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Variability Analysis for Yield, Yield Attributes and Resistance to Foliar Diseases in Groundnut (*Arachis hypogaea* L.)

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ABSTRACT

Groundnut is a highly self-pollinated crop, grown successfully in tropical and subtropical areas. The crop has narrow genetic base therefore, it is essential to create more variability in the segregating materials. Hence, in present investigation an attempt was made to assess the variability of important yield and yield contributing traits which will facilitate an understanding behind expression of character and also role of environment therein. High PCV and GCV values for kernel yield per plant, pod yield per plant, number of pods per plant, 100-pod weight, 100-kernel weight, shell weight and rust score in all backcross population revealed that the variation for these characters contributed markedly to the total variability and there was enough scope for selection based on these characters. Similarly, high values were noticed in all the backcross populations for kernel yield per plant, pod yield per plant, number of pods per plant, 100-pod weight, 100-kernel weight, shell weight, shelling percentage and late leaf spot score exhibited that these characters were mainly controlled by additive genes and selection of such traits might be effective for the improvement of groundnut. Thus, results clearly indicating that the presence of wide spectrum of genetic variation for the characters viz., kernel yield per plant, pod yield per plant, plant height, number of pods per plant, 100-pod weight, 100-kernel weight, shell weight, shelling percentage, late leaf spot and rust score suggesting that they respond to selection with greater efficiency for improvement of pod yield and kernel yield coupled with resistance to foliar diseases in groundnut.

Key words: *Groundnut, per se, variability, yield, late leaf spot, rust.*

INTRODUCTION

Groundnut is an important oilseed crop grown under diverse climatic conditions. So, there is a need to broaden the initial genetic base to stabilize yield. Genetic improvement of any crop depends on the magnitude of genetic variability and the extent of heritability. Variability refers to the presence of differences among the individuals of a population. It is due to the differences either in the genetic constitution of the individual plants or in the environment in which they are grown.

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The success of genetic improvement in any character depends on the nature of variability present in the gene pool for that character. A survey of genetic variability is essentially the first step in crop improvement and plant breeding is an exercise in the management of variability[10]. An insight into the extent and magnitude of variability present in crop species is of utmost importance as it forms the basis for selection in any crop improvement programme. Studies on genetic parameters such as phenotypic variance, genotypic variance, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability (h^2) and genetic advance as per cent of mean (GAM) provides basic information regarding the genetic properties of the populations, based on which breeding methods are formulated for further improvement of the crop. The extent of variability and heritability of characters among genotypes is basic source for the exploitation of heterotic potentiality of the genotypes.

MATERIALS AND METHODS

Crosses were made between foliar disease susceptible genotypes *viz.*, ICGV 00350, ICGV 03128, TMV Gn 13, VRI 2 and foliar disease resistant genotype GPBD 4 in order to develop a foliar disease resistant lines with good pod and kernel yield potential in groundnut. The F_1's of all the four crosses were again backcrossed with the donor parent, GPBD 4. The resultant BC_1F_1 populations of four crosses *viz.*, ICGV 00350 × GPBD 4, ICGV 03128 × GPBD 4, TMV Gn 13 × GPBD 4 and VRI 2 × GPBD 4 were used to investigate the genetic parameters among 12 yield and yield attributing characters. The crop was raised during *Rabi 2013-14*, at the Oilseeds farm, Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore. Recommended cultural practices were followed throughout the crop growing period. The spacing adopted was 30 × 10 cm. All the parents and BC_1F_1 crosses were evaluated in non-replicated trial. Observations were recorded on 12 characters *viz.*, plant height (cm), number of primary branches, number of pods per plant, 100-pod weight (g), 100-kernel weight (g), shell weight (g), shelling percentage, sound mature kernel (SMK) (%), pod yield per plant (g), kernel yield per plant (g), late leaf spot (LLS) score and rust score. Nine point disease scale suggested by Subrahmanyam *et al*[33]., was used to screen the lines for sources of resistance to late leaf spot and rust. The mean, range 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 per cent of mean (GAM) were calculated by adopting the standard statistical procedures.

