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Assessment of Combining Ability Analysis for Pod Yield and its Attributing Traits in Groundnut (*Arachis hypogaea* L.)

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ABSTRACT

Background: Groundnut is a globally significant oil crop. It possesses diversity in the nutritional and medicinal values. Groundnut kernels contain 48%-50% oil, 26%-28% protein and vitamins B and E. Continuous efforts to enhance groundnut productivity is the main driving force for the current study.

Methods: Line × Tester analysis was carried out to estimate the gene action of yield and its attributing traits for their improvement. Seven lines *viz*., VRI 7, VRI 8, VRI 9, VRI 10, K 6, GG 7 and CO 7 and eight testers *viz*., IGCV 15402, IGCV 15412, IGCV 15432, IGCV 15427, IGCV 15426, IGCV 15408, IGCV 15410 and IGCV 15388 were crossed to obtain 56 crosses. GCA and SCA variance revealed the importance of both additive and non-additive gene action of all the traits.

Result: The study observed significantly higher specific combining ability (SCA) variances compared to general combining ability (GCA) variances, indicating a predominant role of non-additive gene action in trait control. Line VRI 7 was observed best GCA, particularly for pod yield and other traits making it a promising variety for pod yield enhancement programs in the future. The SCA for hybrid VRI 8 × ICGV15426 and VRI 7 × ICGV15402 revealed superior performance in terms of pod yield per plant. Notably, the VRI 7 × ICGV15402 cross exhibited outstanding performance across all traits, highlighting the prominence of a parent with strong GCA. The study recommends early-generation selection as a strategic approach for improving groundnut breeding efforts.

Key words: Combining ability, Gene action, Groundnut, L × T analysis, Pod yield.

INTRODUCTION

Groundnut (*Arachis hypogea* L.) is a unique leguminous crop called the "Wonder Legume" as it can be used in diverse ways due to its nutritional, medicinal and fodder values. The crop ranks first in India among the oilseeds grown in the states of Tamil Nadu andhra Pradesh, Gujarat, Karnataka and Maharashtra (Shendekar *et al*., 2023). New varieties with improved agronomic traits have been the major contributor to increased food production. The combining ability analysis quickly reveals the genetic basis of traits and guides the selection of superior parents, leading to improved progeny. Understanding how gene action effecting yield and its components is crucial for selecting the appropriate breeding methods to isolate desired traits in future generations. Line (L) × Tester (T) analysis is one of the most powerful tools for predicting the general combining ability (GCA) of parents and selecting of suitable parents and crosses with high specific combining ability (SCA) (Rashid *et al*., 2007). The L × T analysis provides information about combining ability effects of genotypes and also, knowledge regarding genetic mechanism controlling yield components. Information of GCA and SCA influencing yield and its components has become increasingly important to plant breeders to select appropriate parents for developing hybrid cultivars especially in cross pollinated crops. Many researchers using L × T in some traits for the prediction of the combining abilities and gene action of self-pollinated crops (Jain and Sastry, 2012). The present investigation studies on combining ability effects of groundnut parents and offspring to understand gene actions influencing high yield and economic traits.

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MATERIALS AND METHODS

The popular groundnut varieties VRI 7, VRI 8, VRI 9, K 6, GG 7, CO 7 and VRI 10 were selected as lines (L) available at Regional Research Station (RRS), Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University (TNAU), Vridhachalam, India. Germplasm lines *viz*., IGCV

15402, IGCV 15412, IGCV 15432, IGCV 15427, IGCV 15426, IGCV 15408, IGCV 15410, IGCV 15388 were selected as testers (T) are collected from ICRISAT, Hyderabad (Table 1). All selected testers have fresh seed dormancy. Selected lines and testers were raised in crossing block at RRS during the *Rabi*-2021. Each lines and testers are raised in two and four rows, respectively. Obtained cross seeds of all 56 cross combination were raised in Randomised complete block design (RCBD) in two replicates with a spacing of 30 × 10 cm of 4 m × 3 m row plot size during the *kharif*-2022.

The F_1 hybrids were closely observed for various exclusive traits of their respective male parents and tagged as true F_1s. Observations were recorded in F_1s from each cross combination and their parents for ten quantitative traits *viz*., Plant height (PH, cm), number of primary branches per plant (NPB), number of secondary branches per plant (NSB), number of mature pods per plant (NMP), number of immature pods for plant (NIMP), pod yield per plant (PYP, g), kernel yield per plant (KYP, g), shelling percentage (S%), hundred pod weight (HPW, g) and hundred kernel weight (HKW, g). The mean values were subjected to L × T analysis as suggested by Kempthorne (1957). The recorded data -were analysed for L × T design using the software TNAUSTAT statistical package (*v 2.0.1*) (Manivannan, 2014).

RESULTS AND DISCUSSION

The parents were crossed in L × T mating fashion to synthesize 56 F_1hybrids. Analysis of variance indicated presence of significant differences among genotypes for all the characters studied (Table 2). Significant variances were observed among hybrids and parents for all the characters and also the variances due to hybrids vs. parents had significance for all characters it indicating potential for improved selection outcomes. Considerable genetic variation for various traits including pod yield per plant have been reported by many workers (Rashid *et al*., 2007; Khote *et al*., 2009; Banoth *et al*., 2023; Madhu *et al*., 2023a).

