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Research Note

General and specific combining ability analysis for yield and yield contributing characters in groundnut (*Arachis hypogaea* L.)

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Abstract

The present study was undertaken to analyse the nature of gene action involved in the inheritance of seed yield and its components using F_1s of 7 parents half- diallel cross. The 7 parents and 21 hybrids were planted in a randomized block design with three replications during *summer* 2016. General combining ability and specific combining ability were estimated for 12 characters *viz*.. days to first flowering, days to 50% flowering, days to maturity, plant height, number of pods per plant, pod length, pod yield per plant, shelling %, kernel yield per plant, 100 kernel weight, oil content and haulm yield per plant. The genetic analysis was done following Griffing's Method II with Model I (1956). Analysis of variance for combining ability revealed that GCA and SCA were highly significant for all the characters under study in F_1 generation. This suggested the importance of both additive and non-additive gene effects in the inheritance of traits under study. However, the estimates of variance due to SCA is greater than variance due to GCA for all the characters involved in the study indicating the predominance of non-additive gene action in controlling the expression of all the traits involved in the study.

Key words

Groundnut, general combining ability, specific combining ability, diallel analysis

Groundnut or peanut is an important oilseed and food crop today. In any breeding programme knowledge of the genetic composition and the nature of gene action involved in the expression of the trait to be improved is the basic requirement of the breeder. Diallel is an efficient method for the study of combining ability as well as the gene action involved. The knowledge on combining ability and type of gene action responsible for the regulation of expression of different traits would certainly help in planning appropriate breeding strategies. The general combining ability and the specific combining ability estimates can be translated into measures of additive and dominance components of genetic variation, respectively, in a given population (Griffing, 1956). The aim of most peanut breeding programme is to increase the yield of seed or oil, shelling and milling properties and quality of end use products. Knowledge of combining ability is essential for selection of suitable parents for hybridization and identification of promising hybrids in breeding program.

During *kharif* 2015, F_1 hybrids were produced following half diallel fashion using seven genotypes by hand emasculation and pollination technique *viz.*, ICGS 76 (ICRISAT, Hyderabad), JSP 51 (Jalgaon, Maharashtra), KAUSHAL (Kanpur), KDG 123 (Maharashtra), BAU 13 (Ranchi), JSP 56 (Jalgaon, Maharashtra), HNG 163 that were obtained from the AICRP (Groundnut), Department of Plant Breeding and Genetics, College of Agriculture, CAU, Imphal, Manipur. In summer 2016, all the 21 F_1 crosses along with seven parental lines were grown in the Randomised Block Design (RBD) with three replications in the Experimental Farm of the Plant Breeding and Genetics, College of Agriculture, Central Agricultural University, Imphal, Manipur which is at the altitude of about 790m above mean sea level. Observations were made on 12 characters *viz*.. days to first flowering, days to 50% flowering, days to maturity, plant height, number of pods per plant, pod length, pod yield per plant, shelling %, kernel yield per plant, 100 kernel weight, oil content and haulm yield per plant.

The combining ability analysis was carried out according to Model I and Method II of Griffing (1956). The fixed effect model (Model I) was considered to be more appropriate in the present investigation.

The analysis of variance for the experiment revealed significant differences due to genotypes (parents and F_1s) for all the 12 traits studied i.e. days to first flowering, days to 50% flowering, days to maturity, plant height, number of pods per plant, pod length, pod yield per plant, shelling percentage, kernel yield per plant, 100 kernel weight, oil content and haulm yield per plant suggesting the existence of substantial genetic variability (Table 1). Mean sum of squares due to general combining ability and the specific combining ability were highly significant for all the characters under study. This indicated the importance of both additive and non-additive gene action for the expression of all the characters. The variance due to specific combining ability was greater than the variance due to general combining ability for all the traits. This indicates the predominance of non – additive gene action for these traits. These findings are in conformity with the findings of Mathur *et al.* (2000), Vanaja *et al.* (2003) and Onyia (2011). Hence improvement of these traits could be accomplished by selection in later filial generations. The mean *per se* performance of the parents was a good indicator for their GCA effects (Table 2). The crosses with high SCA for kernel yield per plant simultaneously showed high SCA effects for other yield contributing characters. Similar result was found by Jivani (2004). The parents showing higher mean performance generally proved to be good general combiners. In such cases, additive effect is more important and the choice of parents should be dependent on their performance. Similar result was found by Jivani *et al.* (2009).

