considerable variability for almost all the characters. Higher magnitude of variance in case of hybrids as compared to parents has been observed for many characters like days to 50 percent flowering, plant height, total number of pods per plant, total number of seeds per plant, number of filled seeds per plant and test weight indicating the presence of heterosis for these characters.

However, variance due to lines and testers were not significant for all the characters studied. But the line x tester interaction component of variance was significant for all the characters except for number of primary branches per plant. The results indicate 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.

The variance due to specific combining ability was greater than the variance due to general combining ability for the characters days to 50 per cent flowering, plant height, total number of pods per plant, pod yield per plant, total number of kernels per plant, kernel yield per plant, shelling percentage, sound mature kernel per cent and test weight. 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 Sangha *et al.* (1990) for plant height; Vindhiya Varman and Raveendran (1994) for total number of pods; Vindhiya Varman (2000) and Rudraswamy *et al.* (2001) for pod yield. The pre-dominance of SCA variance was also reported for total number of seeds (Rose Mary Francies and Ramalingam, 1999; Rudraswamy *et al.*, 2001), sound mature kernels (Vindhiya Varman and Raveendran, 1994), Seed yield (Upadhyaya *et al.*, 1992; Rose Mary Francies and Ramalingam, 1999) and shelling percentage (Vindhiya varman and Paramasivam, 1992; Vindhiya Varman, 2000; Manoharan, 2001).

For number of primary branches per plant, both gca and sca variance were of equal in magnitude indicating both additive and non-additive gene components of variance were of equal importance.

The general combining ability effects of parents are presented in Table 2. For days to 50 per cent flowering, the line NRCG 12274 (-2.64) and NRCG 12568 (-1.31) and the tester NRCG 12326 (-1.28) were found to be good combiners for developing early flowering types. The lines NRCG 12274 (-2.52), NRCG 12568 (-1.76), NRCG 11915 and the tester NRCG 12326 were good combiners for developing dwarf types whereas the line NRCG 12899 and the testers ICGV 95454 and NRCG 12965 were considered as good combiners for tall types. For number of primary branches per plant, only the line NRCG 12899 was considered to be good combiner as evident from its significant positive gca effects. Only three parents, of which two were lines namely, NRCG 12568 and NRCG 11915 and one tester NRCG 12326 appeared to be good general combiners for both total number of pods per plant and total number of kernels per plant. Hence it is possible to improve number of filled kernels by involving them in hybridization programme. For pod yield per plant, two lines, NRCG 11915 and NRCG 12568 and two testers, NRCG 12326 and ICGV 95454 were considered to be good general combiners even though their *per se* performance was low for this trait.

NRCG 12568, NRCG 12899 and NRCG 12965 were considered to be good general combiners for sound mature kernels whereas genotypes NRCG 12326 and NRCG 12568 were found to be good general combiners for developing genotypes with higher shelling percentage. For kernel yield per plant, three genotypes *viz.*, NRCG 12326, NRCG 12568 and NRCG 11915 were found to be good general combiners. Considering pod yield, shelling percentage and kernel yield, NRCG 12568 and NRCG 12326 were only good general combiners.

Summarizing the above discussion, no single line or tester was found to be a good general combiner for the traits studied. However, the line NRCG 12568 was observed to have significant gca effects in the desired direction for most of the traits studied followed by other good general combiners NRCG 11915 and NRCG 12326. Since high gca effects are due to additive or additive x additive gene action, they can be readily exploited in breeding programmes.

Estimation of specific combining ability effects of hybrids are presented in Table 3 for various traits. NRCG 12568 x NRCG 12326, NRCG 12274 x ICGV 95454, NRCG 12899 x NRCG 12965, NRCG 12274 x NRCG 12326 were the best superior combinations for early flowering. NRCG 12899 x NRCG 12965, NRCG 12274 x NRCG 12326, NRCG 12568 x NRCG 12326 and NRCG 12899 x ICGV 95454 were the top ranking crosses for tallness whereas the best specific crosses for dwarfness were NRCG 12899 x NRCG 12326, NRCG 12274 x NRCG 12965, NRCG 12568 x NRCG 12965 and NRCG 12568 x ICGV 95454. The two specific hybrids are NRCG 12274 x ICGV 95454 and NRCG 12568 x NRCG 12326 for high number of primary branches.

The hybrids NRCG 12568 x NRCG 12326, NRCG 11915 x ICGV 95454, NRCG 12899 x NRCG 12965 and NRCG 12274 x NRCG 12965 were identified as the best superior combinations for total number of pods per plant. These hybrids involved parents with either high (H x H) or Low (L x L) gca effects. For pod yield, NRCG 12568 x NRCG 12326, NRCG 12899 x NRCG 12965, NRCG 11915 x ICGV 95454 and NRCG 12274 x NRCG 12965 were identified as desirable specific combinations. This is yet another example for low x low or high x high combination of parents producing hybrids with high sca effects. This could be attributed to the involvement of non-additive gene action in the inheritance of pod yield.

