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Research Article

Genetic variability, heritability and genetic advance of yield and related traits in F_3 generation of groundnut (*Arachis hypogaea* L.)

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Abstract
Groundnut is a highly self-pollinated crop and due to the uniformity of the traits imposed by the peanut growers, it is losing its genetic base. Hence, there arises a concern for creating more genetic variability in the population. With this information in background, the present study was carried out to examine the variability of prominent yield and yield attributing traits in this unpredictable legume crop. This will provide insight into the expression of traits and the influence of environment on those traits. High GCV, PCV values were recorded for the number of pods per plant, 100 pod weight, 100 kernel weight, shelling percent and number of mature kernels in the present study. This indicates the presence of ample variability for these traits. Hence these traits can be opted for selection as they contribute more towards variability with least influence of environment over it. Most of the traits recorded high heritability and high GAM, which is a positive sign for least influence of environment on population and presence of additive gene action.

Keywords
Groundnut, Variability, PCV, GCV, Heritability, Genetic advance

Introduction

Groundnut, an annual leguminous oilseed crop, is valued for both high oil and protein content. It is a major oilseed crop in India and it serves as a third most important source of vegetable protein. Being a highly self-pollinated crop, it has narrow genetic base ending up in the need for creating more variability in the segregating population. Presence of genetic variability is prerequisite for any crop improvement programme. In-depth analysis of the genetic variability is essential for beginning crop improvement programme and for formulation of suitable selection techniques. The genetic variability present in the population is assessed with the help of parameters viz., Genotypic coefficient of variation (GCV), Phenotypic coefficient of variation (PCV) and heritability estimates. For the prediction of selection in an effective way, the heritability estimates can be combined along with Genetic advance as percent of mean rather than relying on heritability estimates alone. This approach will help to identify the traits which can be manipulated through selection. The quantification of magnitude and extent of variability along with heritability estimates of characters among genotypes is essential for unravelling the heterotic potential of genotypes.

Materials And Methods

The genotypes taken for the study consisted of F_3 progenies derived from the six crosses. In this study, VRIGn6 and ICGV07222 were used as female parents, Asha, ICGV03128 and ICGV06146 were used as pollen parents. The crop was raised during Kharif 2016, at the oilseeds farm, Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore. Throughout the crop growth period, appropriate cultural practices were followed. All the parents and F_3 progenies were raised in non-replicated trial. Totally, 539 plants derived from the six crosses were taken for observation. Observations were recorded on individual plant basis for plant height (cm), number of primary branches, number of secondary branches, number of pods per plant, 100 pod weight (g), 100 kernel weight (g), shelling percent, number of mature kernels, pod yield per plant (g) and kernel yield per plant (g). Various genetic parameters like phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability in broad sense and genetic advance as a percent of mean were calculated using standard statistical methods. The genetic parameters PCV and GCV were calculated according to Burton (1953) and categorization was based on method quoted by Sivasubramanian and Madhavamenon, 1973. Genetic advance as percent of mean estimates were based on formulae given by Johnson *et al*., (1955) and Falconer, 1960. Heritability (h2) estimates in broad sense was estimated by the methods devised by Lush (1949) and illustrated by Allard (1960). The heritability percent was categorized as suggested by Robinson *et al*.(1949).

Results and Discussion

The results of the mean performance of parents, progenies and various genetic parameters were estimated for ten traits of six crosses namely, VRIGn6 x Asha, VRIGn6 x ICGV03128, VRIGn6 x ICGV06146, ICGV07222 x Asha, ICGV07222 x ICGV03128 and ICGV07222 x ICGV06146 are presented in the Table 1 and 2.

In a crop improvement programme, mean performance is the foremost important criteria to select an individual. For the traits, number of pods per plant (20.1), number of mature kernels per plant (29.9) and kernel yield per plant (8.6), the parent VRIGn6 showed superior mean value. Also, the parent ICGV06146 showed superior mean performance for the traits pod yield per plant (14.6), 100 kernel weight (43.7) and kernel yield per plant (8.9). Asha performed well with respect to the traits 100 pod weight(131.2) and 100 kernel weight (42.5). Based on the mean performance, ICGV06146 and VRIGn6 can be considered for improving the traits higher pod yield per plant and Asha in case of large kernel size. Among the six crosses, VRIGn6 x ICGV06146, ICGV07222 x ICGV06146 and ICGV07222 x ICGV06146 showed superior performance in many of the yield attributing traits. Hence, those crosses can be considered for crop improvement.

