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Genetic Variability Studies in F_3 Segregating Generations for Yield and Yield Attributing Traits in Groundnut (*Arachis hypogaea* L.)

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Variability studies were carried out for different characters of groundnut derived from four crosses viz., Kadri-9 x GPBD-4, ICGV-00351 x GPBD-4, Kadri-9 x Sunoleic-95R, ICGV-00351 x Sunoleic-95R. Results revealed that the presence of moderate to high PCV and GCV for most of the traits, further a high heritability coupled with high genetic advance was also observed for these traits indicating the involvement of additive gene action in controlling these traits making selection effective. Oil content, sound mature kernel, shelling percent, and days to physiological maturity exhibited a low to moderate category range for the genetic parameters indicating that they are under the influence of non-additive gene action thus cannot be considered as a tool in selection program to enhance groundnut productivity.

Introduction

Groundnut, also commonly known as peanut (*Arachis hypogaea* L.), is an important legume mainly grown to produce oil and for human and animal consumption. The peanut, grown in tropical and subtropical regions throughout the world is native to the Western Hemishpere.

Genetic variability for agronomic traits is the key component of breeding programmes for broadening the gene pool. The basic key to bring about the genetic upgrading to a crop is to utilize the available genetic variability. Breeders very often use segregating populations as source population to put into effect selection for opting out homozygous lines with better performance to develop varieties. At the same time, the breeding lines from the advanced generations are also used as parental lines for developing commercially exploitable heterotic hybrids. Segregating populations offer wider opportunities for realizing high success, because of wider genetic base. Selection for high yielding types with wider adaptability shall be not only very useful but shall also help in increasing the production both locally and globally. Many quantitatively inherited characters are fixed rapidly, emphasizing the need to test for character expression in large populations in F_3. Generally high GCV values indicate the greater extent of variability present in the character and can be improved through selection. High value of heritability together with high genetic advance for any character indicates additive gene action and selection will be rewarding for improvement of such traits whereas, high heritability associated with low genetic advance might attribute to the presence of non-additive gene action which indicates dominance/epistasis and their response to selection would be poor (Bhargavi *et al.,* 2016).

Materials and Methods

Study area

The present scientific investigation on groundnut was carried out during *kharif* 2018 at Main Agriculture Research Station, College of agriculture, University of Agricultural Sciences, Raichur, which is situated in the North-Eastern dry zone of Karnataka (Zone 2). The experimental soil was of sandy clay loam type.

Experimental material

The experimental material consisted of four released/advanced breeding parents *viz.,* Kadri-9, GPBD-4, ICGV-00351 and Sunoleic-95R. Four F_3 populations derived from the crosses of above mentioned parents' *viz.,* Kadri-9 x GPBD-4, ICGV-00351 x GPBD-4, Kadri-9 x Sunoleic-95R and ICGV-00351 x Sunoleic-95R were utilised for the present study where, GPBD-4 and Sunoleic-95R were the common male parent. All the parents and F_3 progenies were evaluated in non-replicated trial. Recommended cultural practices were followed throughout the crop growing period. The spacing put into practice was 30 × 10 cm.

Observations recorded

The data was collected from each plant of all the four crosses *viz.,* Kadri-9 x GPBD-4, ICGV-00351 x GPBD-4, Kadri-9 x Sunoleic-95R, ICGV-00351 x Sunoleic-95R developed and maintained at AICRP Groundnut, Main Agriculture Research Station, University of Agriculture Sciences, Raichur during *kharif* 2018. The characters studied to assess genetic variability were days to physiological maturity, plant height (cm), number of primary branches per plant, number of mature pods per plant, number of immature pods per plant, dry pod yield per plant (g), kernel yield per plant (g), haulm yield per plant (g), shelling (per cent), hundred kernel weight (g), SMK (per cent), oil content (per cent), protein content (per cent), Palmitic acid content (per cent), Stearic acid content (per cent), Oleic acid content (per cent) and Linoleic acid content (per cent).

Statistical analysis

Standard statistical procedures were adopted for calculating the mean and various genetic parameters like phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability (h^2) in broad sense and genetic advance as % of mean (GAM).