Analysis of variance for combining ability analysis (Table 2) indicated the presence of significant differences among the lines and testers for all the characters studied. The significant variance of L × T interaction indicated the importance of specific combining ability. The mean squares due to lines were of a larger magnitude than those of testers and L × T for all the characters indicating greater diversity among the lines for combining ability. 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 (Madhu *et al*., 2023). Similar kind of non-additive gene action was reported earlier for kernel yield/plant, pod yield/plant by Shoba *et al*. (2010). Hence improvement of these yield related characters could be accomplished by selection at later generations. The role of non-additive gene action for these characters have been reported by Sprague *et al*. (1942); Jayalakshmi *et al*. (2002); Yadav *et al*. (2006); Manivannan *et al*. (2008); Rekha *et al.* (2009); Ganesan *et al.* (2010); Mothilal and Ezhil (2010). Studies also reported that that dominance effects play a significant role in these traits under water stress conditions (Savithramma *et al.,* 2010; Sangeetha *et al*., 2021).

The *per se* performance of parents for yield and its component characters are presented in (Table 3) and compared with general mean. Based on *per se*, parent VRI 8 recorded higher mean pod weight per plant and kernel weight per plant. Genotype ICGV 15388 recorded higher mean for Shelling percentage, 100 pod weight per plant and 100 kernel weight per plant. Line VRI 9 recorded higher mean for number of pods per plant whereas for plant height

Table 1: List of Parents used in the present study.

Parents	Feature	Source
VRI 7	Moderately resistant to late leaf spot and rust diseases, moderately resistant to leaf miner.	RRS, Vridhachalam
VRI 8	Moderately resistant to sucking pest (Jassids and thrips) moderately resistant to LLS and rust.	
VRI 9	Moderately resistant to sucking pests and defoliators moderately resistant to LLS and rust.	
VRI 10	Moderately resistant to sucking pests and defoliators moderately resistant to LLS and rust.	
K 6	Tolerant to late leaf spot.	RARS-Kadiri
GG 7	Early maturity and Tolerant to late leaf spot.	GAU, Gujarat
CO 7	Tolerant to major foliar diseases *viz*., late leaf spot and rust.	TNAU Coimbatore
ICGV 15402, ICGV 15412, ICGV 15432, ICGV 15427, ICGV 15426, ICGV 15408, ICGV 15410	These parents have 15 days fresh seed dormancy.	ICRISAT, Hyderabad

Table 2: Analysis of variance of mean squares of RCBD and combining ability for parents and hybrids for yield and its component characters in groundnut.

Source	df	PH	NPB	NSB	NMP	NIMP	PYP	KYP	S	HPW	HKW
ANOVA Mean squares of RCBD											
Replication	1	21.45	0.5454	0.5088	0.1363	0.262	0.183	0.0057	8.28	17.39	5.095
Hybrids	55	59.289**	1.7252**	4.8084**	11.4609**	2.926**	12.66**	5.833**	54.1013**	372.71**	48.44**
Parents	14	104.74**	1.8150**	4.3696**	11.928**	1.7379**	15.00**	9.208**	81.7249**	207.52**	52.80**
Hybrids vs Parents	1	397.71**	8.1423**	1.5136**	94.8100**	3.7522**	7.31**	7.30**	20.9793**	48.7221**	361.30**
Error	70	5.3132	0.1366	0.6039	1.855	0.332	1.406	1.013	5.3976	29.4519	5.0427
ANOVA Mean squares of L × T analysis											
Replication	1	14.42	0.6151	0.5022	0.8229	0.3004	0.280	0.0322	15.9	60.03	17.92
Line	6	148.49**	5.7534**	25.88**	11.4609**	8.31**	55.0075**	23.80**	196.84**	627.82**	225.3**
Tester	7	103.19**	0.3309**	1.9040**	24.9951**	2.73**	11.2753**	5.60**	22.91**	353.80**	39.97**
L × T	42	39.2280**	1.1995**	2.5236**	9.1517**	2.189**	6.8462**	3.3043**	38.90**	196.56**	24.58**
Error	55	5.3132	0.1522	0.6011	2.1994	0.3947	1.6478	1.1453	5.890	33.377	5.549
GCA		0.4375	0.0084	0.0536	0.0504	0.0161	0.1269	0.0552	0.3314	3.8415	0.5204
SCA		16.705	0.5236	0.9612	3.4761	0.8973	2.5992	1.0795	16.5084	81.5952	9.5161
GCA/SCA		0.026	0.0160	0.0557	0.014	0.0179	0.0488	0.0511	0.0200	0.0470	0.0546

*, **Significant at 5% and 1% levels, respectively. PH- Plant height (cm), NPB- Number of primary branches per plant, NSB- Number of secondary branches per plant, NMP- Number of mature pods per plant, NIMP- Number of immature pods for plant, PYP- Pod yield per plant (g), KYP- Kernel yield per plant (g), S%- Shelling percentage, HPW- Hundred pod weight (g), HKW- Hundred kernel weight (g).

ICGV 15410 recorded the high mean. Hence these parents were considered as more superior than other parents. Similar results were reported by the Bhargavi *et al.* (2016) and Banoth *et al.* (2021).

The estimates of gca effect (Table 4 and Fig 1) showed that among the lines, VRI 7 was found to be a superior as it showed significant and positive gca effect for number of pods per plant, number of primary and secondary branches per plant, pod weight per plant, kernel weight per plant. The line parent GG 7 was a good general combiner for shelling percentage, 100 pod weight per plant and 100 kernel weight per plant. While CO 7 was a good general combiner for plant height Among the testers, ICGV 15427 was found significant positive gca effect for pod weight per plant, kernel weight per plant, 100 pod weight per plant and 100 kernel weight per plant and for number of pods per plant. Tester ICGV 15402 was revealed as good general combiner. Since, high gca effect is attributed to additive gene actions, these parents could be used in breeding programme for yield improvement through pedigree breeding. Selection for these traits should be based on evaluations across multiple environments (Manivannan *et al.*, 2008). Similar results have been reported by Vishnuvardhan (2011), Waghmode *et al.* (2017); Onyia (2011); Hariprasanna *et al.* (2008) and Shoba*et al.* (2010) in the genetic analysis of groundnut genotypes.