In this study, the phenotypic and genotypic coefficient of variation recorded wide span of values for all the traits. All the crosses taken for study exhibited higher PCV values than the GCV values depicting the fact that environmental factors are influencing these traits. In certain cases, the difference between PCV and GCV values were less, which indicates the greater influence of genetic components than the environmental factors. Number of pods per plant of the cross VRIGn6 x Asha recorded highest PCV and GCV values (472.2, 445.4) followed by the cross VRIGn6 x ICGV06146 (444,390). The lowest PCV and GCV values (14.1,12.9) were recorded for the trait plant height of the cross VRIGn6 x ICGV06146.

The crosses VRIGn6 x Asha and VRIGn6 x ICGV06146 recorded high PCV and GCV values for the trait plant height. Moderate PCV and GCV values were recorded by the crosses VRIGn6 x ICGV03128, ICGV07222 x Asha, ICGV07222 x ICGV03128 and ICGV07222 x ICGV06146. For the trait number of primary branches, number of secondary branches, number of pods per plant, 100 kernel weight, pod yield per plant, number of mature kernels and kernel yield per plantall the six crosses taken for study exhibited high PCV and GCV values. All the crosses recorded high PCV and GCV values for 100 pod weight except the cross ICGV07222 x ICGV03128 which showed moderate values. The crosses VRIGn6 x Asha, VRIGn6 x ICGV03128, ICGV07222 x Asha and ICGV07222 x ICGV03128 recorded high PCV and GCV for shelling percent. Moderate GCV and high PCV was recorded in the crosses VRIGn6 x ICGV06146 and ICGV07222 x ICGV06146.

The results obtained were in accordance with the works of Ali *et al.*(2000), Nath *et al.*(2002), John *et al.*(2008), Khote *et al.*(2009) Ladole *et al.*(2009), Savaliya *et al.*(2009), Shobha *et al.*(2009), Meta *et al.*(2010), Parameshwarappa *et al.*(2010) , Hiremath *et al.*(2011), Thakur *et al.*(2011), Zaman *et al.*(2011), Babariya *et al.*(2012), Narasimhulu *et al.*(2013), Padmaja *et al.*(2013). Prabhu *et al.* (2014) *et al.*, Rao *et al.*(2014) and Li Huang *et al.*(2015) .

Heritability serves as the reliable index for gaining insight into the extent of transmission of characters from parents to the offspring. High heritability estimates alone doesn't ensure the genetic gain. Hence, for gaining clear picture regarding selection of traits, both heritability and genetic advance should be given due importance.

Among all the crosses and trait, highest heritability was recorded by the traits number of mature kernels (98.3) of the cross VRIGn6 x Asha followed by the trait kernel yield per plant (98.1), pod yield per plant (98.1) and number of pods per plant (94.3) of the same cross. Number of pods per plant (76.6) of the cross ICGV07222 x ICGV06146 recorded the lowest heritability value. Highest GAM was recorded by the trait kernel yield per plant (174.7) of the cross VRIGn6 x Asha and it is followed by the same trait kernel yield per plant (151.3) of the cross VRIGn6 x ICGV06146. The trait plant height (24.2) of the cross ICGV07222 x ICGV03128 recorded the lowest GAM value.

High heritability coupled with high GAM was exhibited by the traits plant height, number of primary branches, number of secondary branches, number of pods per plant, 100 pod weight, 100 kernel weight, shelling percent, pod yield per plant, number of mature kernels and kernel yield per plant in all the crosses. Concomitant results were indicated in the works of Ali *et al.*(2000), Nath *et al.*(2002), John *et al.*(2008), Khote *et al.*(2009) Ladole *et al.*(2009), Savaliya *et al.*(2009), Shobha *et al.*(2009), Meta *et al.*(2010), Parameshwarappa *et al.*(2010) , Hiremath *et al.*(2011), Thakur *et al.*(2011), Zaman *et al.*(2011), Babariya *et al.*(2012), Narasimhulu *et al.*(2012), Padmaja *et al.*(2013), Prabhu *et al.* (2014) *et al.*, Rao *et al.*(2014) and Li Huang *et al.*(2015) . The combination of high heritability and high genetic advance conveys the existence of additive gene effects and ensures that selection will be effective under these circumstances.