The range of coefficient of variation (CV) was categorized as per Robinson *et al.,* (1949) below 10% - Low coefficient of variation; 10-20% - Medium coefficient of variation; above 20% - High coefficient of variation. As suggested by Johnson *et al.,* (1955), the heritability range was classified as: less than 30% - Low heritability; 30%-60% - Moderate heritability; more than 60% - High heritability. Similarly, the range of genetic advance as per cent of mean (GAM) was grouped as: less than 10% - Low GAM; 10%-20% - Medium GAM; more than 20% - High GAM (Johnson *et al.,* 1955).

Results and Discussion

The results on the mean performance and various genetic parameters for seventeen yield and yield attributes of four segregating populations are explained hereunder and tabulated in table 1, 2, 3 and 4.

Days to physiological maturity

A low GCV and PCV followed by high heritability and moderate GAM for the crosses ICGV-00351 x GPBD 4 and Kadri-9 x Sunoleic-95R was observed. A moderate and low GAM was observed in crosses Kadri-9 x GPBD 4 and ICGV-00351 x Sunoleic-95R respectively. Estimates of PCV were higher than GCV for the above trait in all the crosses. Vishnuvardhan *et al.,* (2013), Chauhan and Shukla (1985) and Padmaja *et al.,* (2013) reported low GCV and PCV in their study for this trait akin to the present investigation. Whereas low GAM was reported by John *et al.,* (2015).

Plant height (cm)

A moderate PCV and GCV can be seen for the trait plant height (cm) in two crosses except in cross Kadri-9 x GPBD-4 and Kadri-9 x Sunoleic-95R followed by a high broad sense heritability and high GAM. Raut *et al.,* (2010) and Zongo *et al.,* (2017) recorded a moderate estimate of PCV and GCV and high GAM. Correspondingly Ganesan and Sudhakar (1995), and Hiremath *et al.,* (2011) also found moderate GCV and PCV for this character as observed in cross ICGV-00351 x Sunoleic-95R.

Number of primary branches per plant

A high PCV and moderate GCV in all the four crosses followed by a high heritability and high GAM was observed. The following results are in agreement with the earlier results Kumar *et al.,* (2016), Hyndavi (2015), John *et al.,* (2007), Verma *et al.,* (2002).

Number of mature pods per plant

High PCV, GCV, heritability, GAM was remarked for the above trait in all the four crosses. Earlier Raut *et al.,* (2010), Vishnuvardhan *et al.,* (2013), John *et al.,* (2007), Patil *et al.,* (2014), Patel (2017) found similar results for genetic advance. Case was similar with Padmaja *et al.,* (2015) also.

Number of immature pods per plant

High PCV, GCV, heritability, GAM was remarked for the above trait in all the crosses followed by an equal coefficient of variation at genotypic and phenotypic level in cross Kadri-9 x Sunoleic-95R. Vishnuvardhan *et al.,* (2013), Patel (2017), Padmaja *et al.,* (2013), Raut *et al.,* (2010) reported a high PCV and GCV for this trait. Heritability and GAM results were similar to Patel (2017), John *et al.,* (2007) and Shinde *et al.,* (2010).

Dry pod yield per plant (g)

High value was observed for all the variability parameter *viz.* PCV, GCV, heritability, GAM for this trait. Hyndavi (2015), Vishnuvardhan *et al.,* (2013) and Zongo *et al.,* (2017) recorded a high PCV, GCV and high GAM. Venkatesh *et al.,* (2019) recently observed high heritability and GAM for this trait.

Kernel yield per plant (g)

PCV and GCV results were nearly equal to in case of all the populations with a high estimate of broad sense heritability and GAM indicating fruitfulness of selection. A low difference between PCV and GCV with high heritability can also be seen here. Kadam *et al.,* (2007) and Khote *et al.,* (2009) registered a high PCV and GCV. Concomitant results were also obtained by Savaliya *et al.,* (2009) and Shinde *et al.,* (2010).

Haulm yield per plant (g)

High broad sense heritability with high genetic advance as percent mean were observed among population of all the crosses for this trait. The difference between PCV and GCV was small. Similar findings were reported by Khote *et al.,* (2009), Shoba *et al.,* (2009) and Padmaja *et al.,* (2013).

Shelling percentage (per cent)

A moderate to low PCV and GCV was observed explaining less variability among the genotypes studied for the following trait. In addition a high heritability and high genetic advance as per cent mean was outlined for this trait.

Observance of a moderate PCV and high GAM in cross ICGV-00351 x GPBD-4 were in corroboration with experimental results of Zongo *et al.,* (2017), Hyndavi (2015) and Kumar (2016).