RESULTS AND DISCUSSION

The results on the mean performance, range and various genetic parameters for 12 yield and yield attributes of four backcross populations *viz.*, ICGV 00350 × GPBD 4, ICGV 03128 × GPBD 4, TMV Gn 13 × GPBD 4 and VRI 2 × GPBD 4 are presented in **Table 1.**

Mean performance

Mean performance is one of the simplest selection criteria for classification of superior performing progenies and eliminating undesirable genotypes/crosses. Considering the BC_1F_1 generation, the cross ICGV 00350 × GPBD 4 exhibited superiority for number of primary branches, number of pods per plant, 100-pod weight, 100-kernel weight, shelling percentage, sound mature kernel per cent, pod yield per plant and kernel yield per plant over the recurrent parent ICGV 00350. The crosses *viz.*, TMV Gn 13 × GPBD 4 and VRI 2 × GPBD 4 possessed higher number of primary branches over TMV Gn 13 and VRI 2, respectively. No significance was observed for remaining traits in all the crosses.

Variability parameters

In the present study, the phenotypic and genotypic coefficient of variation exhibited wide range for all characters. All the four backcross populations exhibited higher PCV values than the GCV values suggesting the influence of environmental factors for all the characters studied. Less difference observed between PCV and GCV in certain cases indicated greater role of genetic components and less influence by environment. Similar results were obtained by John *et al*[11]., Ladole *et al*[16]., and Shinde *et al*[30]. The genetic parameters studied for various characters in BC_1F_1 generation are narrated below.

Plant height (cm)

The crosses ICGV 00350 × GPBD 4, TMV Gn 13 × GPBD 4 and VRI 2 × GPBD 4 exhibited high PCV and GCV for plant height. Similar results have been reported by Raut *et al*[27]., Thakur *et al*[35]., Dandu *et al*[7]., John *et al*[13]., Makinde and Ariyo[17], Terkimbi and Terkula[34] and Thirumala Rao *et al*[36]. The cross ICGV 03128 × GPBD 4 alone exhibited medium PCV and GCV values. Medium PCV and GCV values for plant height were reported by Mothilal[18], Zaman *et al*[39]., Vishnuvardhan *et al*[38]., and Mukesh *et al*[19]. All the four crosses *viz.,* ICGV 00350 × GPBD 4, ICGV 03128 × GPBD 4, TMV Gn 13 × GPBD 4 and VRI 2 × GPBD 4 recorded high heritability and high genetic advance as per cent of mean (GAM) for plant height. These results are in accordance with Zaman *et al*[39]., Dandu *et al*[7]., John *et al*[13]., Terkimbi and Terkula[34] and Thirumala Rao *et al*[36].

Number of primary branches

Two crosses *viz.,* ICGV 00350 × GPBD 4 and TMV Gn 13 × GPBD 4 possessed high PCV, GCV, heritability and GAM for the trait number of primary branches that were in accordance with the findings of Hiremath *et al*[9]., Zaman *et al*[39]., Dandu *et al*[7]., and Ashutosh and Prashant[5]. High PCV, medium GCV, moderate heritability and medium GAM were recorded by the other two crosses *viz.,* ICGV 03128 × GPBD 4 and VRI 2 × GPBD 4. These findings were similar to Nath and Alam[22] and Vishnuvardhan *et al*[38].

Number of pods per plant

All the four crosses *viz.,* ICGV 00350 × GPBD 4, ICGV 03128 × GPBD 4, TMV Gn 13 × GPBD 4 and VRI 2 × GPBD 4 exhibited high PCV, GCV, heritability coupled with high GAM for the trait number of pods per plant. Similar results have been reported by Khote *et al*[15]., Savaliya *et al*[28]., Raut *et al*[27]., Shinde *et al*[30]., Priyadharsini[26], Anitha[3] and John *et al*[13].

100-pod weight (g)

High PCV, GCV, heritability and GAM were noticed in the all the four backcross populations for 100-pod weight. Ali *et al*[1]., and Ladole *et al*[16]., also possessed the same for the trait 100-pod weight.

100-kernel weight (g)

PCV and GCV values were higher for 100-kernel weight in all the four crosses under study. The same trait also recorded high heritability and high GAM for all the four crosses. Such higher estimates of PCV, GCV, heritability and genetic advance have already been indicated by Savaliya *et al*[28]., Shoba *et al*[31]., Shinde *et al*[30]., Hiremath *et al*[9]., Pradhan and Patra[25], Thakur *et al*[35]., Zaman *et al*[39]., Padmaja *et al*[23,24]., Ashutosh and Prashant[5] and Thirumala Rao *et al*[36].

Shell weight (g)

All the crosses *viz.,* ICGV 00350 × GPBD 4, ICGV 03128 × GPBD 4, TMV Gn 13 × GPBD 4 and VRI 2 × GPBD 4 showed high PCV, GCV, heritability and GAM values for the trait shell weight. Anitha[3] (2013) also reported high PCV, GCV, heritability and GAM values for shell weight.