From the previous section, it is understood that the involvement of parents *viz.*, VRI 7, GG 7 CO 7, ICGV 15427 and ICGV 15402 in crosses is said to be best combiners for yield traits. This may be due to more parental contributions of favourable alleles from any or both parents in progenies (Madhu *et al.*, 2023). The *per se* performance of hybrids for yield and its component characters were presented in (Table 5). The crosses VRI 8 × ICGV 15426, VRI 9 × ICGV 15426, VRI 7 × ICGV 15410, VRI 7 × ICGV 15402, VRI 8 × ICGV 15412, VRI 8 × ICGV 15408 and GG 7 × ICGV 15427 manifested higher *per se* performance for plant height, number of primary and secondary branches per plant, number of mature pods per plant, number of immature pods for plant, shelling percentage and hundred kernel weight respectively. Based on the pod yield per plant, kernel yield per plant, hundred pod weight, VRI 8 × ICGV 15427 is considered as desirable crosses. Similar result was reported by Vanaja *et al.* (2003).

Among 56 crosses, twenty were ranked as top crosses for one or more characters (Table 6). None of these crosses was found desirable simultaneously for all the characters *i.e.*, different crosses expressed significant sca effects for different characters. However, the cross VRI 7 × ICGV 15402 recorded significant sca effects for number of primary branches per plant, number of mature pods per plant, number of immature pods, pod yield per plant, kernel yield per plant. Cross VRI 7 × ICGV 15402 exhibited superior *per se* performance and one of the parents with good general combining ability and additive type of gene action. Hence, selection can be made in early generation itself, in this

Table 3: *Per se* performance of parents for yield and its component characters in groundnut.

Parents	PH	NPB	NSB	NMP	NIMP	PYP	KYP	S	HPW	HKW
Lines										
VRI 7	59.15	6.40	7.29	17.0	4.05	15.50	12.00	77.75	91.65	35.35
VRI 8	54.45	3.95	3.05	16.45	4.75	19.05	15.50	81.1	115.90	46.95
VRI 9	52.10	5.20	2.75	17.45	3.55	18.75	14.60	77.80	107.20	41.70
GG 7	49.85	4.55	1.80	13.65	2.85	15.60	12.10	77.20	114.05	44.05
CO 7	51.25	3.90	1.85	13.65	3.30	14.90	11.35	76.40	108.8	41.55
K 6	59.65	4.95	2.70	16.80	1.65	17.60	12.9	65.9	116.55	38.45
VRI 10	54.10	4.45	5.20	14.95	4.25	16.40	12.75	77.90	109.60	42.70
Testers										
ICGV 15402	58.25	3.85	2.80	9.95	2.60	8.40	6.45	76.85	84.2	32.35
ICGV 15412	46.05	4.30	2.35	14.55	4.05	15.8	11.15	70.40	108.65	38.25
ICGV 15432	47.65	4.65	4.45	12.35	2.5	14.35	10.55	73.65	115.95	42.70
ICGV 15427	57.30	4.55	2.40	13.15	2.5	14.70	11.0	74.75	111.50	41.65
ICGV 15426	46.90	3.90	2.25	13.75	3.2	16.10	9.4	58.75	117.10	34.40
ICGV 15408	53.85	3.90	2.05	12.50	2.30	14.45	11.6	80.25	115.65	46.40
ICGV 15410	72.95	2.25	2.50	9.95	1.70	12.30	9.7	78.95	116.80	48.75
ICGV 15388	65.30	2.95	3.95	10.95	2.45	12.75	10.8	84.55	123.5	49.40
General mean	52.02	4.71	3.35	14.44	3.36	14.80	11.02	74.74	102.57	38.56
SE	1.6299	0.261	0.54	1.362	0.576	0.83	0.71	1.642	3.837	1.587
CD (P=05)	4.564	0.731	1.53	2.69	1.142	2.34	1.993	4.6001	10.745	4.446
CD (P=01)	6.062	0.9722	2.04	3.58	1.517	3.12	2.648	6.1102	14.272	5.905

PH- Plant height (cm), NPB- Number of primary branches per plant, NSB- Number of secondary branches per plant, NMP- Number of mature pods per plant, NIMP- Number of immature pods for plant, PYP- Pod yield per plant (g), KYP- Kernel yield per plant (g), S%- Shelling percentage, HPW- Hundred pod weight (g), HKW- Hundred kernel weight (g).

Table 4: Estimates of general combining ability (gca) effects for yield and its component characters in groundnut.