Regarding the variability parameters , all the F_3 crosses recorded moderate to high PCV and GCV values for number of pods per plant, 100 pod weight, 100 kernel weight, number of mature kernel, pod yield per plant and kernel yield per plant. This revealed that the variation in these traits contributed markedly to the total variability. Hence, there is a more scope for selection based on these characters. Also, high Heritability and high GAM was recorded for the traits 100 pod weight, 100 kernel weight and number of mature kernels per plant. Hence, it discloses that these characters are governed by additive genes and selection for these traits will be effective for yield improvement in this unpredictable legume crop.

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Table 1. Mean performance of parents for various traits in F_3 generation of groundnut

PARENT/TRAIT	PH(cm)	NPB	NSB	NPP	100 PW (g)	100 KW (g)	S%	PYD (g)	NOMK	KYD (g)
Asha	15.3	2.1	8.0*	6.8	131.2*	42.5	51.7	8.9	11.3	4.5
ICGV03128	13	3.8	5.9	12	76.5	39.3	62.1	9.5	17.9	6.2
ICGV06146	16	3.7	4.9	17.5	87.7	43.7*	61.4	14.6*	25.7	8.9*
VRIGn6	24.8*	2	4	20.1*	71.1	31.4	61.5	13.9*	29.9*	8.6*
ICGV07222	10.9	4	8*	14.2	73	36	62.5	11.2	21.8	6.8
Grand Mean	16	3.12	6.16	14.12	87.9	38.58	59.84	11.62	21.32	7
SE	2.38	0.44	0.81	2.29	11.20	2.24	2.04	1.14	3.20	0.81

*, ** Significant at 5% and 1% level of probability, respectively.

PH-Plant height; NPB-Number of primary branches; NSB-Number of secondary branches; NPP-Number of pods per plant;PW-Pod weight; KW-Kernel weight; S%-Shelling percentage; PYP-Pod yield per plant; NMKP-Number of mature kernels per plant; KYP-Kernel yield per plant

Table 2. Variability parameters of various crosses in F_3 generation of groundnut

Character	Cross	MEAN	MIN	MAX	PCV%	GCV%	h2%	GAM%
PH (cm)	**C1**	17.1*	12.2	24.2	21.9	21.5	96.3	43.4
	C2	19.5*	10.5	25.5	18.7	18.4	96.3	37.2
	C3	20.6*	9	36.5	28.0	27.8	98.2	56.7
	C4	11.1	7.5	16.5	16.2	15.1	86.0	28.8
	C5	11.1	7	14.6	14.1	12.9	83.1	24.2
	C6	11.1	6.5	16.5	15.6	14.2	82.3	26.5
NPB	**C1**	2.7	1	5	41.3	40.6	97.02	82.5
	C2	2.5	1	8	45.3	43.7	93.1	86.9
	C3	2.8	1	9	43.9	42.3	93.2	84.2
	C4	4.3*	2	7	25.3	24.9	96.9	50.5
	C5	3.7	2	6	26.6	25.4	90.8	49.8
	C6	3.7	1	7	31.8	30.6	92.6	60.6
NSB	**C1**	3.2	1	10	71.1	68.4	92.4	135.4
	C2	3.9	1	9	49.0	46.5	90.4	91.2
	C3	5.0	1	18	65.7	59.7	82.5	111.8
	C4	9.1*	3	27	45.0	44.5	97.7	90.7
	C5	6.1	1	13	39.8	38.6	94.1	77.2
	C6	8.8*	3	24	34.3	30.6	79.2	56.0
NPP	**C1**	13.5	1	37	472.2	445.4	94.3	114.8
	C2	11.6	2	24	308.6	278.3	90.2	95.7
	C3	18.6*	3	46	444.0	390.0	87.8	88.4
	C4	17.7*	2	35	321.3	312.4	97.3	85.3
	C5	12.9	3	27	248.0	236.6	95.4	86.3
	C6	13.5	2	36	253.6	194.2	76.6	68.5