Shelling percentage

Medium PCV and GCV values were recorded by all the crosses for the trait shelling percentage. High heritability and high GAM were also recorded by all the four crosses *viz.,* ICGV 00350 × GPBD 4, ICGV 03128 × GPBD 4, TMV Gn 13 × GPBD 4 and VRI 2 × GPBD 4. These observations are in agreement with the findings of Nath and Alam[22] and John *et al*[12].

Sound mature kernel per cent

For sound mature kernel per cent, high PCV and GCV values were recorded in TMV Gn 13 × GPBD 4 and VRI 2 × GPBD 4 crosses. Similar finding are reported by Hiremath *et al*. (2011) for sound mature kernel. Medium PCV and GCV were observed in cross ICGV 00350 × GPBD 4. John *et al*[13]., also reported the similar kind of results. Sound mature kernel in ICGV 03128 × GPBD 4 exhibited low magnitudes of PCV and GCV indicating the limited scope of selection for this trait. These results are in accordance with Sawargaonkar *et al*[29]., Thakur *et al*[35]., Ashutosh and Prashant[5] and Mukesh *et al*[19]. The crosses *viz.,* ICGV 00350 × GPBD 4, TMV Gn 13 × GPBD 4 and VRI 2 × GPBD 4 had high heritability and high GAM for sound mature kernel per cent. Hiremath *et al*[9]., also reported the similar kind of results. High heritability and medium GAM was recorded by the cross ICGV 03128 ×

GPBD 4. High heritability and medium GAM for sound mature kernel per cent were earlier reported by John *et al*[13]., Ashutosh and Prashant[5] and Mukesh *et al*[19].

Pod yield per plant (g)

The values of PCV and GCV were found to be higher for pod yield per plant. High PCV and GCV for pod yield per plant were earlier reported by Shinde *et al*[30]., Pradhan and Patra[25], Dandu *et al*[7]., Narasimhulu *et al*[20]., Priyadharsini[26], Anitha[3], John *et al*[13]., Narasimhulu *et al*[21]., Mukesh *et al*[19]., and Thirumala Rao *et al*[36]. High heritability and high genetic advance as per cent of mean (GAM) were noticed for pod yield per plant, in all the crosses. These findings were similar to the findings of Shinde *et al*[30]., Dandu *et al*[7]., Narasimhulu *et al*[20]., Priyadharsini[26], Anitha[3], John *et al*[13]., Narasimhulu *et al*[21]., Mukesh *et al*[19]., and Thirumala Rao *et al*[36]., for pod yield per plant.

Kernel yield per plant (g)

High PCV and GCV values coupled with high heritability and GAM were exhibited by the entire cross derivatives for kernel yield per plant. These findings were similar to the findings of Venkataravana and Injeti[37], Khote *et al*[15]., Savaliya *et al*[28]., Dolma *et al*[8]., Raut *et al*[27]., Shinde *et al*[30]., Dandu *et al*[7]., Narasimhulu *et al*[20]., Priyadharsini[26], Anitha[3], John *et al*[13]., Narasimhulu *et al*[21]., Mukesh *et al*[19]. and Thirumala Rao *et al*[36]., for the trait kernel yield per plant.

Late leaf spot score

All the cross derivatives showed higher PCV and GCV values except ICGV 03128 × GPBD 4 which showed medium PCV and GCV for late leaf spot. High PCV, GCV values were noticed earlier by Khedikar *et al*[14]., Venkataravana and Injeti[37], Dolma *et al*[8]., Narasimhulu *et al*[21]., Padmaja *et al*[23]., Ashish *et al*[4]., and medium PCV, GCV values by Vishnuvardhan *et al*[38]., and Padmaja *et al*[24]. High heritability coupled with high GAM for the trait late leaf spot were recorded in all the four cross combinations. Khedikar *et al*[14]., Venkataravana and Injeti[37], Dolma *et al*[8]., Vishnuvardhan *et al*[38]., Narasimhulu *et al*[21]., Padmaja *et al*[23,24]., and Ashish *et al*[4]., reported earlier for late leaf spot score.

Rust score

Rust score exhibited high PCV and GCV values for all the four crosses in BC_1F_1 generation. Similar results were reported by Venkataravana and Injeti[37], Narasimhulu *et al*[21]., and Ashish *et al*[4]. The trait rust score registered high heritability and high GAM, in three crosses studied except ICGV 03128 × GPBD 4 which recorded medium heritability and high GAM. High heritability and high GAM results are in accordance with John *et al*[12]., Venkataravana and Injeti[37], Vishnuvardhan *et al*[38]., Narasimhulu *et al*[21]., Ashish *et al*[4]., and Shridevi *et al*[32].