Parents	PH	NPB	NSB	NMP	NIMP	PYP	KYP	S	HPW	HKW
Lines										
VRI 7	3.93**	0.54**	2.23**	1.62**	0.33*	1.26**	0.87**	-0.78	-1.39	-1.22*
VRI 8	0.23	-0.24 *	1.14**	1.41**	1.27**	1.99**	1.41**	-0.01	3.59*	0.91
VRI 9	0.10	1.08**	-0.52**	0.33	-0.60**	0.81*	0.71**	-0.41	-3.63*	1.33*
GG 7	-2.34**	-0.42**	-1.20**	-1.81**	-0.62**	-0.67*	0.05	3.56**	10.50**	5.58**
CO 7	-5.19**	-0.03	-0.19	-0.38	0.33*	1.31**	-0.15	-6.81**	12.12**	0.20
K 6	2.73**	-0.56**	-1.29**	-1.10**	-0.74**	-1.61**	-0.59*	3.74**	-3.49*	0.23
VRI 10	0.54	-0.37**	-0.17	-0.08	0.03	-3.11**	-2.30**	-0.13	-17.69**	-7.02**
Testers										
ICGV 15402	1.21	-0.15	-0.44*	1.50**	-0.16	-0.52	-0.30	0.21	-9.89**	-3.57**
ICGV 15412	-3.03 **	0.01	0.02	-1.43**	0.99**	-1.44**	-0.91**	0.92	-2.20	0.56
ICGV 15432	-2.17 **	-0.01	-0.35	-0.09	-0.52**	0.26	-0.25	-2.94**	1.19	-0.55
ICGV 15427	5.37 **	-0.09	0.05	0.23	0.14	1.13**	0.88**	0.70	7.27**	1.86**
ICGV 15426	1.65 *	0.20	-0.30	0.55	-0.09	0.53	0.27	-0.57	-1.74	-0.79
ICGV 15408	-0.02	0.26*	0.62**	-1.39**	-0.07	-1.04**	-0.68*	0.68	3.99*	1.39*
ICGV 15410	-1.35*	-0.16	0.33	0.49	-0.20	0.65	0.62*	0.78	0.96	0.56
ICGV 15388	-1.67*	-0.06	0.07	0.14	-0.09	0.42	0.36	0.21	0.41	0.55
S.E. (Lines)	0.602	0.0975	0.1938	0.3708	0.1571	0.3209	0.2675	0.6067	1.4443	0.5889
S.E. (Testers)	0.644	0.1043	0.2072	0.3964	0.1679	0.3431	0.2860	0.6486	1.5441	0.6296

*, **Significant at 5% and 1% levels, respectively. PH- Plant height (cm), NPB- Number of primary branches per plant, NSB- Number of secondary branches per plant, NMP- Number of mature pods per plant, NIMP- Number of immature pods for plant, PYP- Pod yield per plant (g), KYP- Kernel yield per plant (g), S%- Shelling percentage, HPW- Hundred pod weight (g), HKW- Hundred kernel weight (g).

Table 5: *Per se* performance of hybrids for yield and its component characters in groundnut.

Hybrids	PH	NPB	NSB	NMP	NIMP	PYP	KYP	S	HPW	HKW
VRI 7 × ICGV 15402	54.45	6.75	6.15	20.60	4.65	18.10	13.70	74.45	87.80	33.30
VRI 7 × ICGV 15412	50.85	5.35	5.45	15.90	4.05	14.85	10.65	71.60	93.50	33.45
VRI 7 × ICGV 15432	59.50	5.75	4.65	16.85	3.90	17.10	12.00	70.20	101.10	35.45
VRI 7 × ICGV 15427	60.0	4.55	3.75	17.15	4.55	15.25	12.45	81.65	88.95	36.30
VRI 7 × ICGV 15426	56.8	5.85	6.90	17.15	3.65	16.50	12.80	77.85	95.85	37.35
VRI 7 × ICGV 15408	60.65	5.10	5.35	11.25	2.25	12.20	8.60	71.15	108.85	38.65
VRI 7 × ICGV 15410	44.55	4.50	7.15	14.45	2.65	15.70	11.50	73.35	108.3	39.75
VRI 7 × ICGV 15388	53.85	5.20	5.70	16.55	4.50	17.90	12.50	69.85	108.55	37.85
VRI 8 × ICGV 15402	54.70	4.25	3.65	16.30	3.10	17.70	12.60	71.30	108.35	38.65
VRI 8 × ICGV 15412	44.10	4.85	3.05	13.15	10.30	14.00	10.75	76.85	106.65	41.00
VRI 8 × ICGV 15432	45.70	4.70	4.35	18.05	3.55	18.40	12.10	65.65	102.15	33.55
VRI 8 × ICGV 15427	57.55	4.5	5.40	17.25	4.15	22.60	15.75	69.50	130.60	45.45
VRI 8 × ICGV 15426	60.80	4.30	3.50	17.60	4.60	15.55	12.10	78.0	88.50	34.55
VRI 8 × ICGV 15408	48.85	4.55	5.10	12.80	4.20	12.40	10.25	82.45	96.90	40.0
VRI 8 × ICGV 15410	51.40	5.50	4.20	17.10	3.70	15.85	12.05	75.90	92.80	35.30
VRI 8 × ICGV 15388	48.0	4.10	7.10	15.95	4.15	16.95	12.95	76.60	106.20	40.65
VRI 9 × ICGV 15402	50.80	5.40	3.55	15.15	3.20	15.50	11.95	77.35	96.65	39.45
VRI 9 × ICGV 15412	46.90	5.35	4.10	12.95	3.20	14.05	11.10	78.95	87.90	42.95
VRI 9 × ICGV 15432	45.30	7.35	3.05	13.80	1.95	14.25	9.70	68.05	89.15	35.20
VRI 9 × ICGV 15427	60.25	5.05	2.25	17.50	3.55	17.35	13.40	77.20	108.5	38.35
VRI 9 × ICGV 15426	58.30	7.40	2.15	13.90	2.25	15.55	11.45	73.55	97.15	41.20
VRI 9 × ICGV 15408	48.15	6.20	3.00	16.50	2.55	16.25	11.95	73.80	101.30	36.35
VRI 9 × ICGV 15410	56.55	5.80	3.45	15.50	2.85	16.00	12.35	77.0	100.0	39.80
VRI 9 × ICGV 15388	43.75	4.80	1.55	14.25	3.25	15.05	11.05	73.70	93.85	39.20
GG 7 × ICGV 15402	50.10	3.90	1.60	13.70	2.40	14.25	11.25	79.20	104.05	41.25
GG 7 × ICGV 15412	47.55	5.05	2.40	9.65	2.80	11.20	8.95	79.15	117.20	46.25
GG 7 × ICGV 15432	47.15	4.0	0.50	11.90	2.15	14.05	10.80	76.60	118.235	45.50
GG 7 × ICGV 15427	49.80	4.05	2.05	12.55	3.65	15.00	12.10	80.30	120.20	48.25
GG 7 × ICGV 15426	50.40	4.40	3.95	14.75	2.85	14.35	11.55	80.30	97.45	39.15
GG 7 × ICGV 15408	53.10	4.25	2.90	12.25	3.05	13.90	10.35	74.80	116.35	43.65
GG 7 × ICGV 15410	46.90	3.90	1.80	13.60	3.20	14.65	11.65	79.65	107.35	42.95
GG 7 × ICGV 15388	45.5	5.80	2.45	14.00	2.50	14.75	10.95	74.50	106.25	39.50
CO 7 × ICGV 15402	52.30	4.65	1.10	13.80	4.05	15.20	10.95	72.25	110.10	39.80
CO 7 × ICGV 15412	49.0	4.65	3.70	16.85	3.75	16.40	11.35	69.15	97.45	33.70
CO 7 × ICGV 15432	41.8	3.80	2.00	13.90	2.00	15.05	11.05	73.35	106.3	39.75
CO 7 × ICGV 15427	53.45	5.55	4.75	13.65	4.20	17.25	10.10	58.75	126.05	37.05
CO 7 × ICGV 15426	42.3	4.15	2.15	14.80	4.35	18.35	10.35	56.35	124.05	34.95
CO 7 × ICGV 15408	43.40	7.15	4.65	12.45	4.80	14.20	10.50	74.20	113.70	42.20
CO 7 × ICGV 15410	42.00	4.50	5.05	15.00	3.55	17.60	12.00	68.10	117.25	39.90
CO 7 × ICGV 15388	43.45	4.00	2.30	13.45	3.50	13.95	9.70	69.70	103.60	36.10
K 6 × ICGV 15402	55.20	3.90	1.30	10.30	2.20	8.45	6.10	71.90	82.25	29.55
K 6 × ICGV 15412	52.90	4.80	2.15	13.25	3.00	13.90	10.85	77.60	105.60	40.90
K 6 × ICGV 15432	55.15	4.40	3.05	12.25	2.55	12.25	9.55	77.85	101.41	39.55
K 6 × ICGV 15427	60.65	4.35	2.65	13.45	2.30	13.15	10.80	81.65	97.60	39.85
K 6 × ICGV 15426	46.50	4.10	0.80	13.85	2.75	13.15	10.70	80.65	95.20	38.50
K 6 × ICGV 15408	54.55	4.00	2.10	13.55	3.70	14.00	10.75	76.85	102.80	39.50
K 6 × ICGV 15410	49.90	4.10	1.80	16.50	3.10	15.10	11.70	77.25	91.85	35.50
K 6 × ICGV 15388	56.25	4.55	3.10	15.00	2.10	14.65	12.05	82.20	98.95	40.60
VRI 10 × ICGV 15402	49.00	3.95	3.40	22.95	3.40	10.0	7.70	76.80	44.55	17.15
VRI 10 × ICGV 15412	45.55	3.90	3.15	10.55	4.00	8.35	6.30	74.90	79.45	29.80

