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

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A B S T R A C T

In the present investigation, three lines were crossed with six testers in L × T mating design to estimate the combining ability for yield and component traits in groundnut. Non-additive genetic variance played a preponderant role in the inheritance of majority of characters studied *viz.*, primary branches, secondary branches, matured pods per plant, immature pods, kernel yield per plant, 100 kernel weight, shelling *per cent*, sound mature kernels, chlorophyll content, haulm yield per plant and oil content. Additive genetic variance was more for the plant height and pod yield. The line Dh-86 and tester AGL-635 were found to be good combiners and are considered as superior parents in the present study as they recorded high per se performance with positively significant gca effect. Among the 18 F_1 s, crosses *viz.*, Dh-86 × AGL-108, TMV-2 × AGL-168 and Dh-86 × AGL-635 were considered to be superior as they recorded positively significant sca effect for pod yield per plant.

Introduction

Groundnut (*Arachis hypogaea* L.) is an important oilseed crop of the world. Groundnut kernel is a rich source of energy because of its high oil content (44-50 %) and protein content (25-33 %). It contains 18 per cent carbohydrates, and also rich in minerals (calcium, magnesium and iron) and vitamins (B_1, B_2 and Niacin).

In any breeding programme, the choice of parents is an important aspect for the success of the crop improvement programme. For improvement of any plant character through hybridization, it is necessary to understand the nature of gene action and genetic architecture of the donar parents for that particular character. 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.

Keeping these points in view, an investigation was taken up in groundnut (*Arachis hypogaea* L.) involving a set of three female and six pollen parents crossed in a line × tester design, to study the gca and sca and also the gene action determining the growth and yield traits.

Materials and Methods

The experimental material for the present study comprised 18 F_1's involving three lines GPBD-4, TMV-2 and Dh-86 and six testers AGL-2389, AGL-635, AGL-108, AGL- 168, AGL-289 and AGL-2255. The F_1s along with parents were sown in Randomized Complete Block Design (RCBD) with two replications with spacing of 30 × 10 cm.

Observations were recorded on five randomly selected plants from each F_1 and parents on thirteen quantitative traits *viz.*, plant height (cm), number of primary branches per plant, number of secondary branches per plant, number of matured pods per plant, number of immature pods per plant, pod yield per plant (g), kernel yield per plant (g), shelling percentage (%), sound mature kernel percentage (%), test weight (g), haulm yield per plant (g), chlorophyll content (mg/l) and oil content were recorded as per standard procedures. The statistical analysis was done as per procedure given by Kempthorne (1957) for combining ability analysis using line × tester mating design.

Results and Discussion

Analysis of variance indicated the presence of significant differences among treatments for all the thirteen characters studied (Table 1). Parents Vs crosses differed significantly for all the characters except kernel yield and haulm yield per plant. For efficient selection, presence of variability among the genotypes for the trait of interest is a prerequisite. Analysis of variance for combining ability revealed that variance due to lines was highly significant for three traits *viz.,* plant height, pod yield per plant and oil content whereas testers showed non-significant differences for all the traits studied.

The variance due to lines × testers was highly significant for all the traits under study except kernel yield per plant.

It indicated significance difference of sca effects among the crosses. The analysis of gene action expressed the higher proportion of SCA than GCA for all the characters studied except plant height and pod yield per plant (Table 2), indicating the role of non-additive components of variance in the inheritance of these characters.

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. This experiment results proposing the preponderance of non-additive gene action for the characters studied have supporting evidences from the earlier workers *viz.*, Savitramma *et al.*, (2010) for number of pods per plant and 100 kernel weight, John *et al.*, (2011) for chlorophyll content, Mohan *et al.*, (2012) for sound mature kernel percent and Padmaja *et al.*, (2015) for shelling percentage.

