Electronic Journal of Plant Breeding, 1(2): 162-166 (March 2010)

Research Article

Combining ability analysis for yield and its components in groundnut (*Arachis hypogaea* L.)

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Abstract:
Combining ability was studied among 24 crosses involving eight lines and three testers. The general and specific combining ability variances were highly significant for all the characters studied. The parent VRI Gn 6 proved to be a good general combiner for yield and yield components. Three crosses *viz*., VRI Gn 6 x GAUG 10, VRI Gn 6 x VRI 2 and VRI 4 x UG 9 exhibited desirable *sca* effects and also recorded higher *per se* performance. Most of the crosses involved parents with high x low *gca* effects which showed the involvement of non-additive gene action in controlling these characters.

Key words:
Groundnut, General combing ability, specific combining ability, yield

Introduction

Combining ability is the relative ability of a genotype to transmit its desirable performance to its crosses. Combining ability analysis is not only the quickest method of understanding the genetic nature of quantitatively inherited traits, but also gives essential information about the selection of parents which in turn throws better segregants. The knowledge of the type of gene action involved in the expression of yield and yield components are essential to choose an appropriate breeding methodology to isolate desirable segregants in the later generations. In the present investigation, line x tester design with geographically diverse parents of groundnut was used to obtain information on combining ability of elite lines for seven yield and yield components in groundnut.

Material and methods

The material for the study consisted of eight diverse lines *viz*., TMV Gn 13, Kadiri 3, VRI 4, GPBD 4, K 134, JL 24, VRI 3 and VRI Gn 6 and three testers *viz*., UG 9, GAUG 10 and VRI 2. The parents were crossed in line x tester mating fashion to synthesize 24 F_1 hybrids at the Regional Research Station, Vridhachalam during Kharif 2007. The experiment was laid out in a Randomized Complete Block Design with two replications. The parents and the crosses were raised in ten rows of 3 m length with a spacing of 30 cm x 15 cm. All the recommended package of practices were followed to raise a healthy crop. Ten plants in parents and hybrids were selected randomly in each replication and observations were recorded for plant height (cm), number of primaries per plant, number of secondaries per plant, number of mature pods per plant, pod yield per plant (g), kernel yield per plant (g) and shelling outturn (per cent). The mean values were subjected to line x tester analysis as suggested by Kempthorne (1957).

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Results and discussion

Mean squares due to treatment were highly significant for all the characters studied (Table 1). The lines were found to be significant for all the seven characters while, the testers were found to be highly diverse as evidenced by significant differences among them for most of the characters except for number of mature pods per plant, pod yield and kernel yield per plant. Obviously due to the diverse nature of the line and testers the crosses between them were also found to be significant for all the characters. The significant variance of line x tester interaction indicated the importance of specific combining ability. The mean squares due to lines were of a larger magnitude than those of testers and line x tester for all the characters indicating greater diversity among the lines.

The magnitude of specific combining ability variances was much greater than those of general combining ability variances for all the characters, which indicated the preponderance of non-additive gene action for all the characters. The role of non-additive gene action for these traits have been reported by Upadhyaya *et al*. (1992), Rudraswamy *et al*. (2001), Jayalakshmi *et al*. (2002), Dasaradha Rami Reddy *et al*. (2004), Vasanthi *et al*. (2004), Yadav *et al*. (2006) and Rekha *et al*. (2009).

The *per se* performance and general combining ability effects are presented in Table 2. The parent VRI Gn 6 recorded significantly higher mean for number of mature pods, pod yield and kernel yield per plant. However, Kadiri 3 registered significantly higher mean for number of secondaries, pod yield and kernel yield per plant. The line parent GPBD 4 recorded significantly high mean for number of secondaries and number of mature pods per plant.

The estimates of *gca* effect showed that among the lines, VRI Gn 6 was found to be superior as it showed significant and positive *gca* effect for plant height, number of mature pods, pod yield per plant, kernel yield per plant and shelling outturn. The line parent K 134 was a good general combiner for shelling outturn, while VRI 4 was a good combiner for number of primaries and number of secondaries per plant. The best general combiner for number of primaries per plant was Kadiri 3. Among the tester parents, GAUG 10 recorded significant positive *gca* effect for number of primaries and number of secondaries per plant while, VRI 2 was a good combiner for shelling outturn. Since, high *gca* effect is attributed to additive and additive x additive type of gene actions, these parents could be used in breeding programme for yield improvement through pedigree breeding.