Comparison of characters based on GCV is more appropriate as it represents the heritable portion of total variability, while PCV estimates include environmental effect also[2]. Genotypic coefficient of variation alone is not useful for selection, and Burton[6] suggested that GCV together with heritability estimates would give the best picture of the extent of genetic gain to be expected by selection. A relative comparison of heritability estimates and expected genetic advance as per cent of mean will give an idea about the nature of gene action governing a particular trait. 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.

Considering the variability parameters, all the four backcross populations *viz.*, ICGV 00350 × GPBD 4, ICGV 03128 × GPBD 4, TMV Gn 13 × GPBD 4 and VRI 2 × GPBD 4 recorded high PCV and GCV values for kernel yield per plant, pod yield per plant, number of pods per plant, 100-pod weight, 100-kernel weight, shell weight and rust score. The crosses ICGV 00350 × GPBD 4, TMV Gn 13 × GPBD 4 and VRI 2 × GPBD 4 recorded high PCV and GCV for late leaf spot score except the cross ICGV 03128 × GPBD 4 which alone recorded medium PCV and GCV values. This revealed that the variation for these characters contributed markedly to the total variability and selection for these traits would be effective only on lesser environmental impact over the trait. Hence, there was enough scope for selection based on these characters.

Regarding the heritability and genetic advance as per cent of mean (GAM), high values were noticed in all the backcross populations for kernel yield per plant, pod yield per plant, number of pods per plant, 100-pod weight, 100-kernel weight, shell weight, shelling percentage and late leaf spot. The crosses ICGV 00350 × GPBD 4, TMV Gn 13 × GPBD 4 and VRI 2 × GPBD 4 recorded high heritability and high GAM except the cross ICGV 03128 × GPBD 4 which alone possessed moderate heritability and high GAM values for rust score. As indicated, these characters were mainly controlled by additive genes and selection of such traits might be effective for the improvement of groundnut (**Table 2**).

Table 1: Estimates of genetic variability parameters in four backcross populations of groundnut

