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Genetic divergence and selection indices for yield and its contributing traits in virginia groundnut

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Abstract

The genetic divergence measured by Mahalanobis's D^2 -statistic grouped 60 genotypes into 13 clusters. The clustering pattern of the genotypes did not confirm to the geographical distribution. The lowest intra-cluster distance was in cluster X whereas the highest intra-cluster distance was in cluster XIII. The maximum inter-cluster distance found between cluster XIII and V. The minimum inter-cluster distance found between cluster VI and V. Among all the 31 selection indices, the index based on five component characters *viz.*, pod yield per plant, number of matured pods per plant, 100-kernel weight, biological yield per plant and harvest index possessed the highest genetic gain and relative efficiency followed by an index based on four characters *viz.*, pod yield per plant, number of matured pods per plant, 100-kernel weight and biological yield per plant possessed the highest genetic gain and relative efficiency.

Keywords: Genetic divergence and selection indices, virginia groundnut

Introduction

Success of plant breeding programme depends largely on the choice of appropriate parents. It is expected that the utilization of divergent parents in hybridization results in promising recombinants. Genetic improvement mainly depends upon the amount of genetic variability present in the population. The use of Mahalanobis's D^2 -statistics for estimating genetic divergence have been emphasized by many workers (Murthy and Arunachalam, 1966) [6] because it permits precise comparison among all the population given in any group before effecting actual crosses.

The use of discriminant function was a better way of exploiting genetic correlation with several traits having high heritability is to construct an index which combines information on all the characters associated with yield. The best-known selection indices involve discriminant function based on the relative economics importance of various clusters. Hazel and Lush (1943) [5] showed that the selection based on such an index is more efficient than selecting indices has been proved by Hazel (1943) [4] and Robinson *et al.* (1951) [8].

Cultivated groundnut (*Arachis hypogaea* L.) is a self-pollinated crop. Groundnut is an important oilseed crop, with oil content around 40-50% and is extensively used for cooking purposes. Oil is a rich source of vitamin A, B and E. Groundnut is also known as the "King" of oilseeds or "Wonder nut" or "Poor man's cashew nut". The total groundnut production in India during the year 2018-19 was about 5.20 million tones with 3.89 million hectares area and 1336 kg/ha productivity. Groundnut is the major oilseed crop of Gujarat with 1.47 million hectares area and 2.08 million tons of production with 1421 kg/ha productivity (Annon, 2018) [1].

Materials and methods

The experimental material consisted of 60 genotypes of groundnut derived from different origins like 16 from J.A.U. Junagadh, 21 from ICRISAT (Patancheru), 7 from ANGRAU (Andhra Pradesh), 7 from CSAUA & T (Mainpuri), 7 from Rajasthan, 1 from PDVK (Akola) and 1 is exotic collection. The genotypes were obtained from the Main Oilseeds Research Station, Junagadh Agricultural University, Junagadh. These genotypes grown in a Randomized Block Design with three replications at the Instructional Farm, College of Agriculture, J.A.U., Junagadh during *kharif* 2018 [1]. Each genotype was accommodated in a single row of 3.0 meter length with a spacing of 60 cm between rows and 15 cm between plants within the row. The experiment was surrounded by two guard rows to avoid damage and border effects.

The observations were recorded on five randomly selected plants from each entry and replication for fifteen different characters. The observations were recorded on 14 characters viz., days to 50% flowering, days to maturity, plant height (cm), number of branches per plant, number of matured pods per plant, number of immature pods per plant, number of pods per plant, pod yield per plant (g), sound mature kernel (%), 100-kernel weight (g), shelling out-turn (%), biological yield per plant (g), harvest index (%) and oil content (%). The significant mean squares due to genotypes for all the traits suggested the presence of considerable genetic variability for all the traits studied. Based upon 14 characters, the Mahalanobis's D²-statistic was computed for all possible pairs of 60 genotypes in order to assess the genetic divergence present among the genotypes under study. Grouping of the genotypes was carried-out by following Tocher's method (Rao, 1952) ^[7] with the assumption that the genotypes within

the cluster have smaller D²- values among themselves than those from groups belonging to different clusters. In all, 13 clusters were formed from 60 genotypes. The composition of cluster is given in Table-1 and clustering pattern is shown in Table-2.