Twelve out of 24 crosses were ranked as top crosses for one or more characters (Table 3). None of the crosses was found desirable simultaneously for all the characters i.e., different crosses expressed significant *sca* effects for different characters. However, the cross VRI Gn 6 x GAUG 10 showed significant *sca* effects in the desirable direction for number of secondaries per plant, number of mature pods per plant, pod yield per plant, kernel yield per plant and shelling outturn. It is worthwhile to mention that this particular cross also manifested higher per se performance for the above said characters. The cross VRI Gn 6 x VRI 2 also exhibited significant *sca* effect for number of mature pods per plant, pod yield and kernel yield per plant. Similarly the cross VRI 4 x UG 9 was found to be desirable for number of primaries per plant, number of secondaries per plant, number of mature pods per plant, pod yield per plant, kernel yield per plant and shelling outturn. Biparental mating followed by selection might be worthwhile for fostering greater recombination in these crosses (Francis and Ramalingam, 1999).

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Table 1. ANOVA for combining ability for various characters in groundnut

Source of variation	df	Mean squares						
		Plant height	Number of primaries	Number of secondaries	Number of mature pods	Pod yield	Kernel yield	Shelling outturn
Replications	1	4.78*	0.20	0.68	0.82	5.57*	1.91	7.06*
Treatments	34	97.53**	3.59**	4.78*	23.75**	21.86**	12.45**	13.85**
Parents	10	104.61**	2.80**	3.49*	41.27**	31.41**	16.62**	11.28**
Parents Vs Crosses	1	1039.71**	13.39**	4.06	184.56**	19.44**	10.40**	4.26*
Crosses	23	53.48**	3.49**	5.38**	9.14**	17.81**	10.72**	15.38**
Lines	7	87.33**	8.33**	7.52**	15.63**	42.04**	23.88**	10.07*
Testers	2	37.58**	1.72*	5.16**	1.83	0.42	0.038	15.18**
Line x Tester	14	38.84**	1.33**	4.34**	6.94*	8.18	5.67	18.07**
Error	23	4.318	0.322	0.465	2.346	4.229	2.420	2.032
σ^2 gca		0.505	0.074	0.035	0.076	0.332	0.174	-0.092
σ^2sca		17.26	0.505	1.939	2.296	1.977	1.626	8.019
σ^2gca/ σ^2sca		0.029	0.146	0.018	0.033	0.167	0.107	0.011

*, ** significant at 5% and 1% levels, respectively

Table 2. Estimates of gca effect with *per se* performance of 11 parents for yield and its components in groundnut

Parents	Plant height		Number of primaries		Number of secondaries		Number of mature pods		Pod yield		Kernel yield		Shelling outturn	
	mean	gca effect	mean	gca effect	mean	gca effect	mean	gca effect	mean	gca effect	mean	gca effect	mean	gca effect
Lines														
TMV Gn 13	32.31	1.38	5.80	-0.31	2.17	-1.30**	18.75	-0.51	16.12	-2.34*	11.77	-1.55*	71.92	1.16
Kadiri 3	27.56	-6.79**	6.45	2.39**	3.88*	1.56**	16.41	-0.60	23.31*	0.60	16.59*	0.32	70.95	-0.32
VRI 4	18.40	-0.66	4.00	0.97**	3.30	1.34**	15.50	-0.11	17.30	1.15	12.79	0.68	73.83	-1.10
GPBD 4	27.30	-1.88*	3.50	-0.76**	5.50*	0.31	21.90*	-0.97	15.82	-0.96	11.24	-0.89	71.00	-0.74
K 134	28.40	-2.83**	3.70	-0.45	2.20	-1.58**	21.30*	-0.88	12.51	-1.35	9.04	-0.78	71.74	1.93**
JL 24	26.80	2.30*	4.45	-0.77**	2.40	-0.38	15.16	-0.23	17.48	-0.42	12.38	-0.40	70.76	-1.12
VRI 3	40.50*	3.62**	4.25	-1.25**	1.38	-0.22	13.50	-0.62	10.14	-2.43**	7.56	-1.85**	74.80*	-1.24
VRI Gn 6	35.78	4.85**	6.61	0.17	3.16	0.27	23.89*	3.93**	22.29*	5.75**	16.32*	4.47**	73.54	1.42*
SE gca	-	0.848	-	0.231	-	0.278	-	0.625	-	0.839	-	0.635	-	0.582
Testers														
UG 9	18.40	1.55**	3.50	-0.05	0.80	-0.10	12.60	-0.39	12.60	0.05	8.43	0.04	65.95	0.19
GAUG 10	30.40	-1.52**	4.10	0.35*	1.40	0.61**	26.10*	0.19	17.17	0.14	12.01	0.01	69.98	-1.06**
VRI 2	39.01	-0.03	5.76	-0.30*	2.38	-0.51**	14.35	0.20	14.70	-0.18	10.67	-0.05	72.78	0.86*
SE gca	-	0.519	-	0.142	-	0.170	-	0.383	-	0.514	-	0.389	-	0.336