The important criterion of selection is the general combining ability (gca) of parents. The parents with good *per se* performance and significant gca effects are considered as good general combiners for deriving desirable transgressive segregants in self-pollinated crops. Among testers AGL-635 recorded significant gca effect in desirable direction for important traits like matured pods per plant, pod yield per plant, shelling per cent, sound mature kernel per cent and haulm yield per plant. The line Dh-86 recorded gca effect in desirable direction for pod yield per plant. Among the lines Dh-86 and among all the testers AGL-635 could be considered as best combiners with respect to gca effect (Table 3). Thus, it would be worthwhile to use above parents in breeding programme for exploiting additive gene effects.

Table.1 Analysis of variance (ANOVA) for yield and yield contributing traits in parents and hybrids in groundnut (*Arachis hypogaea* L.)

Source	d.f	Plant height (cm)	Primary branches per plant	Secondary branches per plant	Matured pods per plant	Immature pods per plant	Dry pod yield per plant (g)	Kernel yield per plant (g)	100 Kernel weight (g)	Shelling percentage (%)	Sound Mature Kernel Per cent	Chlorophyll content (mg/l)	Haulm yield per plant (g)	Oil content (%)
Replication	1	3.35*	0.06	0.04	0.35	0.29	0.06	28.74	0.15	0.37	1.84	0.10	0.12	0.13
Treatments	26	34.27**	1.66**	0.36**	18.40**	0.78**	44.93**	18.99*	59.83**	25.86**	20.19**	9.90**	9.59**	2.61**
Parents	8	52.11**	2.74**	0.47**	20.47**	0.48**	25.69**	25.45*	41.69**	8.52**	10.75**	7.43**	4.47**	2.04**
Lines	2	112.18**	2.94**	0.32*	28.84**	0.68*	60.60**	48.86**	81.09**	5.158**	7.17*	12.21**	6.96**	0.95*
Testers	5	27.85**	1.72**	0.57**	20.82**	0.46*	9.512**	11.09	26.40**	11.47**	13.36**	6.90**	4.17**	2.88**
Lines Vs testers	1	53.29**	7.47**	0.28	1.96**	0.13	36.80**	50.40*	39.31**	0.51	4.85	0.49	1.00	0.03
Crosses	17	11.86**	1.02**	0.31**	15.10**	0.91**	44.17**	17.07*	61.77**	30.12**	20.55**	11.22**	12.55**	2.85**
Parents Vs. Crosses	1	272.58**	3.92**	0.37*	58.08**	0.92*	211.67**	0.09	171.91**	92.25**	89.58**	7.41**	0.26	3.02**
Error	26	0.52	0.13	0.08	1.78	0.13	0.66	1.83	0.66	0.90	1.37	0.64	0.29	0.19

Note: * - Significant at 5%, ** - Significant at 1%

Table.2 Analysis of variance (ANOVA) for combining ability for different traits in groundnut (*Arachis hypogaea* L.)

Source	d.f	Plant height (cm)	Primary branches per plant	Secondary branches per plant	Matured pods per plant	Immature pods per plant	Dry pod yield per plant (g)	Kernel yield per plant (g)	100 Kernel weight (g)	Shelling percentage (%)	Sound Mature Kernel Per cent	Chlorophyll content (mg/l)	Haulm yield per plant (g)	Oil content (%)
Replication	1	3.39*	0.01	0.04	0.11	0.11	0.04	25.00	0.24	0.18	1.78	0.01	0.65	0.09
Crosses	17	11.86**	1.02**	0.31*	15.10**	0.91**	44.17**	17.07	61.77**	30.12**	20.55**	11.22**	12.55**	2.85**
Lines	2	47.56**	0.70	0.10	1.00	1.33	235.74**	19.84	1.52	38.81	11.30	8.71	18.30	9.70*
Testers	5	9.38	0.81	0.22	17.71	0.84	19.26	19.09	59.86	9.63	20.73	14.16	9.81	2.26
Lines × testers	10	5.97**	1.19**	0.39**	16.61**	0.86**	18.31**	15.51	74.78**	38.62**	22.31**	10.24**	12.77**	1.78**
Error	17	0.62	0.17	0.10	0.23	0.15	0.86	14.37	0.88	1.20	1.29	0.38	0.34	0.15
s^2 GCA		3.0946	0.0645	0.0068	1.0135	0.1035	14.0708	0.9351	3.3125	2.5582	1.6359	1.2282	1.5238	0.6486
s^2 SCA		2.6737	0.5053	0.1479	8.1918	0.3538	8.7263	2.2293	36.9492	18.7111	10.5111	4.9314	6.2158	0.8184
s^2 GCA/ var SCA		1.15	0.12	0.04	0.12	0.29	1.61	0.41	0.08	0.13	0.15	0.249	0.24	0.79