For the construction of selection indices, the characters, which had desirable correlation as well as moderate to high direct effect on green pod yield per plant were considered. In this context, pod yield per plant (X₁) along with its four components viz., number of matured pods per plant (X₂), 100-kernel weight (X₃), biological yield per plant (X₄) and harvest index (X₅) were identified and considered for the construction of selection indices. Their respective genetic advances were calculated and relative efficiency of different discriminant functions in relation to the straight selection for pod yield was compared and assuming the efficiency of straight selection for pod yield per plant as 100%.

Table 1: Grouping of 60 genotypes of virginia groundnut in various clusters on the basis of D²-statistic

Cluster	No. of genotypes	Name of genotypes	Source
I	29	ICGV- 9001, C-156, ICGV- 89955, AMR-174, ICGV-86325, 72-39, 4896, ICGV- 91026	ICRISAT
		KDG-123, K-1574, KDG-213, KADIRI-7, K-1643	ANGRAU
		KAUSHAL, CSMG- 9101, CSMG-9708, CSMG-884	CSAUA & T
		NRCG-8, JVR-HPS-2289, GG-13, GG-14, JVR-HPS-2284, GG-20, JVB-49, SOMNATH, GG-11	Junagadh
		RG-559-3, HNG-36	Rajasthan
		AK-143	PDVK, Akola
II	1	CSMG-HPS- 9101	CSAUA & T
III	1	GJG-22	Junagadh
IV	9	59-112, 4343, 59-239,	ICRISAT
		CSMG-9907	CSAUA & T
		JVR-309, GG-21, JVR-HOC-3,	Junagadh
		HNG-HPS-2, RG-382	Rajasthan
V	9	48-114, ALG-05-253, ICGS-5, ICGV-00350	ICRISAT
		K-1577	ANGRAU
		JVR-308, JVB-147	Junagadh
		HNG-57A, HNG-56B	Rajasthan
VI	1	CGC-07	ICRISAT
VII	1	KDG-128	ANGRAU
VIII	1	RG-438-2	Rajasthan
IX	1	JVB-154	Junagadh
X	2	ICGV- 86590, ICGV-87846	ICRISAT
XI	1	CGC-1-19	ICRISAT
XII	3	BAV-18	ICRISAT
		CSMG-2005-18	CSAUA & T
		EC-146615	Exotic collection
XIII	1	ICGV-86564	ICRISAT

Table 2: Source and clustering pattern of 60 genotypes of virginia groundnut

Source	ICRISAT	ANGRAU	CSAUA & T	Junagadh	Rajasthan	PDVK, Akola	Exotic collection	Total
I	8	5	4	9	2	1	-	29
II	-	-	1	-	-	-	-	1
III	-	-	-	1	-	-	-	1
IV	3	-	1	3	2	-	-	9
V	4	1	-	2	2	-	-	9
VI	1	-	-	-	-	-	-	1
VII	-	1	-	-	-	-	-	1
VIII	-	-	-	-	1	-	-	1
IX	-	-	-	1	-	-	-	1
X	2	-	-	-	-	-	-	2
XI	1	-	-	-	-	-	-	1
XII	1	-	1	-	-	-	1	3
XIII	1	-	-	-	-	-	-	1

Results and Discussion

Genetic divergence

In the present study, D^2 -statistic estimated on 60 genotypes of groundnut for 14 characters. On the basis of D^2 -values, 13 clusters were formed from 60 genotypes. The cluster I contained 29 genotypes from different origins. On the other hand, the clusters II, III, VI, VII, VIII, IX, XI and XIII possessed only one genotype in each cluster.