*, ** significant at 5% and 1% levels, respectively

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

Characters	Crosses	Mean	*sca* effect	*gca* status of parents	
				P_1	P_2
Plant height	K 134 x GAUG 10	26.93	-6.56**	Low	Low
	Kadiri 3 x GAUG 10	29.31	-0.22	Low	Low
	GPBD 4 x UG 9	31.09	-6.42**	Low	High
	Kadiri 3 x UG 9	31.28	-1.31	Low	High
	Kadiri 3 x VRI 2	32.55	1.53	Low	Low
Number of primaries	Kadiri 3 x GAUG 10	8.78*	0.34	High	High
	Kadiri 3 x UG 9	8.07*	0.03	High	Low
	VRI 4 x UG 9	7.90*	1.29**	High	Low
	Kadiri 3 x VRI 2	7.41*	-0.37	High	Low
	VRI 4 x GAUG 10	6.36	-0.65	High	High
Number of secondaries	VRI 4 x UG 9	7.08*	3.75**	High	Low
	Kadiri 3 x GAUG 10	4.67*	0.42	High	High
	VRI Gn 6 x GAUG 10	4.45*	1.49**	Low	High
	Kadiri 3 x VRI 2	4.03*	0.91	High	Low
	VRI 3 x GAUG 10	3.21	0.74	Low	High
Number of mature pods	VRI Gn 6 x GAUG 10	21.84*	3.08**	High	Low
	VRI Gn 6 x VRI 2	17.46	-1.31	High	Low
	VRI 4 x UG 9	16.86	2.73*	Low	Low
	Kadiri 3 x VRI 2	16.45	2.22	Low	Low
	VRI Gn 6 x UG 9	16.40	-1.77	High	Low
Pod yield per plant	VRI Gn 6 x GAUG 10	25.12*	4.06*	High	Low
	VRI Gn 6 x UG 9	19.06	-1.91	High	Low
	VRI Gn 6 x VRI 2	18.59	-2.15	High	Low
	VRI 4 x UG 9	17.88	1.51	Low	Low
	Kadiri 3 x UG 9	17.09	1.28	Low	Low
Kernel yield per plant	VRI Gn 6 x GAUG 10	18.70*	3.35**	High	Low
	VRI Gn 6 x UG 9	13.73	-1.66	High	Low
	VRI Gn 6 x VRI 2	13.60	-1.69	High	Low
	VRI 4 x UG 9	13.45	1.85	Low	Low
	Kadiri 3 X UG 9	12.38	1.14	Low	Low
Shelling per cent	VRI 4 xX UG 9	75.19*	5.06**	Low	Low
	K 134 x GAUG 10	74.83*	0.99	High	High
	VRI 3 x VRI 2	74.26*	3.60**	Low	High
	K 134 x GAUG 10	74.01*	2.10*	High	Low
	VRI Gn 6 x GAUG 10	73.51	2.119*	High	Low

*, ** significant at 5% and 1% levels, respectively