Table 5: Continue....

Table 5: Continue....

VRI 10 × ICGV 15432	48.30	3.80	3.80	14.90	4.40	13.55	9.40	69.20	91.00	31.50
VRI 10 × ICGV 15427	54.0	5.15	3.35	12.35	2.70	10.15	7.90	77.65	82.10	31.90
VRI 10 × ICGV 15426	54.55	5.05	2.30	14.10	3.05	13.05	9.25	70.80	92.80	32.90
VRI 10 × ICGV 15408	49.25	4.40	5.05	13.75	3.10	12.60	9.20	73.25	91.50	33.50
VRI 10 × ICGV 15410	57.30	4.45	2.70	13.60	3.70	12.45	9.45	76.00	91.85	34.90
VRI 10 × ICGV 15388	55.60	5.0	2.15	14.10	3.50	12.50	9.65	76.70	88.80	34.10

PH- Plant height (cm), NPB- Number of primary branches per plant, NSB- Number of secondary branches per plant, NMP- Number of mature pods per plant, NIMP- Number of immature pods for plant, PYP- Pod yield per plant (g), KYP- Kernel yield per plant (g), S%- Shelling percentage, HPW- Hundred pod weight (g), HKW- Hundred kernel weight (g).

Table 6: Estimates of specific combining ability effects for yield and its component characters in groundnut.