General combining ability (GCA) effects: The general combining ability (GCA) effects represents the fixable components of genetic variance which include both additive and additive x additive interactions. An overall perusal of the parents for general combining ability effects (Table 3 and Table 4) revealed that JSP 56 and KDG 123 are good general combiners for most of the traits under study. However, none of the parents was a good combiner simultaneously for all the characters studied. JSP 56 was a good general combiner for pod yield per plant, shelling percentage, kernel yield per plant, 100 kernel weight and haulm yield. Similar results were found by Jogloy *et al.* (1987) and Jivani *et al.* (2009). BAU 13 was a good general combiner for pod length, 100 kernel weight and haulm yield. Similar results were found by Wynne *et al.* (1975) and Garet (1976). For days to first flowering, days to 50% flowering, days to maturity, number of pods per plant, pod yield per plant and haulm yield, KDG 123 was a good general combiner. Similar results were reported by Mathur *et al.* (2000) and Savithramma *et al.* (2010). ICGS 76 and JSP 56 were good general combiners for shelling percentage. For plant height, KAUSHAL, HNG 163 and JSP 51 were good general combiner. In most of the cases, good general combiners showed better *per se* performance, which indicated the parents may be selected either on the basis of GCA or *per se* performance or in combination.

On the basis of overall performance across 12 characters, JSP 56, KDG 123 and JSP 51 were identified as the most promising parents because the parents were noticed either good or average general combiners for kernel yield per plant and other yield contributing characters. The present study was in agreement with the earlier findings of Garet (1976), Savithramma *et al.* (2010) and Onyia (2011). These parents may serve as valuable parents for hybridization programme or multiple crossing programme to achieve good segregants. Therefore, simultaneous improvement in important yield components and associated trait along with kernel yield per plant may be better approach for raising yield potential in groundnut.

Specific combining ability (SCA) effects: Out of 21 cross combinations (Table 5), the cross JSP 56 × JSP 51 showed highest significant SCA effects for kernel yield per plant in F_1 generation. Among the important yield components, number of pods per plant, pod yield per plant and haulm yield per plant played an important role in enhancing the productivity of kernel yield. Similar results were found by Vanaja *et al.* (2003) and Savithramma *et al.* (2010). In general, maximum crosses showing significant SCA effects were invariably associated with better mean *per se* performance for respective traits. It is revealed that most of the good specific cross combinations for different characters involved parents of low x low, low x average, average x average, average x high and high x high general combining ability. Manoharan *et al.* (1990) concluded that the crosses which have high specific combining ability effects either have high x low or low x low combinations. However in majority of cases, the crosses exhibiting high SCA effects were found to have either or both of the parents as good general combiner for kernel yield and its attributing characters. Dagade and Dhaduk (2015) reported that most of the cross combinations with high SCA effects involved high x high, high x low and low x low GCA combiners for yield and yield attributing characters. The major part of such variance would be fixable in later generations. Recombination breeding through multiple crosses involving these hybrids would be desirable to breed genotypes combining these characters. The present findings are in tune with Vanaja *et al.* (2003) and Jivani *et al.* (2009)

A perusal of results of combining ability analysis indicated considerable non-additive gene action in the inheritance of majority of the attributes studied. Under such situations, breeding procedures have to be amended suitably by postponing the selection to later generations (Baker, 1968). Alternatively intermating of the F_2 segregants followed by recurrent selection and pedigree breeding can harness the different kinds of gene - effects. Repeated selection and inter-mating of segregating materials for two or three cycles, makes it possible to achieve simultaneously improvement in yield attributes.

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Table 1. Analysis of variance for different characters in a half diallel cross of groundnut

Source of variation	d.f.	Mean sum of squares											
		Days to first flowering	**Days to 50% flowering**	**Days to maturity**	**Plant height (cm)**	**No. of pods per plant**	**Pod length (cm)**	**Pod yield/plant (g)**	**Shelling %**	**Kernel yield/plant (g)**	**100 kernel weight (g)**	**Oil content (%)**	**Haulm yield/plant (g)**
Repl.	2	14.28**	19.19**	22.10**	36.03**	48.29**	0.13*	53.76**	12.84	11.20	55.76**	0.47	146.44**
Trts	27	5.66**	8.82**	16.14**	176.69**	31.27**	0.26**	243.17**	134.34**	75.89**	476.70**	39.78**	2517.83**
Error	54	0.33	0.74	0.53	3.83	3.43	0.033	3.16	4.83	10.65	1.53	3.08	3.36