The best specific combiners for total number of kernels per plant were NRCG 12568 x NRCG 12326, NRCG 12899 x NRCG 12965, NRCG 12274 x ICGV 95454 and NRCG 11915 x ICGV 95454. Five hybrids viz., NRCG 12899 x ICGV 95454, NRCG 12274 x NRCG 12326, NRCG 11915 x NRCG 12326, NRCG 12568 x ICGV 95454 and NRCG 11915 x NRCG 12965 were identified as desirable specific combinations for sound mature kernel.

The hybrids NRCG 12568 x NRCG 12326 and NRCG 12274 x ICGV 95454 topped the list of best performing hybrids for kernel yield per plant. The best performing hybrids for shelling percentage were NRCG 12899 x ICGV 95454, NRCG 12274 x ICGV 95454 and NRCG 12568 x NRCG 12965. Whereas, NRCG 12899 x ICGV 95454, NRCG 11915 x NRCG 12326, NRCG 12274 x NRCG 12965 and NRCG 12568 x NRCG 12965 were observed to be the best specific combinations for test weight.

Most of the crosses exhibiting desirable sca effects involved parents with high and low 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 programme for developing superior 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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**Table 1. ANOVA for combining ability for 10 growth and yield related traits in groundnut.**

Source	df	Days to 50% flowering	Plant height (cm)	No. of Primary branches	Number of pods	Pod yield per plant (g)
Replication	2	0.36	1.47	0.28	0.98	2.05
Lines	3	49.36	140.50	0.46	1285.45	311.84
Testers	2	17.69	25.11	0.45	512.50	152.16
Line X Tester	6	26.24**	50.74**	0.19	906.10**	350.33**
Error	22	0.42	1.07	0.12	1.81	1.50

Source	df	No. of kernels per plant	Sound mature Kernel (%)	Kernel yield per plant (g)	Shelling Percentage	Test weight (g)
Replication	2	4.23	2.24	1.25	33.05	0.18
Lines	3	2670.17	425.67	94.42	114.36	836.37
Testers	2	1934.13	144.34	265.12	226.47	59.18
Line X Tester	6	1155.15**	179.11**	134.86**	575.07**	235.68**
Error	22	2.00	7.15	0.56	9.15	0.68

* Significant at P = 0.05

** Significant at P = 0.01

**Table 2. General Combining Ability effects of parents (lines and testers) for 10 growth and yield related traits in groundnut.**

Lines/ Testers	Days to 50% flowerin g	Plant height (cm)	No. of Primary branche s	Number of pods per plant	Pod yield per plant (g)	Number of kernels per plant	Sound Mature Kernel (%)	Kernel yield /plant (g)	Shelling percenta ge	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

* Significant at P= 0.05

** Significant at P=0.01

**Table 3. Specific combining ability effects of hybrids for 10 growth and yield related traits in groundnut.**

HYBRIDS	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 per plant (g)	Shelling Percentage (%)	Test Weight (g)
NRCG 12568 X NRCG 12965	0.64**	-	-0.08	-	-	-	1.58	-4.02**	6.85**	4.69**
NRCG 12568 X ICGV 95454	2.64**	-	-0.22	-	-3.15**	-	3.11**	-7.22*	-17.89**	-6.45**
NRCG 12568 X NRCG 12326	-3.28**	2.84**	0.29**	27.62**	14.74**	30.75**	-4.68**	11.23**	-11.04**	1.77**
NRCG 11915 X NRCG 12965	-1.92**	0.46	0.12	-3.07**	-2.74**	-0.83	2.04*	1.23**	3.07**	-3.06**
NRCG 11915 X ICGV 95454	0.08	-0.28	0.06	14.02**	9.84**	7.69**	-7.61**	1.80**	-8.00**	-5.36**
NRCG 11915 X NRCG 12326	1.83**	-0.18	-0.18	-	-7.10**	-6.87**	5.57**	-3.03**	4.93**	8.42**
NRCG 12274 X NRCG 12965	3.31**	-	-0.20	7.25**	4.22**	-2.74**	-2.03*	1.77**	-3.27**	4.94**
NRCG 12274 X ICGV 95454	-2.36**	-0.59	0.31**	-0.86	-0.79	11.78**	-4.95**	4.00**	8.81**	-1.25**
NRCG 12274 X NRCG 12326	-0.94**	3.78**	-0.11	-6.39**	-3.43**	-9.04**	6.98**	-5.77**	-5.53**	-3.69**
NRCG 12899 X NRCG 12965	-2.03**	4.25**	0.16	11.55**	10.10**	18.01**	-1.59	1.02**	-6.64**	-6.57**
NRCG 12899 X ICGV 95454	-0.36	2.19**	-0.15	-1.27**	-5.89**	-3.17**	9.45**	1.42**	17.08**	13.07**
NRCG 12899 X NRCG 12326	2.39**	-	-0.01	-	-4.20**	-	-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

* Significant at P= 0.05

** Significant at P=0.01