Hybrids	PH	NPB	NSB	NMP	NIMP	PYP	KYP	S	HPW	HKW
VRI 7 × ICGV 15402	-1.84	1.52**	0.95	2.86**	1.04*	2.67**	2.22**	0.48	-1.37	0.36
VRI 7 × ICGV 15412	-1.20	-0.04	-0.21	1.09	-0.72	0.34	-0.21	-3.08	-3.36	-3.62*
VRI 7 × ICGV 15432	6.59**	0.38	-0.64	0.71	0.64	0.89	0.47	-0.62	0.85	-0.51
VRI 7 × ICGV 15427	0.46	-0.74**	-1.94**	0.68	0.64	-1.83	-0.21	7.18**	-17.38**	-2.07
VRI 7 × ICGV 15426	0.07	0.27	1.56**	0.36	-0.03	0.02	0.76	4.65**	-1.47	1.63
VRI 7 × ICGV 15408	5.59**	-0.54	-0.90	-3.59**	1.46**	-2.71	-2.50	-3.29	5.50	0.75
VRI 7 × ICGV 15410	-9.18**	-0.72*	1.18*	-2.28*	-0.93*	-0.90	-0.90	-1.20	8.34*	2.67
VRI 7 × ICGV 15388	0.44	-0.12	-0.01	0.17	0.82	1.53	0.37	-4.12*	8.89*	0.79
VRI 8 × ICGV 15402	2.10	-0.19	-0.45	-1.23	-1.46**	1.53	0.58	-3.44*	14.39**	3.58*
VRI 8 × ICGV 15412	-4.26*	0.24	-1.52**	-1.45	4.59**	-1.24	-0.66	1.40	4.81	1.80
VRI 8 × ICGV 15432	-3.52*	0.11	0.16	2.12*	-0.65	1.46	0.03	-5.94**	-3.09	-4.54**
VRI 8 × ICGV 15427	0.79	-0.01	0.81	1.00	-0.71	4.78**	2.55**	-5.74**	19.28**	4.95**
VRI 8 × ICGV 15426	7.76**	-0.49	-0.74	1.02	-0.03	-1.66	-0.49	4.04*	-13.81**	-3.30*
VRI 8 × ICGV 15408	-2.52	-0.30	-0.06	-1.83	-0.45	-3.24**	-1.39	7.24**	-11.41**	-0.03
VRI 8 × ICGV 15410	1.37	1.06**	-0.67	0.58	-0.82	-1.48	-0.89	0.59	-12.20**	-3.91
VRI 8 × ICGV 15388	-1.72	-0.44	2.48**	-0.22	-0.48	-0.15	0.27	1.86	1.75	1.46
VRI 9 × ICGV 15402	-1.66	-0.37	1.10*	-1.29	0.51	0.52	0.63	2.19	9.72*	3.96*
VRI 9 × ICGV 15412	-1.32	-0.58*	1.19*	-0.57	-0.64	-0.01	0.39	3.08	-6.72	3.33
VRI 9 × ICGV 15432	-3.78*	1.44**	0.51	-1.05	-0.38	-1.51	-1.67*	-3.96*	-8.86*	-3.31
VRI 9 × ICGV 15427	3.63*	-0.77**	-0.69	2.33*	0.56	0.72	0.90	1.55	4.46	-2.57
VRI 9 × ICGV 15426	5.40**	1.28**	-0.44	-1.59	-0.51	-0.48	-0.44	-0.83	2.07	2.93
VRI 9 × ICGV 15408	-3.08	0.03	-0.50	2.95**	-0.23	1.79	1.01	-1.83	0.49	-4.10
VRI 9 × ICGV 15410	6.65**	0.04	0.23	0.06	0.20	-0.15	0.11	1.27	2.22	0.17
VRI 9 × ICGV 15388	-5.83**	-1.06**	-1.14*	-0.84	0.49	-0.87	-0.93	-1.46	-3.38	-0.41
GG 7 × ICGV 15402	0.08	-0.37	-0.16	-0.60	-0.26	0.75	0.60	0.89	2.99	1.51
GG 7 × ICGV 15412	1.77	0.62*	0.17	-1.72	-1.02*	-1.38	-1.09	0.13	8.45*	2.38
GG 7 × ICGV 15432	0.51	-0.41	-1.36*	-0.81	-0.16	-0.23	0.10	1.74	6.21	2.74
GG 7 × ICGV 15427	-4.39*	-0.27	-0.21	-0.48	0.69	-0.15	0.27	1.50	1.98	3.08
GG 7 × ICGV 15426	-0.07	-0.22	2.04**	1.40	0.12	-0.20	0.33	2.77	-11.76**	-3.37*
GG 7 × ICGV 15408	4.31*	-0.43	0.08	0.84	0.29	0.92	0.08	-3.98*	1.41	-1.05
GG 7 × ICGV 15410	-0.56	-0.36	-0.74	0.31	0.57	-0.02	0.08	0.77	-4.16	-0.93
GG 7 × ICGV 15388	-1.64	-1.44**	0.17	1.06	-0.23	0.31	-0.36	-3.81*	-5.11	-4.36*
CO 7 × ICGV 15402	5.13**	-0.01	-1.67**	-1.94	0.44	-0.28	0.50	4.31*	7.42	5.44**
CO 7 × ICGV 15412	6.07**	-0.17	0.47	4.04**	-1.02*	1.84*	-1.51*	0.50	-12.92**	-4.79**
CO 7 × ICGV 15432	-1.99	-100**	-0.86	-0.24	-1.26**	-1.21	0.55	8.56**	-5.41	2.37
CO 7 × ICGV 15427	2.11	0.84**	1.49**	-0.82	0.29	0.12	-1.53	-9.69**	6.21	-2.74
CO 7 × ICGV 15426	-5.32**	-0.86**	-0.76	0.01	0.67	1.82*	-0.67	-10.81**	13.22**	-2.19
CO 7 × ICGV 15408	-2.54	2.09**	0.82	-0.39	-1.09*	-0.76	0.43	5.79**	-2.86	2.88

Table 6: Continue...

Table 6: Continue...