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

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Table 2. Mean *per se* performance of parents and crosses for 12 characters in a half-diallel cross of groundnut

Parent/Cross	Days to first flowering	Days to 50% flowering	Days to maturity	Plant height (cm)	Number of pods/plant	pods length (cm)	Pod yield/plant (g)	Shelling %	Kernel yield/plant (g)	100 kernel weight (g)	Oil content (%)	Haulm yield/plant (g)
1. ICGS 76	50.66	54.33	128.33	52.76	15.33	3.10	23.41	76.36	17.86	76.66	39.50	60.14
2. JSP 51	51.33	55.66	130.66	53.76	12.66	2.30	17.91	63.89	11.43	50.76	38.05	47.69
3. KAUSHAL	51.00	54.33	130.00	55.40	16.33	2.33	21.09	60.36	12.72	45.43	47.32	50.18
4. KDG 123	48.66	51.66	126.00	54.90	19.00	2.50	28.62	58.35	16.72	54.63	39.82	64.76
5. BAU 13	51.33	56.00	130.00	61.50	11.33	2.16	29.76	58.70	17.46	93.34	43.70	58.43
6. JSP 56	49.33	52.33	126.00	57.63	14.00	2.76	24.39	72.05	17.60	71.93	36.25	49.73
7. HNG 163	48.66	52.66	125.00	52.06	11.00	2.63	11.86	69.31	8.22	61.26	48.00	30.23
ICGS 76 × JSP51	52.00	54.33	130.33	56.40	13.33	2.51	9.73	60.49	4.50	33.18	47.95	51.90
ICGS 76 ×KAUSHAL	50.00	53.00	125.33	62.38	13.33	3.01	21.07	63.20	13.31	53.43	39.82	49.78
ICGS 76 × KDG 123	48.66	50.66	127.33	55.08	20.66	2.60	32.02	58.79	18.76	63.16	39.40	41.26
ICGS 76 × BAU 13	49.00	52.33	128.66	62.10	17.66	3.33	13.20	68.59	9.03	75.40	46.15	23.04
ICGS 76 × JSP 56	49.33	51.66	129.00	62.50	14.00	2.66	22.02	58.99	13.23	69.06	42.55	47.04
ICGS 76 × HNG 163	49.66	52.00	128.66	51.76	17.00	3.14	25.60	69.99	17.86	65.26	39.62	46.05
JSP 51 × KAUSHAL	48.66	50.33	127.66	47.35	22.00	2.92	34.48	58.56	20.18	55.56	46.5	42.90
JSP 51 × KDG 123	49.00	51.33	126.66	50.50	19.33	2.66	27.61	57.47	15.76	53.20	42.72	51.34
JSP 51 × BAU 13	50.00	52.66	129.00	58.66	17.33	3.21	36.33	57.29	20.80	85.03	43.05	88.08
JSP 51 × JSP 56	50.66	53.00	131.66	65.10	17.66	2.90	50.90	53.41	27.19	62.06	38.00	119.71
JSP 51 × HNG 163	52.33	54.66	133.66	54.76	13.00	2.62	20.98	63.67	13.36	70.93	41.27	43.00
KAUSHAL × KDG 123	50.00	52.00	130.66	40.50	21.00	2.80	44.26	55.62	24.60	50.03	40.42	81.78
KAUSHAL × BAU 13	49.33	52.33	128.66	52.50	14.00	3.11	18.97	64.95	12.31	79.98	37.97	46.79
KAUSHAL × JSP 56	53.00	55.00	133.33	59.43	16.33	3.15	32.42	59.01	19.13	72.86	47.90	45.55
KAUSHAL × HNG 163	50.00	52.66	127.66	50.31	21.00	2.56	34.00	65.95	22.42	63.46	38.12	58.29
KDG 123 × BAU 13	49.33	51.33	129.66	60.42	17.00	3.34	34.94	52.82	18.45	75.50	35.27	169.52
KDG 123 × JSP 56	47.66	50.00	126.66	74.90	12.00	2.54	20.69	71.79	14.86	65.80	44.02	61.50
KDG 123 × HNG 163	47.00	48.66	125.00	53.86	16.00	2.69	27.77	44.14	12.27	68.30	43.55	70.65
BAU 13 × JSP 56	50.33	53.33	128.33	77.93	12.00	3.01	18.66	67.59	12.60	70.00	46.56	50.25
BAU 13 × HNG 163	49.66	53.66	128.66	53.36	12.66	2.83	22.32	64.45	14.39	73.43	37.97	40.57
JSP 56 × HNG 163	51.00	48.54	131.66	52.16	16.00	2.96	24.48	64.60	15.78	64.36	38.85	85.89
Range	**47.00 to 53.00**	**48.66 to 56.00**	**125.00 to 133.66**	**40.50 to 77.93**	**11.00 to 22.00**	**2.16 to 3.33**	**9.73 to 50.90**	**44.14 to 76.36**	**4.50 to 24.60**	**33.18 to 93.34**	**35.27 to 48.00**	**23.04 to 169.52**
C.V	**1.11**	**1.54**	**0.61**	**2.78**	**10.84**	**6.25**	**7.01**	**3.54**	**7.56**	**1.55**	**5.21**	**3.05**