Character	Cross	Mean	SE	Min	Max	PCV (%)	GCV (%)	Heritability (BS) (%)	GAM (%)
Plant height (cm)	**C1**	8.81	0.40	5.00	14.00	25.46	23.32	83.90	44.01
	C2	19.87	0.59	14.50	25.00	15.26	14.57	91.19	28.67
	C3	24.64	0.98	11.00	38.00	27.15	26.91	98.19	54.92
	C4	26.47	0.65	10.00	44.00	20.85	20.58	97.34	41.82
Number of branches	**C1**	6.39*	0.29	4.00	10.00	25.14	20.96	69.53	36.01
	C2	4.23	0.22	2.00	6.00	26.16	15.66	35.84	19.31
	C3	5.57*	0.23	3.00	11.00	28.67	23.86	69.24	40.89
	C4	5.46*	0.13	2.00	8.00	20.15	11.93	35.04	14.54
Number of pods per plant	**C1**	10.45*	0.86	2.00	28.00	45.74	43.69	91.25	85.98
	C2	25.58	2.39	5.00	56.00	47.55	47.23	98.65	96.64
	C3	12.72	0.88	1.00	25.00	47.15	45.82	94.44	91.73
	C4	9.97	0.50	2.00	23.00	42.68	40.25	88.96	78.21
100-pod weight (g)	**C1**	62.30*	5.18	12.00	104.30	46.26	45.83	98.15	93.54
	C2	87.67	5.26	28.70	137.60	30.61	30.28	97.86	61.71
	C3	72.27	4.69	5.50	118.80	44.53	44.19	98.51	90.36
	C4	72.03	3.80	13.20	133.80	44.71	44.38	98.52	90.74
100-kernel weight (g)	**C1**	30.70*	1.27	15.38	40.00	23.09	20.77	80.88	38.47
	C2	32.39	1.65	20.11	51.25	26.00	24.18	86.45	46.31
	C3	33.89	1.26	10.50	46.67	25.57	23.88	87.21	45.94
	C4	35.39	0.91	14.83	48.60	21.94	20.11	84.06	37.99
Shell weight (g)	**C1**	2.20	0.23	0.50	7.24	58.92	54.98	87.08	105.69
	C2	5.17	0.50	0.96	10.24	49.08	48.25	96.64	97.71
	C3	2.59	0.20	0.27	6.35	52.03	48.82	88.05	94.37
	C4	2.50	0.13	0.50	5.13	43.96	39.83	82.08	74.33
Shelling percentage	**C1**	66.92*	1.36	43.33	74.73	11.34	11.17	97.07	22.67
	C2	65.15	1.37	49.33	76.89	10.75	10.56	96.56	21.37
	C3	67.56	1.54	23.49	77.43	15.62	15.50	98.49	31.69
	C4	65.16	1.13	23.48	76.03	14.75	14.62	98.17	29.84
SMK (%)	**C1**	92.78*	1.85	50.00	100.00	11.10	11.08	99.56	22.78
	C2	96.03	1.29	77.78	100.00	6.83	6.80	98.93	13.93
	C3	86.57	2.77	22.22	100.00	21.93	21.92	99.87	45.13
	C4	86.40	2.21	25.00	100.00	21.69	21.67	99.87	44.62
Pod yield per plant (g)	**C1**	7.01*	0.77	1.20	21.77	61.16	59.22	93.75	118.11
	C2	15.47	1.52	2.87	29.68	50.26	49.78	98.10	101.57
	C3	8.94	0.75	0.55	18.77	57.86	56.60	95.71	114.07
	C4	7.78	0.48	1.32	18.28	52.32	50.47	93.06	100.29
Kernel yield per plant (g)	**C1**	4.82*	0.55	0.52	14.53	63.38	61.69	94.73	123.69
	C2	10.30	1.10	1.64	22.11	54.41	53.99	98.44	110.34
	C3	6.36	0.58	0.28	14.47	62.01	61.02	96.84	123.70
	C4	5.28	0.36	0.31	13.43	58.13	56.59	94.79	113.50
LLS score	**C1**	3.13	0.17	2.00	5.00	30.59	26.32	74.01	46.64
	C2	4.58	0.17	3.00	6.00	18.72	15.38	67.56	26.05
	C3	3.02	0.14	2.00	5.00	31.24	26.74	73.27	47.15
	C4	4.63	0.14	2.00	7.00	24.99	22.66	82.18	42.31
Rust score	**C1**	2.90	0.33	1.00	6.00	62.48	57.54	84.80	109.15
	C2	2.42	0.19	1.00	5.00	40.73	28.41	48.66	40.82
	C3	3.72	0.25	1.00	7.00	46.42	42.35	83.26	79.61
	C4	4.78	0.19	2.00	8.00	33.00	29.49	79.88	54.29

C1 - ICGV 00350 × GPBD 4 **C2 -** ICGV 03128 × GPBD 4 **C3 -** TMV Gn 13 × GPBD 4 **C4 -** VRI 2 × GPBD 4

* Significant @ 5% level of probability.

Table 2: Selection of traits for effective improvement of groundnut

S. No.	Characters	Gene Effects				Selection Remarks
		ICGV 00350 × GPBD 4	ICGV 03128 × GPBD 4	TMV Gn 13 × GPBD 4	VRI 2 × GPBD 4	
1	**Plant height (cm)**	Additive	Additive	Additive	Additive	✓
2	**Number of branches**	Additive	Non additive	Additive	Non additive	×
3	**Number of pods per plant**	Additive	Additive	Additive	Additive	✓
4	**100-pod weight (g)**	Additive	Additive	Additive	Additive	✓
5	**100-kernel weight (g)**	Additive	Additive	Additive	Additive	✓
6	**Shell weight (g)**	Additive	Additive	Additive	Additive	✓
7	**Shelling percentage**	Additive	Additive	Additive	Additive	✓
8	**Sound mature kernel (%)**	Additive	Non additive	Additive	Additive	×
9	**Pod yield per plant (g)**	Additive	Additive	Additive	Additive	✓
10	**Kernel yield per plant (g)**	Additive	Additive	Additive	Additive	✓
11	**Late leaf spot score**	Additive	Additive	Additive	Additive	✓
12	**Rust score**	Additive	Additive	Additive	Additive	✓

✓ - Enough scope for selection of particular trait due to the presence of high genetic variation / additive gene effect

× - Selection may not be rewarding due to the presence of low genetic variation / non additive gene effect

CONCLUSION

Thus, results clearly indicating that the presence of wide spectrum of genetic variation for the characters *viz.*, kernel yield per plant, pod yield per plant, plant height, number of pods per plant, 100-pod weight, 100-kernel weight, shell weight, shelling percentage, late leaf spot and rust score suggesting that they respond to selection with greater efficiency for improvement of pod yield and kernel yield coupled with resistance to foliar diseases in groundnut.

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