CO 7 × ICGV 15410	-2.61	-0.15	1.51**	0.27	-0.03	0.95	0.63	-0.41	3.72	1.40
CO 7 × ICGV 15388	-0.84	-0.75**	-0.98	-0.93	-0.18	-2.47**	-1.41	1.76	-9.38	-2.38
K 6 × ICGV 15402	0.10	-0.22	-0.38	-4.72**	-0.35	-4.12**	-3.92	-6.59	-4.82	-4.85**
K 6 × ICGV 15412	2.04	0.51	0.01	1.16	-0.71	2.26*	1.45	-1.60	10.84**	2.37
K 6 × ICGV 15432	3.43*	0.13	1.28*	-1.18	0.36	-1.09	-0.52	2.51	3.25	1.93
K 6 × ICGV 15427	1.39	0.17	0.48	-0.30	-0.55	-1.07	-0.39	2.66	-6.63	0.02
K 6 × ICGV 15426	-9.04**	-0.37	-1.02	-0.22	0.13	-0.46	0.12	3.24	-0.02	1.32
K 6 × ICGV 15408	0.68	-0.53	-0.63	1.42	1.06*	1.96*	1.11	-2.11	1.85	0.15
K 6 × ICGV 15410	-2.63	0.02	-0.65	2.49*	0.59	1.37	0.76	-1.81	-6.06	-3.03
K 6 × ICGV 15388	4.03*	0.33	0.91	1.34	-0.52	1.15	1.38	3.71*	1.59	2.08
VRI 10 × ICGV 15402	-3.90*	0.36	0.60	6.91**	0.08	-1.07	-0.61	2.18	-28.32**	-10.00**
VRI 10 × ICGV 15412	-3.11	-0.58*	-0.11	-2.56*	-0.48	-1.79	-1.39	-0.43	-1.11	-1.48
VRI 10 × ICGV 15432	-1.23	-0.65*	0.91	0.46	1.44**	1.71	1.04	-2.23	7.05	1.33
VRI 10 × ICGV 15427	-3.07	0.78**	0.06	-2.42*	-0.92*	-2.57**	-1.59	2.53	-7.93	-0.68
VRI 10 × ICGV 15426	1.20	0.39	-0.64	-0.99	-0.34	0.94	0.38	-3.05	11.78**	2.97
VRI 10 × ICGV 15408	-2.43	-0.32	1.20*	0.61	-0.31	2.06*	1.27	-1.84	4.75	1.40
VRI 10 × ICGV 15410	6.96**	0.15	-0.87	-1.43	0.42	0.22	0.22	0.80	8.14*	3.62*
VRI 10 × ICGV 15388	5.57**	0.60*	-1.16*	-0.58	0.11	0.50	0.68	2.08	5.64	2.83

PH- Plant height (cm), NPB- Number of primary branches per plant, NSB- Number of secondary branches per plant, NMP- Number of mature pods per plant, NIMP- Number of immature pods for plant, PYP- Pod yield per plant (g), KYP- Kernel yield per plant (g), S%- Shelling percentage, HPW-Hundred pod weight (g), HKW- Hundred kernel weight (g).

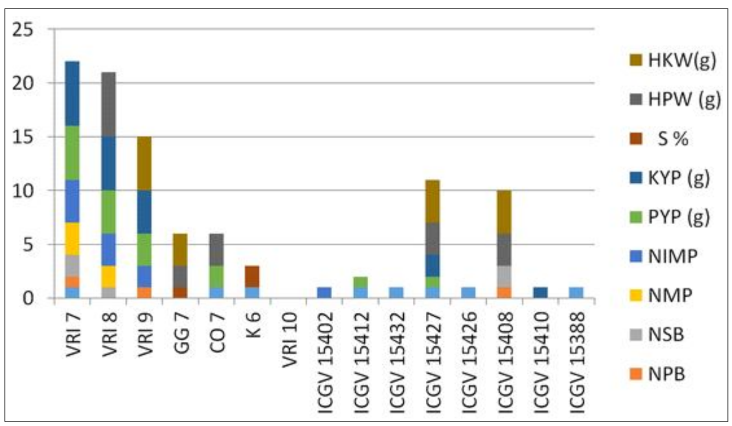

Fig 1: List of best combiners among the parents.

cross. Similar kind of results were reported by Ganesan *et al.* (2010); Mothilal and Ezhil (2010); Savithramma *et al.* (2010).

CONCLUSION

It might be concluded that the parent VRI 7 was considered as good combining parent for pod yield per plant and component characters and could be utilized in breeding programme. Most of the high pod yielding crosses exhibiting desirable *sca* effects involved parents with high and low *gca* effects, indicating the influence of non-additive gene interactions in these crosses. Among the hybrids VRI 7 × ICGV 15402, VRI 7 × ICGV 15427 exhibited superior *per se* performance and one of the parents with good general combining ability and additive type of gene action. Hence, selection could be made in early generation itself, in these crosses.

Conflict of interest

All authors declare that they have no conflicts of interest.

REFERENCES

Banoth, M., Prabhavathi, K., Bhadru, D. and Mallaiah, B. (2021). Breeding resistance for post flowering stalk rot (*Macrophomina phaseolina*) in maize identification of resistance against post flowering stalk rot (*Macrophomina phaseolina*) in maize. Journal of Experimental Agriculture International. 43(4): 44-55.

Banoth, M., Subbarayan, S., Sadasivam, M., Marimuthu, M., Sivakami, R. and Boopathi, N.M. (2023). Biochemical analysis of metabolites in cotton (*Gossypium hirsutum* L.) conferring resistance to leaf hopper *Amrasca biguttula biguttula* (Ishida). Electronic Journal of Plant Breeding. 14(3): 965-975.

Bhargavi, G., Satyanarayana V. and Narasimha Rao, K.L. (2016). Genetic variability, heritability and genetic advance of yield and related traits of Spanish bunch groundnut (*Arachis hypogaea* L.). Agricultural Science Digest-A Research Journal. 36(1): 60-62. doi: 10.18805/asd.v35i1.9313.