Table 3. Analysis of variance for combining ability for different characters in 7- parent diallel of groundnut

Source of variation	d.f.	Mean sum of squares											
		Days to first flowering	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of pods per plant	Pod length (cm)	Pod yield/plant (g)	Shelling %	Kernel yield/plant (g)	100 kernel weight (g)	Oil content (%)	Haulm yield/plant (g)
GCA	6	3.07**	4.91**	5.87**	118.42**	18.91**	2.67**	69.65**	58.43	18.54**	438.45**	2.68*	713.65**
SCA	21	1.54**	2.37**	5.23**	41.89**	7.99**	3.82**	84.31**	40.88**	27.22**	79.03**	16.28**	875.17**
Error	54	0.11	0.24	0.17	1.27	1.14	0.01	1.05	1.61	3.55	0.51	1.02	1.12
σ^2_g		0.33	0.52	0.63	13.02	1.97	0.29	7.62	6.31	1.67	48.66	0.18	79.17
σ^2_s		1.43	2.13	5.06	40.62	6.85	3.82	83.26	39.27	23.68	78.52	15.26	874.05
σ^2_g/σ^2_s		0.23	0.24	0.13	0.32	0.29	0.08	0.09	0.16	0.07	0.62	0.01	0.09

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

Table 4. Estimates of general combining ability effects for various characters under studty in a half-diallel cross of groundnut.

Parents	Days to first flowering	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of pods per plant	Pod length (cm)	Pod yield/plant (g)	Shelling %	Kernel yield/plant (g)	100 kernel weight (g)	Oil content (%)	Haulm yield/plant (g)
1. ICGS 76	0.13	-0.02	-0.41**	0.18	0.25	-0.18**	-4.03**	3.69**	-1.82**	-0.79**	0.23	-11.08**
2. JSP 51	0.65**	0.64**	1.17**	-1.75**	0.66*	-0.40**	0.96**	-0.82*	0.54	-6.50**	0.33	1.55**
3. KAUSHAL	0.39**	0.23	0.40**	-3.71**	1.88**	-0.31**	1.95**	-1.04*	0.51	-6.11**	0.60	-5.96**
4. KDG 123	-1.15**	-1.50**	-1.33**	-0.67	1.29**	-0.42**	3.85**	-4.08**	0.56	-4.16**	-1.11**	14.05**
5. BAU 13	0.10	0.71**	0.36**	4.09**	-2.11**	0.78**	-0.65*	-0.11	-1.17*	13.56**	-0.04	6.22**
6. JSP 56	0.13	0.08	0.25	5.57**	-0.55**	-0.24**	0.94**	2.60**	2.39**	3.10**	-0.10	3.40**
7. HNG 163	-0.26*	-0.13	-0.44**	-3.70**	-1.44	0.79**	-3.03**	-0.23	-1.02	0.91**	0.08	-8.19**
S.E.	**0.10**	**0.15**	**0.13**	**0.34**	**0.33**	**0.03**	**0.31**	**0.39**	**0.58**	**0.22**	**0.31**	**0.32**

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

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Table 5. Estimates of Specific combining ability effects for days to first flowering, days to 50% flowering, days to maturity, plant height, No. of pods per plant and Pod length in a half-diallel cross of groundnut

