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Research Article

Identification of crosses and good combiners for developing new genotypes in groundnut (*Arachis hypogaea* L.)

K.N.Ganesan, R. Paneerselvam and N.Manivannan

Abstract:
A line × tester analysis involving five female and four male parents was carried out to synthesize F_1 hybrids in groundnut (*Arachis hypogaea* L.). Present study revealed the preponderance of non-additive gene action for all the traits studied as evident from the higher sca for the traits studied. The parents such as CO(Gn)5, VRI 2, BSR 1, BS 9702, Bulundi and Spanish have exhibited good combining ability for the one or the other economic traits and they were considered for the utilization in the breeding programmes. The hybrid combinations viz., BSR 1 x Spanish and CO(Gn)5 x Bulundi have recorded superior *per se* for pod yield / plant and oil content respectively. These crosses were derived from high x high and high x low *gca* parents. Hence, these crosses would be used for further selection to obtain high yielding segregants in the segregating generations

Keywords :
Groundnut, high yield, combining ability, gene action.

Introduction

Groundnut *(Arachis hypogaea* L.) is one of the leading oilseed crops of India and is a rich source of edible oil and protein for human diet. In order to improve pod yield of groundnut, the plant breeder must have knowledge on the nature of gene action in different biometrical traits which contribute for enhanced yield. Nature of gene action of different traits in genotypes to be used as parents in hybridization will also help the plant breeder to design the successful breeding programme to achieve the desired breeding objectives. Among the different methodologies available to assess the nature of gene action and also the combining ability effects of genotypes, the line x tester analysis is most widely used because of its ease and simplicity. Hence, to determine the combining ability of five lines and four testers in groundnut, the present study was taken up.

Department of Millets,
Centre for Plant Breeding and Genetics,
Tamil Nadu Agricultural University, Coimbatore - 641 003
Email: knganesan17@yahoo.co.in

Material and Methods

The popular groundnut varieties and elite groundnut genotypes *viz*., BSR1, VRI 2, CO(Gn) 5, JL 24 and BS 9702 were used as female parents (lines) and elite germplasm lines *viz*., Bulundi, IARI 731, Spanish and ICGV 86590 were used as male parent (testers) for synthesizing 20 cross combinations. About 40 - 50 hybrid seeds collected in each cross combination were utilized to raise F_1 generation. All the F_1s were raised in a randomized block design and evaluated with three replications. Individual cross combinations along with their parents were raised in four meter row with a spacing of 30 x 10 cm. The package of practices recommended for the groundnut cultivation was followed for all the entries throughout the crop growing period.

Observations were recorded on plant height, number of primary branches per plant, number of secondary branches per plant, number of pods per plant, sound matured kernel (SMK) (%), shelling (%), and pod yield per plant in all the cross combinations and parents on ten randomly selected plants. The data generated were analysed for line x tester analysis as suggested by Kempthorne (1957).

Results and Discussion

The analysis of variance revealed that variance due to lines for all the traits was significant indicating existence of differences among the combining ability of lines. The variances due to testers were significant for all the traits except primary branches. The variances due to hybrids were significant for all the traits studied (Table 1). Present study revealed the preponderance of non-additive gene action for all the traits studied as evident from the ratio between the GCA and SCA variances. Therefore, selection should be postponed to later generation for all the traits evaluated. Similar non-additive gene action for most of these traits had already been reported by Bansal *et al*. (1998), and Vindhiyavarman (2000), for pod number and pod yield per plant by Manivannan *et al*. (2008). However, predominance of additive gene action for shelling outturn, 100-pod weight, 100-seed weight, number and proportion of sound mature kernels were also reported (Hariprasanna *et al*., 2008). The relative contribution of lines towards the total variance was high for which all the traits studied except shelling outturn indicates the appropriate selection of lines.