Ganesan, K.N., Paneerselvam, R. and Manivannan, N. (2010). Identification of crosses and good combiners for developing new genotypes in groundnut (*Arachis hypogaea* L.). Electronic Journal of Plant Breeding. 1(2): 167-172.

Hariprasanna, K., Chuni, L., Radhakrishnan, T., Gor, H.K. and Chikani, B.M. (2008). Analysis of diallel cross for some physical-quality traits in peanut (*Arachis hypogaea* L.). Euphytica. 160(1): 49-57.

Jain, S.K. and Sastry, E.V.D. (2012). Heterosis and combining ability for grain yield and its contributing traits in bread wheat (*Triticum aestivum* L.). Journal of Agriculture and Allied Science. 1: 17-22.

Jayalakshmi, V., Raja Reddy, C., Reddy, P.V. and Lakshmikantha Reddy, G. (2002). Combining ability analysis of morphological and physiological attributes in groundnut (*Arachis hypogaea* L.). Indian Journal of Agricultural Research. 36(3): 177-181.

Kempthorne, O. (1957). An Introduction to Genetic Statistics. John Wiley and Sons Inc., New York, pp. 545.

Khote, A.C., Patil, P.P., Patil, S.P. and Walke, B.K. (2009). Genetic variability studies in groundnut (*Arachis hypogaea* L.). International Journal of Plant Science. 4: 141-149.

Madhu, B., Sivakumar, S., Manickam, S., Murugan, M., Rajeswari, S. and Boopathi, N.M. (2023). Improvising cotton (*Gossypium hirsutum* L.) genotypes for compact plant architecture traits suitable for mechanical harvesting. Indian Journal of Genetics and Plant Breeding. 83(3): 398-406.

Madhu, B., Sukrutha, B., Singh, N.U. and Venkateswarao, G. (2023a). Breeding strategies for improvement of drought tolerance in rice: recent approaches and future outlooks. sustainable rice production-challenges, strategies and opportunities. Intech Open. doi: 10.5772/intechopen.107313.

Manivannan, N. (2014). TNAUSTAT-Statistical package. Retrived from https://sites.google.com/site/tnaustat.

Manivannan, N., Muralidharan, V. and Mothilal, A. (2008). Combining ability analysis in groundnut (*Arachis hypogaea* L.). Madras Agricultural Journal. 95(1-6): 14-17.

Mothilal, A. and Ezhil, A. (2010). Combining ability analysis for yield and its components in groundnut (*Arachis hypogaea* L.). Electronic Journal of Plant Breeding. 1(2): 162-166.

Onyia, V.N. (2011). Combining ability analysis for yield and yield components in eight breeding lines of rice (*Oryza sativa* L.). Agro-Science. 10(2): 7-15.

Rashid, M., Cheema, A.A. and Ashraf, M. (2007). Line × Tester analysis in basmati rice. Pakistan Journal of Botany. 39(6): 2035-2042.

Rekha, D., Savithramma, D.L., Shankar, A.G. and Marappa, N. (2009). Combining ability studies for growth and yield traits in groundnut (*Arachis hypogaea* L.). Environment and Ecology. 27(1): 117-120.

Sangeetha, V.R., Viswanathan, P.L. Manonmani, S. Rajendran, L. Selvakumar, T. (2021). Estimation of heterosis and combining ability of yield traits in groundnut (*Arachis hypogaea* L.). Indian Journal of Agricultural Research. 55(3): 310-316. doi: 10.18805/IJARe.A-5486.

Savithramma, D.L, Rekha, D. and Sowmya, H.C. (2010). Combining ability studies for growth and yield traits in groundnut (*Arachis hypogaea* L.). Electronic Journal of Plant Breeding. 1(4): 1010-1015.

Shendekar, S.A., Gulwane, V.P., Yadav, T.V., Madhu, B., Meshram, M.R., Gadpayale, D.P. and Kumar, M.N. (2023). Genetic variability, mean performance studies in groundnut (*Arachis hypogaea* L.) under controlled environmental condition. Pharma Innovation. 12(5): 3221-3224.

Shoba, D.N., Manivannan, N. and Vindhiyavarman, P. (2010). Gene effects of pod yield and its components in three crosses of groundnut (*Arachis hypogaea* L.). Electronic Journal of Plant Breeding. 1(6): 1415-1419.

Sprague, G.R. and Tatum, A. (1942). General vs specific combining ability in single crosses of cotton. Journal of the American Society of Agronomy. 34: 923-932.

Sukrutha, B., Rajeswari, S., Premalatha, N., Boopathi, N.M., Thirukumaran, K. and Manivannan, A. (2023). Combining ability and gene action studies for yield and fibre traits in *Gossypium arboreum* using griffings numerical and haymans graphical approach. Journal of Cotton Research. 6(1): 12.

Vanaja, T., Babu, L.C., Radhakrishnan, V.V. and Pushkaran, K. (2003). Combining ability analysis for yield and yield components in rice varieties of diverse origin. Journal of Tropical Agriculture. 41: 7-15.

Vishnuvardhan, K.M., Vasanthi, R.P. and Reddy, K.H. (2011). Combining ability of yield, yield traits and resistance to late leaf spot and rust in groundnut. Journal of SAT Agricultural Research. 9: 1-6.

Waghmode, B.D., Kore, A.B., Navhale, V.C., Sonone, N.G. and Thaware, B.L. (2017). Genetic analysis of promising crosses and good combiners for developing new genotypes in groundnut (*Arachis hypogaea* L.). International Journal of Current Microbiology Applied Science. 6(7): 324-331.

Yadav, K.N.S., Gowda, M.B., Savithramma, D.L. and Girish, G. (2006). Studies on combining ability for pod yield and its components in groundnut. Crop Research. 32(1): 90-93.