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Study of Genetic Variability and Correlations in a Mutant Population of Groundnut

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A B S T R A C T

A mutant population comprising of 42 primary mutants, 7 secondary mutants and 4 tertiary mutants along with the parent Dharwad Early Runner (DER) and eight most popular groundnut varieties were evaluated during *kharif* 2012 for various agronomic, traits and for resistance to rust and late leaf spot. The genotypes showed significant genotypic differences for all the quantitative and nutritional traits studied. They also differed significantly for rust and LLS resistance except for LLS at 70 DAS. Phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) revealed high variability for number of pods/plant and pod yield/plant (g). LLS and rust resistance at three stages exhibited moderate variability. Number of pods/plant (g) and pod yield/plant (g) also showed very high heritability and genetic advance over mean. Moderately high heritability was observed for LLS and rust resistance at 80 and 90 DAS when compared to 70 DAS. Pod yield/plant (g) showed positive and significant phenotypic and genotypic correlation with number of pods/plant, shelling percentage, test weight (g), SMK (%) and pod length (cm). Pod yield/plant (g) showed negative but significant correlation both at phenotypic and genotypic level with scores taken at all the three stages of LLS and rust disease development. The association analyses between stages (70, 80 and 90 DAS) showed positive and significant phenotypic correlation for LLS and rust resistance. However, the association between LLS and rust resistance across the stages was not significant. Pod yield per plant (g) can be considered as a tool in selection programme to enhance groundnut productivity, as it showed high heritability coupled with high genetic advance over mean (GAM) and positive association with productivity traits.

Introduction

The cultivated groundnut (*Arachis hypogaea* L.) is one of the major and important oilseed crop of the world. Among various oilseeds, groundnut is unique in that it can be consumed directly as an item of food and also utilized in diverse ways viz., source of oil and preparation of value added food products. Further its protein-rich meal and fodder for livestock are added advantages to the farming community. With about 26 per cent protein, 48 per cent oil and 3 per cent fibre and higher calcium, thiamine and niacine contents, it has the potential to be used as a highly economical food supplement to fight malnutrition that occurs due to deficiencies of these nutrients in the cereal grains.

Efficiency of the selection is dependent upon the nature, extent and magnitude of the genetic variability present in the material and the extent to which it is heritable. Correlations provide estimates of magnitude and direction of association between the traits. Hence, an attempt was undertaken to assess the variability and association between the important traits in diverse mutant.

Materials and Methods

The study employed a mutant population consisting 42 primary mutants, 7 secondary mutants, 4 tertiary mutants, parents and eight popular varieties representing various subspecies and botanical varieties.

All the primary mutants originated upon mutagenesis with ethyl methane sulphonate (EMS) (0.5%) from Dharwad Early Runner (DER). DER was recovered from a cross involving two *fastigiata* cultivars, *viz.* Dh 3-20 and CGC-1 (Gowda *et al.*, 1989). Secondary mutants were obtained from a few primary mutants upon mutagenesis. However, spontaneous mutations in the secondary mutants gave rise to tertiary mutants.

The experiment was carried out in randomized complete block design with two replications during *kharif* season (2012) at the IABT Garden, Main Agricultural Research station, Dharwad. The replicated data of all the traits were subjected for statistical analysis *viz.*, Analysis of variation (ANOVA), mean, range, genetic variability components such as phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability and genetic advance as per cent mean (GAM) and correlation analysis. Statistical package Windostat Version 8.1was used for the analysis.

Results and Discussion

The genotypes were evaluated in field during *kharif* 2012 for agronomic and productivity traits along with their reaction to LLS and rust. The genotypes showed significant differences for all the agronomic and productivity traits (Table 1a) except resistance to LLS at 70 DAS (Table 1b).

The improvement of character in a population is a function of variability existing in the population. Hence, formulation of objectives in breeding programme should be essentially accompanied with the assessment of existing variability in the segregating populations. Phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) revealed high variability for number of pods per plant and pod yield per plant(g), and moderate variability for other traits Rao (2016) and Bhargavi *et al.*, (2017) (Table 2a). LLS and rust resistance at 70, 80 and 90 DAS, exhibited moderate variability (Table 2b). While high variability was recorded with the results published by Khedikar *et al.*, (2008), Reddy and Gupta (1992).