Note: * - Significant at 5%, ** - Significant at 1%

Table.3 Estimation of general combining ability effects of lines and testers for different traits in groundnut (*Arachis hypogaea* L.)

Sl. No.	Parents	Plant height (cm)	Primary branches per plant	Secondary branches per plant	Matured pods per plant	Immature pods per plant	Dry pod yield per plant (g)	Kernel yield per plant (g)	100 Kernel weight (g)	Shelling percentage (%)	Sound Mature Kernel Per cent	Chlorophyll content (mg/l)	Haulm yield per plant (g)	Oil content (%)
Lines														
1	GPBD 4	-0.51*	0.23	-0.08	0.25	-0.08	-2.86**	1.39	0.21	1.51**	0.44	-0.73**	1.42**	0.94**
2	Dh 86	2.19**	0.006	-0.01	0.06	-0.28*	5.10**	-0.25	-0.41	0.47	0.66	-0.20	-0.67**	-0.84**
3	TMV 2	-1.68**	-0.24	0.10	-0.31*	0.36**	-2.24**	-1.13	0.19	-1.98**	-1.11**	0.93**	-0.74**	-0.09
	SE for lines	0.22	0.12	0.09	0.14	0.11	0.26	0.95	0.27	0.31	0.32	0.17	0.16	0.11
	CD @ 5%	0.48	0.25	0.19	0.29	0.24	0.56	2.02	0.57	0.66	0.69	0.37	0.35	0.23
	CD @ 1%	0.66	0.35	0.26	0.40	0.33	0.77	2.78	0.78	0.91	0.95	0.52	0.49	0.32
Testers														
4	AGL2255	-0.56	0.07	-0.26	-1.26**	0.66**	-1.87**	1.37	2.98**	-1.63**	-2.59**	-2.38**	0.18	0.33
5	AGL289	1.76**	-0.29	0.00	0.33	-0.33	-1.21**	0.14	-3.63**	0.17	2.07**	0.31	1.82**	-0.19
6	AGL 168	-0.77*	0.30	0.00	-1.30**	-0.26	-1.61**	1.47	2.51**	1.29*	-1.88**	-1.12**	-0.98**	0.81**
7	AGL 108	1.20**	-0.39*	-0.03	0.83**	-0.16	1.08*	-1.42	-1.79**	-0.21	0.46	1.12**	-1.05**	0.23
8	AGL 635	-1.52**	-0.22	0.33*	2.90**	0.20	2.42**	1.27	-3.05**	1.52**	1.51**	0.19	1.17**	-0.99**
9	AGL2389	-0.09	0.53**	-0.03	-1.50**	-0.10	1.18**	-2.85	2.98**	-1.14*	0.42	1.85**	-1.14**	-0.19
	SE for testers	0.32	0.17	0.12	0.19	0.16	0.37	1.35	0.38	0.44	0.46	0.25	0.24	0.16
	CD @ 5%	0.67	0.36	0.27	0.41	0.34	0.80	2.86	0.80	0.94	0.97	0.53	0.50	0.33
	CD @ 1%	0.93	0.50	0.37	0.57	0.46	1.10	3.93	1.11	1.29	1.34	0.73	0.69	0.46

Note: * - Significant at 5%, ** - Significant at 1%

Table.4 Top three desirable crosses with their sca and gca effect of their parents with respect to 13 characters in groundnut