C1-VRIGn6 x Asha, C2- VRIGn6 x ICGV03128, C3-VRIGn6 x ICGV06146, C4- ICGV07222 x Asha, C5-ICGV07222 x ICGV03128, C6-ICGV07222 x ICGV06146

*, ** Significant at 5% and 1% level of probability, respectively.
PH-Plant height; NPB-Number of primary branches; NSB-Number of secondary branches; NPP-Number of pods per plant;

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Table 2. Variability parameters of various crosses in F_3 generation of groundnut

Character	Cross	MEAN	MIN	MAX	PCV%	GCV%	h2%	GAM%
100 PW (g)	**C1**	83.9*	51.4	121.8	22.5	21.7	92.9	43.1
	C2	50	27.3	103.9	25.4	24.3	91.7	48.0
	C3	67.2	18.4	166.6	29.2	27.4	88.1	53.0
	C4	86.0*	30.50	150.80	22.8	21.9	91.9	43.2
	C5	71.8	30.40	110.63	19.1	18.1	89.7	35.4
	C6	86.7*	30.40	140.19	23.7	22.2	87.7	42.8
100 KW (g)	**C1**	34.1	15.2	65	30.8	30.3	96.9	61.5
	C2	22.9	9.9	54	28.4	27.4	93.0	54.4
	C3	36.0	10.15	75.6	33.3	30.8	85.5	58.7
	C4	39.1*	10.30	50.99	25.5	24.8	94.7	49.8
	C5	32.1	10.02	50.21	30.5	29.8	95.1	59.8
	C6	39.8*	10.22	60.50	30.6	28.2	84.7	53.4
S (%)	**C1**	55.9	26.67	72.62	23.7	23.3	96.4	47.2
	C2	55	14.97	78.57	21.7	212	95.0	42.5
	C3	59.0*	17.83	84.83	21.4	19.0	78.9	34.7
	C4	55.8	19.75	75.14	25.2	24.8	96.7	50.2
	C5	49.8	13.07	68.90	22.0	21.3	94.0	42.6
	C6	58	20.38	82.84	21.2	18.7	77.8	34.0
PYP (g)	**C1**	11.8	0.6	40.6	73.3	72.6	98.1	148.2
	C2	6	0.56	24.94	68.0	65.4	92.6	129.8
	C3	13.0*	1.14	37.75	55.3	51.6	87.3	99.4
	C4	15.0*	1.05	33.48	43.9	43.2	96.9	87.6
	C5	9.5	1.67	22.93	51.2	49.9	95.2	100.3
	C6	11.7	1.78	33.35	50.6	45.7	81.6	85.1
NOMK	**C1**	20.4	1	64	70.7	70.1	98.3	143.2
	C2	15.4	3	39	59.0	57.9	96.2	117.0
	C3	26.5*	2.0	75.0	54.7	53.1	94.0	106.0
	C4	27.0*	2	59	47.0	46.2	96.7	93.6
	C5	17.1	3	35	48.4	46.6	92.8	92.5
	C6	19.8	3	55	49.2	45.3	84.9	86.1
KYD (g)	**C1**	7.2	0.2	27.3	86.3	85.5	98.1	174.4
	C2	3.4	0.44	17.09	81.9	77.5	89.7	151.3
	C3	8.0*	0.38	23.53	62.6	57.4	84.2	108.6
	C4	8.5*	0.26	19.88	52.1	51.4	97.4	104.6
	C5	5.0	0.40	11.59	57.6	55.6	93.2	110.6
	C6	7.1	0.75	22.59	62.4	56.1	81.1	104.1

C1-VRIGn6 x Asha, C2- VRIGn6 x ICGV03128, C3-VRIGn6 x ICGV06146, C4- ICGV07222 x Asha, C5-ICGV07222 x ICGV03128, C6-ICGV07222 x ICGV06146

*, ** Significant at 5% and 1% level of probability, respectively.
PW-Pod weight; KW-Kernel weight; S%-Shelling percentage; PYP-Pod yield per plant; NMKP-Number of mature kernels per plant; KYP-Kernel yield per plant

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