Crosses	Days to first flowering	Days to 50% flowering	Days to maturity	Plant height (cm)	Number of pods/plant	pods length (cm)	Pod yield/plant (g)	Shelling %	Kernel yield/plant (g)	100 kernel weight (g)	Oil content (%)	Haulm yield/plant (g)
ICGS 76 × JSP51	13.12**	13.13**	30.96**	10.99**	0.30	0.43**	-0.55	18.16**	-0.25	-13.19**	14.33**	27.53**
ICGS 76 ×KAUSHAL	11.12**	11.80**	25.96**	16.97**	0.30	0.92**	8.11**	10.60**	4.28**	7.05**	6.20**	25.41**
ICGS 76 × KDG 123	9.79**	10.47**	27.96**	9.67**	7.63**	0.51**	19.06**	6.47**	9.74**	16.78**	5.78**	16.94**
ICGS 76 × BAU 13	10.12**	11.80**	29.29**	16.69**	4.63**	1.24**	0.24	15.99**	0.01	29.02**	12.53**	-1.32
ICGS 76 × JSP 56	10.46**	11.47**	29.62**	17.09**	3.30**	0.57**	9.43**	6.39**	4.20**	22.68**	8.93**	22.67**
ICGS 76 × HNG 163	10.79**	10.47**	29.29**	6.36**	4.63**	1.05**	12.64**	4.71**	8.83**	18.95**	9.01**	21.68**
JSP 51 × KAUSHAL	8.83**	8.76**	25.62**	5.82**	8.15**	1.11**	10.29**	12.23**	5.01**	14.85**	8.29**	-9.50**
JSP 51 × KDG 123	9.16**	9.76**	24.62**	8.97**	5.49**	0.85**	3.42**	10.81**	0.58	12.48**	9.41**	-1.06
JSP 51 × BAU 13	10.16**	11.10**	26.96**	17.13**	3.49**	1.39**	12.14**	10.96**	5.62**	44.32**	9.98**	35.68**
JSP 51 × JSP 56	10.83**	11.43**	29.62**	23.57**	3.82**	1.08**	26.72**	8.42**	12.01**	21.35**	8.45**	67.64**
JSP 51 × HNG 163	12.50**	13.10**	31.62**	13.23**	-0.84	0.80**	-3.19**	17.35**	7.21**	30.22**	5.43**	-8.93**
KAUSHAL × KDG 123	10.61**	10.95**	30.03**	3.48**	5.37**	0.81**	18.81**	8.94**	9.75**	7.35**	7.81**	44.97**
KAUSHAL × BAU 13	9.94**	11.28**	28.03**	15.48**	-1.62	1.12**	-6.47**	18.27**	-2.52	36.13**	5.36**	9.97**
KAUSHAL × JSP 56	13.61**	13.95**	32.70**	19.38**	0.71	1.17**	6.98**	12.33**	4.29**	30.18**	15.28**	8.73**
KAUSHAL × HNG 163	10.61**	11.62**	27.0**	13.70**	5.37**	0.58**	8.56**	19.27**	7.91**	20.78**	5.51**	21.47**
KDG 123 × BAU 13	12.53**	13.17**	31.62**	20.20**	-2.28	0.80**	7.35**	15.11**	4.40**	28.29**	4.42**	95.90**
KDG 123 × JSP 56	10.87**	11.84**	27.96**	31.67**	1.71*	0.95**	-6.89**	30.75**	0.81	21.26**	13.17**	-12.10**
KDG 123 × HNG 163	10.20**	10.50**	27.29**	10.64**	-2.28**	1.27**	0.18	3.10**	-1.77	23.76**	12.70**	-2.96**
BAU 13 × JSP 56	11.61**	11.69**	27.77**	26.64**	2.82**	-1.22**	0.35	18.68**	2.19	-1.40*	14.44**	-9.09**
BAU 13 × HNG 163	10.94**	12.02**	28.11**	2.07*	3.49**	8.43**	4.01**	15.54**	3.98**	2.03**	5.86**	-18.77**
JSP 56 × HNG 163	11.75**	12.80**	30.44**	-2.93**	4.30**	0.92**	1.78**	13.23**	0.11	9.13**	5.18**	30.24**
S.E.(Sij)	**0.25**	**0.38**	**0.32**	**0.86**	**0.81**	**0.07**	**0.78**	**0.96**	**1.43**	**0.54**	**0.77**	**0.80**

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