Choice of parents

Among the lines used in the study, the BSR 1 has recorded the maximum and significantly positive GCA values for pod number per plant (6.00), SMK (4.50) and pod yield per plant (3.33) (Table 2). Among the testers, Bulundi has recorded the highest and significantly positive GCA for pod number per plant (1.52), shelling outturn (2.47), SMK (3.13) and pod yield per plant (1.77). Apart from this, the genotype Spanish has also recorded the highest mean pod yield (13 g) with the comparable positively significant GCA of 1.27. Hence these parents namely, BSR 1, Bulundi and Spanish were considered as general combiners for their involvement in future breeding programmes.

Choice of crosses

While identifying the cross combinations for further exploitation, the mean performance and the gene actions are considered as the most valid selection criteria. Considering the *per se* performance and sca of crosses (Table 3) the cross BSR 1 x Spanish exhibited highest mean (26) and significantly positive sca for pod number per plant (5.90) while the cross BSR 1 x IARI 731 exhibited highest mean and positive significant sca (6.97) for shelling (72%) outturn . The cross JL 24 x IARI 731 exhibited highest and significant sca for SMK (15.35) while the cross, BSR 1 x Spanish has recorded the maximum mean of 82%. The cross Co(Gn) 5 x Bulundi exhibited highest mean (54.26%) and highest positive significant sca for oil content (2.77) and BSR 1 x Spanish exhibited highest mean (21 g) and highest positive significant sca for pod yield per plant (4.97).

Considering the mean performance and the gene action the crosses viz., BSR 1 x Spanish can be identified as the best cross as this cross was found to be superior than all the other crosses for the traits pod number per plant, SMK and pod yield per plant. However, the cross Co(Gn)5 x Bulundi has exhibited high mean as well as positively significant sca for oil content. Hence, these two crosses could be exploited further.

Among the parents, BSR 1, and Bulundi were good general combiners for pod number per plant (1.52), Shelling outturn (2.47), SMK (3.13) and pod yield per plant. The genotype BS 9702 exhibited highest positive and significant GCA value (1.98) for shelling outturn. However, the genotypes viz., Spanish and CO(Gn) 5 were found to be best general combiners for pod yield per plant and oil content respectively. Similarly, VRI 2 exhibited good GAC for SMK. Hence, the genotypes viz., BSR 1, Bulundi, Spanish, BS 9702, CO(Gn) 5 and VRI 2 could be utilized in the breeding programme to improve the pod yield, shelling (%), oil content, SMK etc.,

Considering the results of the crosses, BSR 1 x Spanish could be forwarded to the next generation to practice selection as both the parents possess the best general combining ability. However, in the cross, Co(Gn)5 x Bulundi, one of the parent is the good general combiner for oil content and more desirable genotypes possessing the enhanced oil content could be expected in the later generations.

It could be concluded from the results of the present study that the parents viz., CO(Gn)5, VRI 2, BSR 1, BS 9702, Bulundi and Spanish were considered as desirable parents and could be used in breeding programme. Among the hybrids, BSR 1 x Spanish and Co(Gn)5 x Bulundi have recorded superior *per se* for pod yield / plant and oil content respectively. These crosses were derived from high x medium or high x high *gca* parents. Hence, these crosses would be used for further selection to obtain high yielding segregants in the segregating generations.

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Table 1. Analysis of variance for combining ability analysis under Line X Tester

Sources	df	Mean squares							
		Plant height	Primary branches	Secondary branches	No. of pods/plant	Shelling outturn	SMK	Oil content	Yield/ plant
Replication	1	24.81	4.90	0.90	1.23	38.03	2.03	3.62	27.23
Cross	19	249.92	6.40	27.89	41.73	49.76	207.52	7.90	28.65
Line	4	917.02**	21.03**	52.94**	118.56**	23.96**	152.44**	18.54**	45.98**
Tester	3	64.55**	2.07	37.93**	34.96**	85.09**	150.16**	2.26*	36.83**
LXT	12	73.89**	2.61*	17.04**	17.81**	49.53**	240.22**	5.77**	20.83**
Error	19	1.31	0.90	1.43	1.49	1.13	2.29	0.64	0.54
GCA		7.7063	0.1660	0.4753	1.0471	0.0102	-1.4316	0.0934	0.3424
SCA		36.2896	0.8542	7.8056	8.1622	24.1995	118.9663	2.5657	10.1421
A (F=0)		30.8253	0.6640	1.9013	4.1884	0.0407	-5.7265	0.3737	1.3696
D (F=0)		145.1585	3.4167	31.2224	32.6487	96.7978	475.8654	10.2629	40.5684