Characters	Crosses	SCA Effect	GCA Effect	
			Female	**Male**
Plant height (cm)	GPBD-4 × AGL-108	2.51**	Low	High
	Dh-86 × AGL-635	1.95**	High	Low
	Dh-86 × AGL-2389	1.50*	High	Low
Number of primary branches per plant	Dh -86 × AGL-635	1.06**	Low	Low
	GPBD-4 × AGL-2389	0.86*	Low	High
	Dh-86 × AGL-168	0.62	Low	Low

Number of secondary branches per plant	GPBD-4 × AGL-2255 Dh-86 × AGL-635 TMV-2 × AGL-2389	0.61* 0.45 0.40	Low Low Low	Low High Low
Number of matured pods per plant	GPBD-4 × AGL-2389 TMV-2 × AGL-289 Dh-86 × AGL-635	3.91** 2.45** 2.10**	Low Low Low	Low Low High
Number of immature pods per plant	TMV-2 × AGL-635 GPBD-4 × AGL-108 Dh-86 × AGL-168	-1.10** -1.08** -0.38	Low Low High	Low Low Low
Pod yield per plant (g)	Dh-86 × AGL-108 TMV-2 × AGL-168 Dh-86 × AGL-635	4.79** 2.74** 2.66**	High Low High	High Low High
Kernel yield per plant (g)	TMV-2 × AGL-2255 Dh-86 × AGL-108 Dh-86 × AGL-168	4.03 3.55 2.05	Low Low Low	Low Low Low
100 kernel weight (g)	Dh-86 × AGL-289 GPBD-4 × AGL-635 Dh-86 × AGL-168	7.52** 6.53** 4.91**	Low Low Low	Low Low High
Shelling per cent	TMV-2 × AGL-2389 Dh-86 × AGL-108 GPBD-4 × AGL-168	7.15** 5.31** 3.46**	Low Low High	Low Low High
Sound mature kernel per cent	Dh-86 × AGL-168 TMV-2 × AGL-635 GPBD-4 × AGL-108	4.37** 3.95** 3.63**	Low Low Low	Low High Low
Chlorophyll content (mg/l)	TMV-2 × AGL-289 GPBD-4 × AGL-2255 TMV-2 × AGL-168	3.57** 2.50** 2.20**	High Low High	Low Low Low
Haulm yield per plant (g)	GPBD-4 × AGL-289 Dh-86 × AGL-108 GPBD-4 × AGL-635	3.34** 2.73** 2.63**	High Low High	High Low High
Oil content (%)	Dh-86 × AGL-168 TMV-2 × AGL-2255 TMV-2 × AGL-108	1.36** 0.91** 0.73*	Low Low Low	High Low Low

Among the 18 crosses evaluated, the crosses Dh-86 × AGL-635, Dh-86 × AGL-108 and TMV-2 × AGL-168 recorded significant sca effects for pod yield and its component traits in desirable direction (Table 4). For the majority of the traits, except plant height, pod yield, chlorophyll content and haulm yield per plant the low x low *gca* combination of parents were more observed to be the heterotic cross combinations, indicating the predominance of non-additive gene action. Similar findings were reported by Ganesan *et al.*, (2010) and John *et al.*, (2011) for oil conent, Mohan *et al.*, (2012) and Padmaja *et al.*, (2015) for shelling percentage. For pod yield and haulm yield per plant high × high *gca* combination of parents were more observed indicating the predominance of additive gene action.

The results were in agreement with findings of Kavani *et al.*, (2004), John *et al.*, (2011) and Padmaja *et al.*, (2015) for haulm yield per plant and Vasanthi *et al.*, (2015) for pod yield per plant. For the traits plant height and chlorophyll content high × low *gca* combination of parents were more observed indicating the predominance of additive × non-additive type of gene action, which were in accordance of Mohan *et al.*, (2012).

In conclusion, Based on gca, the parents Dh-86 and AGL-635 could be better choices for improvement of yield and its component traits through hybridization. The crosses Dh-86 x AGL-635, Dh-86 x AGL-108 and TMV-2 x AGL-168 which had highly significant sca effect for most of the yield contributing traits may be exploited for the development of hybrids since they also had high per se performance.

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