Hundred kernel weight (g)

The values of phenotypic variance are more than the genotypic variance in all the crosses. Shoba *et al.,* (2009), Padmaja *et al.,* (2013), Ganesan and Sudhakar (1995) and Hiremath *et al.,* (2011) reported high PCV and GCV estimates for this trait with a narrow difference between GCV and PCV as observed in present investigation.

High heritability and GAM interpreted from the values of variability of the above trait in all the four crosses were also represented by Savaliya *et al.,* (2009).

Sound mature kernel (per cent)

A low PCV and GCV was observed for the population of cross Kadri-9 x GPBD-4, ICGV-00351 x GPBD-4 and Kadri-9 x Sunoleic-95R except in cross ICGV-00351 x Sunoleic-95R where a high PCV was observed. In cross ICGV-00351 x GPBD-4 a moderate heritability value coupled with low GAM was obtained.

Hugar and Savithramma (2015) also registered a high heritability coupled with high GAM. High heritability estimates coupled with low expected rate of genetic advance as percent mean was observed in cross ICGV-00351 x GPBD-4 and Kadri-9 x Sunoleic-95R.

Oil content (per cent)

More or less equal and a low PCV and GCV values can be seen for the above trait in all the crosses followed by a high heritability and a moderate GAM. Ganesan and Sudhakar (1995) and Hiremath *et al.,* (2011) observed a similar trend in PCV and GCV.

Protein content (per cent)

A moderate PCV and GCV values with high heritability and GAM was observed for the above trait in crosses Kadri-9 x GPBD-4, ICGV-00351 x GPBD-4 and Kadri-9 x Sunoleic-95R except in cross ICGV-00351 x Sunoleic-95R which have got a low GCV and high heritability with moderate GAM. Raut *et al.,* (2010) and Hiremath *et al.,* (2011), also observed similar trend in PCV and GCV. High heritability was registered by Darshora *et al.,* (2002).

Table.1 Estimation of mean and genetic variability parameters for quantitative and qualitative traits in groundnut F_3 generation Cross 1-Kadri-9 x GPBD-4

Sl. No.	Character	Mean	Range		Coefficient of variation		$h^2_{(bs)}$ (%)	GAM at 5% mean
			Minimum	Maximum	PCV (%)	GCV (%)		
1	Days to physiological maturity	112.00	112.00	115.00	0.78	0.40	26.00	0.41
2	Plant height (cm)	33.76	17.00	45.00	18.14	16.93	87.00	32.55
3	No. of primary branches/plant	4.00	3.00	7.00	20.18	16.86	77.60	49.77
4	No. of mature pods/plant	15.00	5.00	31.00	37.49	30.88	67.00	51.66
5	No. of immature pods/plant	4.00	0.00	21.00	75.63	66.95	78.00	115.5
6	Dry pod yield (g/plant)	9.39	0.90	15.24	39.43	39.37	99.00	80.93
7	Kernel yield (g/plant)	6.34	0.57	11.81	40.65	39.50	94.00	79.02
8	Haulm yield (g/plant)	15.59	1.35	50.87	52.09	51.70	98.00	105.70
9	Shelling (%)	67.25	60.00	81.82	19.32	8.34	93.50	92.11
10	Hundred kernel weight (g)	27.07	12.50	60.00	26.15	24.94	91.00	48.98
11	Sound mature kernel (%)	82.08	64.23	97.00	9.43	8.82	87.00	17.02
12	Oil content (%)	51.47	39.59	55.37	5.23	5.19	98.00	10.62
13	Protein content (%)	24.81	19.15	30.55	10.13	10.13	99.00	20.83
14	PAC (%)	10.10	5.09	13.00	16.31	16.31	99.00	33.56
15	SAC (%)	2.16	0.99	3.46	26.07	13.54	26.00	14.35
16	OAC (%)	44.31	31.77	65.76	15.12	15.02	98.00	30.73
17	LAC (%)	34.11	4.86	48.82	26.28	26.28	74.00	54.11

Where,
GCV - Genotypic coefficient of variance PCV - Phenotypic coefficient of variance h^2 - Broad sense heritability
GAM - Genetic advance as per cent of mean

Table.2 Estimation of mean and genetic variability parameters for quantitative and qualitative traits in groundnut F_3 generation Cross 2- ICGV-00351 x GPBD-4