The maximum inter-cluster distance varied from 6.71 (clusters IV and II) to 16.79 (clusters XIII and V), which indicates considerable diversity among the genotypes evaluated, whereas the lowest inter cluster distance ($D=6.46$) found between clusters VI and V (Table-3). The lowest intra-cluster distance were found in cluster X ($D=5.90$), whereas the highest intra-cluster distance was in cluster XIII ($D=9.34$). The maximum coefficient of variation was recorded for harvest index (14.14%) followed by number of immature

Pods per plant (13.98%), number of pods per plant (10.81%), pod yield per plant (10.57%), plant height (10.38%), while it was low for number of matured pods per plant (9.97%), 100-kernel weight (9.78%), number of branches per plant (8.28%), biological yield per plant (7.00%), sound mature kernel (5.30%), oil content (5.29%), shelling out-turn (5.27%), days to 50% flowering (4.65%) and days to maturity (3.18%).

The analysis of per cent contribution of various characters towards the expression of total genetic divergence indicated that pod yield per plant (19.77%) followed by days to 50% flowering (16.78%), biological yield per plant (16.05%), shelling out-turn (15.31%), plant height (11.02%) and number of matured pods per plant (10.00%) contributed maximum towards total genetic divergence in the present study (Table-4).

Table 3: Average inter and intra-cluster distance ($D = \sqrt{D^2}$) values in virginia groundnut

Cluster	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
I	6.58	7.63	7.71	8.51	9.07	8.74	8.05	9.07	8.54	10.31	10.08	10.12	12.57
II		0.00	10.28	6.71	10.21	9.98	11.91	9.17	7.69	9.16	6.98	9.57	9.68
III			0.00	11.40	7.42	12.32	7.84	12.73	8.50	11.99	10.07	9.68	14.74
IV				6.41	11.54	8.54	11.93	9.23	8.72	10.58	9.87	11.75	10.30
V					7.26	13.50	11.17	12.39	9.55	14.10	11.86	10.21	16.79
VI						0.00	8.32	9.27	12.77	8.57	13.79	15.03	12.07
VII							0.00	12.15	12.28	10.30	13.42	13.48	14.79
VIII								0.00	9.44	13.94	12.43	11.83	14.03
IX									0.00	13.94	7.25	8.93	12.23
X										5.90	11.72	15.01	10.61
XI											0.00	9.46	9.30
XII												9.34	14.67
XIII													0.00