Number of pods per plant and pod yield per plant (g) also showed very high heritability and genetic advance over mean, indicating the scope for selection among the genotypes. Similar reports were observed by Singh *et al.*, (1996), Abhay-Darshora *et al.*, (2002) and Shinde *et al.*, (2010), Mukhesh *et al.*, (2014) and Balaraju and Kenchangoudar (2016). SMK(%), test weight(g) and pod length showed high heritability though they had moderate level of variability Rao (2016), Bhargavi *et al.*, (2017) and Yusuf *et al.*, (2017) (Table 2a). Moderately high heritability was observed for LLS and rust resistance at 80 and 90 DAS compared to 70 DAS (Table 2b). Correlation coefficients were computed to assess the magnitude and direction of association between the traits.

Table.1a ANOVA for agronomic traits among mutant population and check varieties of groundnut

Source of variation	df	Plant height (cm)	Primary branch length (cm)	No. of primary branches	No. of secondary branches	Leaf Length (cm)	Leaf width (cm)	Shelling percentage	Sound Mature kernel	Test Weight (g)	Pod Length (cm)	Pod Width (cm)	No. of pods per plant	Pod yield per plant (g)
Replications (rMSS)	1	0.12	24.80	4.65	0.07	1.07	0.00	16.33	1415.82	1.16	0.01	0.02	12.58	11.20
Genotypes (gMSS)	61	76.04**	93.15**	12.47**	2.70**	1.64**	0.32**	277.72**	309.98**	93.88**	0.52**	0.11**	69.88**	50.43**
Error (eMSS)	61	4.74	13.76	1.22	0.02	0.30	0.14	78.82	70.32	31.39	0.04	0.05	4.03	2.26
F		16.0	6.8	10.3	135.1	5.5	2.4	3.5	4.4	3.0	12.0	2.1	17.3	22.3
SEm±		1.5	2.6	0.8	0.1	0.4	0.3	6.3	5.9	4.0	0.1	0.2	1.4	1.1
CV (%)		7.7	10.9	15.5	9.8	10.0	13.9	17.3	10.3	17.6	7.4	17.5	13.3	15.1
CD (5%)		4.4	7.4	2.2	0.3	1.1	0.7	17.8	16.8	11.2	0.4	0.5	4.0	3.0

Table.1b ANOVA for reaction to LLS and rust among mutant population and check varieties of groundnut

Source of variation	df	Late leaf spot at 70 DAS	Late leaf spot at 80 DAS	Late leaf spot at 90 DAS	Rust at 70 DAS	Rust at 80 DAS	Rust at 90 DAS
Replications (rMSS)	1	0.03	5.88	5.04	0.65	0.98	0.03
Genotypes (gMSS)	61	0.47	1.63**	2.97**	0.46*	2.09**	3.47**
Error (eMSS)	61	0.43	0.39	0.81	0.28	0.53	0.88
F		1.1	4.2	3.7	1.7	3.9	3.9
SEm±		0.5	0.4	0.6	0.4	0.5	0.7
CV (%)		18.6	10.6	12.7	14.6	12.6	13.5
CD (5%)			1.2	1.8	1.1	1.5	1.9

*, ** : Significance at 5% and 1% probability, respectively

Table.2a Estimates of genetic parameters for agronomic traits among mutant population and check varieties of groundnut

Traits	Mean	Range		PCV (%)	GCV (%)	h^2 (Broad Sense) (%)	GA	GAM
		Min	Max					
Plant height (cm)	28.39	15.06	42.30	18.04	13.11	53	0.25	19.61
Primary branch length (cm)	33.95	21.56	64.57	13.86	4.46	10	0.10	2.96
No. of primary branches	7.11	3.40	14.20	15.38	13.43	76	1.42	24.17
No. of secondary branches	2.92	0.00	26.40	17.15	14.62	73	1.83	25.68
Leaf length (cm)	5.50	3.57	7.74	13.32	8.44	40	0.40	11.01
Leaf width (cm)	2.66	2.08	4.41	17.69	15.27	75	1.57	27.15
Shelling percentage	51.36	22.00	72.00	18.95	16.36	75	2.02	29.09
Sound mature kernel	81.77	19.00	96.50	9.31	9.15	97	1.96	18.52
Test weight (g)	31.88	20.00	53.50	14.93	14.26	91	0.81	28.07
Pod length (cm)	2.80	1.76	3.99	12.06	11.90	97	11.63	24.17
Pod width (cm)	1.29	0.92	2.43	18.04	13.11	53	0.25	19.61
No. of pods per plant	15.12	4.05	37.95	39.09	37.95	94	11.48	75.89
Pod yield per plant (g)	9.98	1.40	30.63	50.33	49.18	96	9.88	99.02

Table.2b Estimates of genetic parameters for LLS and rust resistance traits among mutant population and check varieties of groundnut