Table. 2. *Per se* performance and general combining ability effects of parents for various triats

Traits	Plant height		Primary branches		Secondary branches		Pod number/plant		Shelling (%)		SMK (%)		Oil content (%)		Pod yield / plant	
Parents	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA
Lines																
BSR 1	45.50	1.90 **	5.50	0.60 ns	4.00	1.00 *	9.50	6.00 **	64.50	1.23**	73.00	4.50**	47.00	-0.59ns	9.00	3.33**
VRI 2	64.00	11.92**	5.50	-1.52**	6.00	3.25 **	13.50	1.50 **	64.50	0.10 ns	71.00	3.88**	48.06	-0.42ns	15.50	1.58**
CO(Gn)5	69.00	-4.81**	7.50	2.47**	9.00	1.00 *	12.50	-3.50**	63.50	-2.40**	69.50	-3.63**	49.35	2.69 **	12.50	-2.30**
JL 24	59.50	6.65**	4.50	-1.27**	5.50	-2.88 **	16.00	-1.38**	63.00	-0.90*	70.00	-5.25**	47.30	-1.05**	13.00	-0.68*
BS 9702	56.50	-15.66**	6.00	-0.28ns	6.50	-2.38 **	16.00	-2.63**	63.00	1.98 **	74.50	0.50 ns	47.25	-0.64*	12.50	-1.92**
Testers																
Bulundi	53.00	-2.48**	4.50	0.40 ns	2.50	-1.30 **	13.50	1.52**	62.00	2.47**	67.50	3.13**	50.95	0.26 ns	11.00	1.77 **
IARI 731	57.00	-1.18**	3.50	-0.10ns	6.00	-2.00 **	12.00	-2.58**	65.50	0.77 *	67.50	3.03**	47.10	0.52 ns	9.50	-2.42**
Spanish	61.00	0.24 ns	2.00	0.30 ns	5.00	2.00 **	16.00	1.23**	62.00	-4.22**	73.00	-1.17*	45.80	-0.53ns	13.00	1.27**
ICGV 86590	62.50	3.43**	4.00	-0.60ns	6.00	1.30 **	14.00	-0.17ns	63.50	0.98**	72.00	-4.97**	45.90	-0.25ns	11.50	-0.63*

Table 3. *Per se* performance and specific combining ability of groundnut crosses for various triats