Sl. No.	Character	Mean	Range		Coefficient of variation		$h^2_{(bs)}$ (%)	GAM at 5% mean
			Minimum	Maximum	PCV (%)	GCV (%)		
1	Days to physiological maturity	114.00	113.00	117.00	1.89	0.51	75.23	14.32
2	Plant height (cm)	34.18	15.00	55.00	22.41	21.41	91.00	42.10
3	No. of primary branches/plant	4.00	2.00	6.00	41.78	18.66	61.20	79.50
4	No. of mature pods/plant	16.00	3.00	56.00	35.95	29.93	69.00	53.00
5	No. of immature pods/plant	3.00	0.00	14.00	96.40	88.54	64.00	141.00
6	Dry pod yield (g/plant)	10.39	0.60	15.28	33.29	33.11	98.00	67.85
7	Kernel yield (g/plant)	8.34	0.60	10.52	33.91	33.45	97.00	55.15
8	Haulm yield (g/plant)	23.32	1.08	83.74	53.76	53.12	97.00	108.10
9	Shelling (%)	82.04	60.00	95.23	10.25	5.91	90.45	29.07
10	Hundred kernel weight (g)	32.69	6.00	88.00	24.69	23.18	88.00	34.54
11	Sound mature kernel (%)	83.93	70.00	96.00	5.95	3.76	40.00	4.90
12	Oil content (%)	51.51	35.62	55.41	5.40	5.38	99.00	11.06
13	Protein content (%)	25.20	19.12	30.90	10.62	10.25	99.00	21.07
14	PAC (%)	11.41	3.29	13.44	14.36	14.34	99.00	29.44
15	SAC (%)	2.25	1.04	3.39	19.24	14.05	53.00	20.88
16	OAC (%)	41.17	31.04	82.94	22.35	22.19	98.00	45.37
17	LAC (%)	39.56	4.25	49.18	21.04	20.61	95.00	41.58

Where,
GCV - Genotypic coefficient of variance   PCV - Phenotypic coefficient of variance h^2 - Broad sense heritability
GAM - Genetic advance as per cent of mean

Table.3 Estimation of mean and genetic variability parameters for quantitative and qualitative traits in groundnut F_3 generation Cross 3- Kadri-9 x Sunoleic-95R

Sl. No.	Character	Mean	Range		Coefficient of variation		$h^2_{(bs)}$ (%)	GAM at 5% mean
			Minimum	Maximum	PCV (%)	GCV (%)		
1	Days to physiological maturity	112.00	112.00	113.00	1.64	0.44	74.20	12.50
2	Plant height (cm)	33.93	10.00	45.00	19.21	19.14	99.00	39.25
3	No. of primary branches/plant	5.00	3.00	7.00	20.24	18.24	81.00	31.40
4	No. of mature pods/plant	14.00	2.00	29.00	42.31	37.26	77.00	68.07
5	No. of immature pods/plant	4.00	0.00	21.00	78.88	78.88	91.00	132.75
6	Dry pod yield (g/plant)	8.62	0.93	15.00	45.86	45.81	99.00	94.19
7	Kernel yield (g/plant)	14.00	0.61	10.32	45.48	45.47	96.00	120.07
8	Haulm yield (g/plant)	15.39	1.49	54.40	59.08	58.74	98.00	120.33
9	Shelling (%)	66.78	51.43	88.89	8.12	8.08	98.00	16.54
10	Hundred kernel weight (g)	26.74	9.50	60.67	32.18	31.25	94.00	62.96
11	Sound mature kernel (%)	84.70	72.50	97.00	5.88	5.03	73.00	8.85
12	Oil content (%)	50.16	39.34	55.24	7.02	7.02	91.62	14.45
13	Protein content (%)	25.09	15.63	30.82	11.19	11.19	95.02	23.03
14	PAC (%)	10.36	3.55	12.86	15.65	15.65	90.27	32.23
15	SAC (%)	2.17	1.07	10.56	43.13	43.29	99.00	88.94
16	OAC (%)	54.20	1.28	81.66	25.33	25.33	93.00	52.17
17	LAC (%)	35.84	15.59	48.69	15.80	15.80	93.95	32.53

Where,
GCV - Genotypic coefficient of variance PCV - Phenotypic coefficient of variance h^2 - Broad sense heritability
GAM - Genetic advance as per cent of mean

Table.4 Estimation of mean and genetic variability parameters for quantitative and qualitative traits in groundnut F_3 generation Cross 4-ICGV-00351 x Sunoleic-95R