Traits	Mean	Range		PCV (%)	GCV (%)	h^2 (Broad sense) (%)	GA	GAM
		Min	Max					
Late leaf spot at 70 DAS	3.52	3.00	5.50	13.86	4.46	10	0.10	2.96
Late leaf spot at 80 DAS	5.88	4.00	8.00	15.38	13.43	76	1.42	24.17
Late leaf spot at 90 DAS	7.10	4.00	9.00	17.15	14.62	73	1.83	25.68
Rust at 70 DAS	3.60	3.00	5.00	13.32	8.44	40	0.40	11.01
Rust at 80 DAS	5.78	4.00	7.50	17.69	15.27	75	1.57	27.15
Rust at 90 DAS	6.95	4.00	9.00	18.95	16.36	75	2.02	29.09

Table.3a Phenotypic and genotypic correlation coefficients for agronomic traits

Traits	Plant height (cm)	Primary branch length (cm)	No. of primary branches	No. of secondary branches	Leaf length (cm)	Leaf width (cm)	Shelling percentage	Sound mature kernel	Test weight (g)	Pod length (cm)	Pod width (cm)	No. of pods per plant	Pod yield per plant (g)
Plant height (cm)	1.000	0.458**	-0.224*	-0.322**	0.363**	0**.305	0.245**	0.200*	0.244**	0.315**	0.160	0.120	0.370**
Primary branch length (cm)	0.457**	1.000	-0.140	0.020	0.251**	0.281**	-0.140	0.070	-0.233**	0.110	-0.170	-0.010	0.030
No. of primary branches	-0.242*	-0.152	1.000	0.610**	-0.455**	-0.365**	-0.275**	-0.245**	-0.100**	-0.040	-0.150	0.100	-0.200
No. of secondary branches	-0.334**	0.025	0.653**	1.000	-0.500**	-0.256**	-0.497**	-0.457**	-0.311**	-0.090	-0.208*	-0.238**	-0.410**
Leaf length (cm)	0.414**	0.308**	-0.519**	-0.564**	1.000	0.693**	0.030	0.130	-0.090	0.150	0.200*	-0.100	0.170
Leaf width (cm)	0.471**	0.456**	-0.454**	-0.354**	0.808**	1.000	-0.100	-0.110	-0.170	0.130	0.160	-0.303**	0.020
Shelling percentage	0.313**	-0.245**	-0.356**	-0.580**	0.128	-0.155	1.000	0.579**	0.439**	-0.040	-0.010	0.483**	0.570**
Sound mature kernel	0.245**	0.072	-0.292**	-0.516**	0.228*	-0.136	0.678**	1.000	0.411**	-0.040	-0.010	0.441**	0.520**
Test weight (g)	0.311**	-0.359**	-0.134	-0.374**	0.009	-0.308**	0.503**	0.428**	1.000	0.461**	0.412**	0.170	0.500**
Pod length (cm)	0.359**	0.155	-0.050	-0.097	0.156	0.166	-0.044	-0.085	0.569**	1.000	0.470**	-0.120	0.180*
Pod width (cm)	0.236**	-0.229*	-0.223**	-0.288**	0.413**	0.398**	-0.095	-0.078	0.614**	0.600**	1.000	-0.100	0.090
No. of pods per plant	0.136	0.017	0.095	-0.245**	-0.110	-0.390**	0.617**	0.546**	0.229*	-0.129	-0.147	1.000	0.600**
Pod yield per plant (g)	0.400**	0.035	-0.235**	-0.418**	0.210*	0.057	0.648**	0.594**	0.568**	0.194*	0.102	0.621**	1.000

Table.3b Phenotypic and genotypic correlation coefficients for LLS and rust diseases at 70, 80, 90 days after sowing (DAS)

Traits	Late leaf spot at 70 DAS	Late leaf spot at 80 DAS	Late leaf spot at 90 DAS	Rust at 70 DAS	Rust at 80 DAS	Rust at 90 DAS
Late leaf spot at 70 DAS	1.000	0.479**	0.487**	0.273**	0.060	-0.010
Late leaf spot at 80 DAS	0.865**	1.000	0.789**	0.140	0.273**	0.130
Late leaf spot at 90 DAS	0.796**	0.939**	1.000	0.198*	0.160	0.150
Rust at 70 DAS	0.369**	0.277**	0.294**	1.000	0.448**	0.488**
Rust at 80 DAS	-0.112	0.319**	0.260**	0.657**	1.000	0.823**
Rust at 90 DAS	-0.040	0.153	0.243**	0.699**	0.930**	1.000