Cross	Plant height		Primary branches		Secondary branches		Pod number/plant		Shelling (%)		SMK (%)		Oil content (%)		Pod yield / plant	
	Mean	SCA	Mean	SCA	Mean	SCA	Mean	SCA	Mean	SCA	Mean	SCA	Mean	SCA	Mean	SCA
BSR 1 x Bulundi	52.00	-6.18**	8.50	1.10 ns	1.50	-3.70**	17.00	-3.40**	61.50	-5.22**	70.50	-3.00*	46.90	-1.32*	11.00	-5.53**
BSR 1 x IARI 731	57.60	-1.88*	6.00	0.90 ns	6.50	2.00*	15.00	-1.30ns	72.00	6.97**	61.00	-12.40**	48.06	-0.41ns	12.00	-0.33ns
BSR 1 x Spanish	61.15	0.25ns	7.50	0.20 ns	7.50	-1.00ns	26.00	5.90 **	53.00	-7.03**	82.00	12.80**	48.09	0.66ns	21.00	4.97**
BSR 1 x ICGV 86590	71.90	7.81**	6.00	-0.40ns	10.50	2.70 **	17.50	-1.20ns	70.50	5.28**	68.00	2.60 *	48.77	1.07ns	15.00	0.87ns
VRI 2 x Bulundi	67.20	-1.00ns	4.50	-0.78ns	9.00	1.55 ns	17.00	1.10 ns	67.50	1.90*	76.00	3.13 **	47.74	-0.65ns	16.00	1.23*
VRI 2 x IARI 731	69.10	-0.41ns	6.00	1.23 ns	1.50	-5.25**	9.00	-2.80**	58.50	-5.40**	66.50	-6.28 **	48.32	-0.32ns	7.50	-3.08**
VRI 2 x Spanish	73.75	2.83**	5.50	0.32 ns	14.00	3.25 **	15.00	-0.60ns	63.00	4.10**	70.00	1.42 ns	47.94	0.34 ns	14.50	0.22ns
VRI 2 x ICGV 86590	72.70	-1.41ns	3.50	-0.77ns	10.50	0.45 ns	16.50	2.30 *	63.50	-0.60ns	66.50	1.72 ns	48.50	0.63 ns	14.00	1.63**
Co(Gn) 5 x Bulundi	54.70	3.23**	10.50	1.23 ns	8.00	2.80 **	9.50	-1.40ns	63.50	0.40 ns	66.50	1.13 ns	54.26	2.77 **	9.00	-1.90**
Co(Gn) 5 x IARI 731	55.10	2.33**	8.50	-0.27ns	4.50	0.00 ns	9.50	2.70**	57.00	-4.40**	79.50	14.23**	54.11	2.36 **	10.50	3.80**
Co(Gn) 5 x Spanish	50.80	-3.39**	8.50	-0.67ns	6.50	-2.00 *	7.50	-3.10**	58.00	1.60*	51.00	-10.07**	47.93	-2.78**	8.00	-2.40**
Co(Gn)5 x ICGV86590	55.20	-2.18*	8.00	-0.27ns	7.00	-0.80ns	11.00	1.80ns	64.00	2.40**	52.00	-5.28 **	48.63	-2.35**	9.00	0.50 ns
JL 24 x Bulundi	55.10	-7.83**	5.00	-0.53ns	1.50	0.17 ns	14.00	0.98ns	65.00	0.40ns	52.00	-11.75**	47.14	-0.61ns	15.00	2.48**
JL 24 x IARI 731	69.75	5.52 **	3.50	-1.52 *	1.00	0.38 ns	9.00	0.08ns	63.50	0.60ns	79.00	15.35 **	47.34	-0.67ns	8.50	0.17 ns
JL 24x Spanish	69.40	3.75**	6.00	0.57 ns	6.50	1.88*	13.00	0.27ns	62.00	4.10**	61.50	2.05 ns	48.01	1.04ns	11.50	-0.52ns
JL 24 x ICGV 86590	67.40	-1.44ns	6.00	1.48 *	1.50	-2.42**	10.00	-1.33ns	58.00	-5.10**	50.00	-5.65 **	47.48	0.24 ns	8.00	-2.13**
BS 9702 x Bulundi	52.40	11.78**	5.50	-1.02ns	1.00	-0.83ns	14.50	2.72 **	70.00	2.53**	80.00	10.50 **	47.98	-0.19ns	15.00	3.72**
BS 9702 x IARI 731	36.35	-5.57**	7.50	1.48 *	4.00	2.88**	9.00	1.33 ns	68.00	2.22**	58.50	-10.90**	47.47	-0.95ns	6.50	-0.58ns
BS 9702 x Spanish	39.90	-3.44**	6.00	-0.43ns	3.00	-2.13*	9.00	-2.47**	58.00	-2.78**	59.00	-6.20 **	48.11	0.73ns	8.50	-2.28**
BS 9702 x ICGV86590	43.75	-2.78**	5.50	-0.02ns	4.50	0.08 ns	8.50	-1.58ns	64.00	-1.98*	68.00	6.60 **	48.06	0.41ns	8.00	-0.88ns