Sl. No.	Character	Mean	Range		Coefficient of variation		$h^2_{(bs)}$ (%)	GAM at 5% mean
			Minimum	Maximum	PCV (%)	GCV (%)		
1	Days to physiological maturity	114.00	113.00	116.00	0.89	0.61	71.25	2.69
2	Plant height (cm)	36.70	20.00	62.00	21.30	20.54	92.00	40.76
3	No. of primary branches/plant	4.00	3.00	6.00	22.44	14.40	72.50	79.75
4	No. of mature pods/plant	18.00	6.00	41.00	31.44	29.21	86.00	57.66
5	No. of immature pods/plant	4.00	0.00	26.00	80.01	73.54	84.00	128.50
6	Dry pod yield (g/plant)	10.97	0.90	15.13	28.59	28.29	97.00	57.61
7	Kernel yield (g/plant)	13.05	0.60	9.36	57.77	57.76	99.00	144.90
8	Haulm yield (g/plant)	24.18	1.53	94.04	54.14	53.57	97.00	109.18
9	Shelling (%)	64.82	60.00	70.48	4.55	4.33	90.00	8.46
10	Hundred kernel weight (g)	24.50	10.02	56.10	22.86	22.50	96.00	45.63
11	Sound mature kernel (%)	85.06	80.00	95.00	27.19	7.36	52.90	89.20
12	Oil content (%)	51.49	41.53	55.41	4.92	4.89	99.00	10.02
13	Protein content (%)	23.58	19.05	30.83	9.46	9.15	93.00	18.23
14	PAC (%)	11.02	3.91	13.46	20.45	20.41	99.00	41.92
15	SAC (%)	2.12	1.06	3.01	20.76	19.02	83.00	35.84
16	OAC (%)	55.18	33.43	85.83	32.03	32.02	94.58	65.96
17	LAC (%)	37.82	1.85	49.34	32.73	32.73	98.50	67.39

Where,
GCV - Genotypic coefficient of variance PCV - Phenotypic coefficient of variance h^2 - Broad sense heritability
GAM - Genetic advance as per cent of mean

Palmitic acid content (per cent)

Almost equal and moderate PCV and GCV were observed followed by high heritability and high GAM in the above trait for two crosses. Cross ICGV-00351 x Sunoleic-95R recorded a high PCV and GCV estimate along with high heritability and high GAM. Moderate PCV and GCV with high to very high heritability coupled with moderate to high GAM was recorded by Azharudheen *et al.*, (2013), and Sarvamangala *et al.*, (2011).

Stearic acid content (per cent)

A combination of high and moderate PCV and GCV values are observed in the above mentioned character. Where cross Kadri-9 x GPBD-4 and Cross ICGV00351 x GPBD-4 recorded moderate GCV and Cross Kadri-9 x Sunoleic-95R and ICGV00351 x Sunoleic-95R recorded a high PCV and GCV. Low to moderate heritability and genetic advance as per cent mean can be seen for this trait. A moderate PCV and GCV and moderate to high heritability and GAM were outlined by Azharudheen *et al.*, (2013) and Sarvamangala *et al.*, (2011).

Oleic acid content (per cent)

Although PCV and GCV effects are high they are nearly equal with a minute difference. This is further accompanied by a high heritability and high GAM. Azharudheen *et al.*, (2013) and Sarvamangala *et al.*, (2011) registered a moderate PCV and GCV with high to very high heritability coupled with moderate to high GAM for this trait.

Linoleic acid content (per cent)

Although PCV and GCV effects are high the difference between them as observed is very miniscule. This is further accompanied by a high heritability and high genetic advance.

In conclusion thus from the present investigation it can be concluded that most of the crosses registered superiority for varied characters understudy. High percentage of PCV, GCV, heritability coupled with high GAM values were recorded by number of primary branches per plant, number of mature pods per plant, number of immature pods per plant, dry pod yield per plant (g), haulm yield per plant, kernel yield per plant (g) and hundred kernel weight in varied crosses. Hence, an inference could be gathered out that there is preponderance of additive gene action in determining the above characters; hence a simple phenotypic selection can be effective for improvement of the above mentioned traits in their respective crosses of segregating populations for a better outcome. Oil content, sound mature kernel, shelling per cent and days to physiological maturity exhibited a low to moderate category ranges for the genetic parameters indicating that they are under the influence of non additive gene action and thus early generation selection would not be effective for these traits to contribute in genetic improvement of groundnut.

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