Below diagonal genotypic correlation coefficients; Above diagonal phenotypic correlation coefficients**;** ** : Significance at 5% and 1% probability, respectively

Table.3c Phenotypic and genotypic correlation coefficients for productivity, nutritional diseases resistance traits

Traits	Shelling percentage	Sound mature kernel	Test weight (g)	Late leaf spot at 70 DAS	Late leaf spot at 80 DAS	Late leaf spot at 90 DAS	Rust at 70 DAS	Rust at 80 DAS	Rust at 90 DAS	No. of pods per plant	Pod yield per plant (g)
Shelling percentage	1.000	0.579**	0.439**	-0.094	-0.031	-0.166	0.060	0.018	-0.058	0.483**	0.570**
Sound mature kernel	0.678**	1.000	0.411**	-0.032	-0.181*	-0.122	0.106	-0.076	-0.003	0.441**	0.519**
Test weight (g)	0.503**	0.428**	1.000	-0.174	0.043	0.010	-0.080	-0.013	-0.105	0.174	0.500**
Late leaf spot at 70 DAS	-0.721**	-0.116	-1.076	1.000	0.479**	0.487**	0.273*	0.057	-0.012	-0.212*	-0.244**
Late leaf spot at 80 DAS	-0.036	-0.150	0.088	0.865**	1.000	0.789**	0.143	0.273**	0.126	-0.234**	-0.190*
Late leaf spot at 90 DAS	-0.176	-0.116	0.053	0.796**	0.939**	1.000	0.198*	0.160	0.154	-0.258**	-0.267**
Rust at 70 DAS	-0.007	0.276**	-0.136	0.369**	0.277**	0.294**	1.000	0.448**	0.488**	-0.133	-0.299**
Rust at 80 DAS	0.099	-0.101	0.014	-0.112	0.319**	0.260**	0.657**	1.000	0.823**	0.290**	-0.229*
Rust at 90 DAS	-0.032	-0.012	-0.194**	-0.040	0.153	0.243**	0.699**	0.930**	1.000	0.303**	-0.312**
No. of pods per plant	0.617**	0.546**	0.229*	-0.611**	-0.283**	-0.323**	-0.248**	-0.373**	-0.384**	1.000	0.601**
Pod yield per plant (g)	0.648**	0.594**	0.568**	-0.737**	-0.225*	-0.313**	-0.467**	-0.269**	-0.395**	0.622**	1.000

Below diagonal genotypic correlation coefficients Above diagonal phenotypic correlation coefficients *, **: Significance at 5% and 1% probability, respectively

Pod yield per plant (g) showed positive and significant phenotypic and genotypic correlation with number of pods per plant, shelling percentage, test weight (g), sound mature kernel per cent(%) and pod length (cm) (Table 3a). Similar results of significant positive association of number of pods with pod yield per plant was reported by Francis and Ramalingam (1997) Sarala and Gowda (1998) and Narasimhalu *et al.*, 2012, Similar results of significant positive association of pod yield per plant with shelling percentage were reported by Abhay-Darshora *et al.*, (2002) Mahalakshmi *et al.*, (2005) and Wang *et al.*, (2006). Similar results of significant positive association of pod yield per plant(g) with test weight(g) was reported by Channayya (2009) and Azharudheen (2010), While significant positive association of pod yield per plant with sound mature kernel per cent was reported by Francis and Ramalingam (1997) and Vasanthi *et al.*, (2015). This indicates the importance of the number of pods per plant (g), shelling percentage (%), test weight (g), sound mature kernel per cent and pod length (cm) traits towards contribution to pod yield per plant (g). Selection for these traits will be more reliable to derive high yielding genotypes.

Pod yield per plant(g) showed negative but significant correlation both at phenotypic and genotypic level with disease scores at all the three stages of LLS and rust development as these foliar diseases reduce the photosynthetic activity of the plant (Table 3c). Similar results of significant negative association of pod yield per plant (g) with disease score were reported by John *et al.*, (2005) and Wang *et al.*, (2006). The association analyses between stages (70, 80 and 90 DAS) showed positive and significant phenotypic correlation for LLS and rust resistance. However, the association between LLS and rust resistance across the stages was not significant (Table 3b).

Results indicated that the trait pod yield per plant(g) showed higher heritability coupled with high genetic advance over mean and positive correlation with number of pods per plant, shelling percentage, test weight(g), sound mature kernel(%) and pod length(cm) it can be considered to be used in selection programmes to improve yield of groundnut.

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