Table 4: Cluster means for 14 different characters in virginia groundnut

Cluster	Days to 50% Flowering	Days to maturity	Plant height (cm)	Number of branches per plant	Number of matured pods per plant	Number of immature pods per plant	Number of pods per plant	Pod yield per plant (gm)	Sound mature kernel (%)	100-kernel weight	Shelling out-turn	Biological yield per plant	Harvest index (%)	Oil content (%)
I	42.24	127.40	19.92	3.04	12.29	5.03	17.27	14.80	78.17	44.32	77.46	61.38	24.89	45.79
II	45.29	130.19	20.70	3.23	10.60	4.45	15.23	10.70	78.27	34.53	62.12	57.68	23.25	44.06
III	41.99	130.00	24.45	3.00	15.47	5.45	20.85	18.52	80.87	51.80	73.22	70.95	26.87	47.77
IV	43.15	129.61	21.91	3.07	9.88	4.14	13.96	11.04	73.20	40.86	73.54	45.16	24.77	45.89
V	48.47	133.20	21.55	2.95	15.58	5.05	20.58	17.26	82.70	41.20	74.16	62.88	29.03	46.06
VI	34.80	124.88	14.97	3.00	11.27	3.88	15.47	12.00	75.80	46.66	83.98	48.63	27.23	44.73
VII	34.94	117.41	19.95	3.07	14.80	4.85	19.74	18.80	82.00	48.77	87.79	70.00	25.70	45.35
VIII	48.32	136.79	13.27	3.23	9.43	4.72	14.27	9.85	71.84	48.73	87.72	58.74	17.46	43.46
IX	49.52	133.00	25.98	3.20	11.03	3.61	14.54	15.00	76.01	50.00	74.17	65.24	19.61	45.00
X	31.83	121.48	20.21	3.27	13.23	4.47	17.88	11.49	81.08	34.66	62.39	55.46	23.42	48.76
XI	46.12	130.00	33.30	3.17	12.23	4.55	16.94	9.11	78.18	35.45	63.81	69.25	15.16	45.70
XII	49.30	134.56	25.52	3.06	10.77	7.37	17.17	13.42	75.35	39.66	71.39	67.32	21.89	45.65
XIII	35.00	124.07	29.35	3.10	6.07	3.63	10.08	9.00	56.05	35.00	63.00	54.09	17.41	47.20
Mean	42.38	128.66	22.39	3.11	11.74	4.71	16.46	13.15	76.12	42.43	73.44	60.52	22.82	45.80
S.Em.±	1.15	2.35	1.26	0.14	0.70	0.39	1.06	0.86	2.35	2.39	2.27	2.38	2.01	1.39
C. V. %	4.65	3.18	10.38	8.28	9.97	13.98	10.81	10.57	5.30	9.78	5.27	7.00	14.14	5.29
Percentage contribution of characters towards total divergence														
Number of times appearing first	297	9	195	30	177	69	11	350	2	33	271	284	23	19
% contribution	16.78	0.51	11.02	1.69	10.00	3.90	0.62	19.77	0.11	1.86	15.31	16.05	1.30	1.07

Selection indices

Thirty-one selection indices were constructed in all possible combinations of the four yield contributing characters and pod yield per plant. The data on selection indices, discriminant functions, genetic gain and relative efficiency are given in Table-5. When the relative efficiency of single character index was measured, it was noted that the maximum efficiency of 315.65% was exhibited by biological yield per plant followed by 100-kernel weight (156.03%), harvest index (114.23%), pod yield per plant (100.00%) and number of matured pods per plant (87.90%).

The maximum genetic gain advance (Gs) and relative efficiency in a single character discriminant function was 17.30g and 315.65%, respectively which however, increased to 21.27g and 388.12%, respectively in two character

combinations, 26.13g and 476.79%, respectively in three character combinations and 29.29g and 534.49%, respectively in four character combinations. Thus, there was an increase in the genetic gain as well as relative efficiency with inclusion of an additional trait in the character combinations. The index based on five component characters viz., pod yield per plant, number of matured pods per plant, 100-kernel weight, biological yield per plant and harvest index ($X_1+X_2+X_3+X_4+X_5$) possessed the highest genetic gain and relative efficiency (31.49g and 574.67%) as compared to straight selection for pod yield per plant. Dobariya *et al.* (2008) [3] was also with the same opinion that an increase in character results in an increase in genetic gain and that the selection indices improve the efficiency of selection than the straight selection for yield alone.

Table 5: Selection index, discriminant function, expected genetic advance in yield and relative efficiency from the use of different selection indices in virginia groundnut

Sr. No.	Selection index	Discriminant function	Expected genetic advance	Relative efficiency (%)
1	X_1 : Pod yield per plant (g)	$0.9121X_1$	5.48	100.00
2	X_2 : Number of matured pods per plant	$0.9226X_2$	4.82	87.90
3	X_3 : 100-kernel weight (g)	$0.7894X_3$	8.55	156.03
4	X_4 : Biological yield per plant (g)	$0.9296X_4$	17.30	315.65
5	X_5 : Harvest index (%)	$0.7496X_5$	6.26	114.23
6	$X_1.X_2$	$0.9171X_1 + 1.0029X_2$	10.04	183.22
7	$X_1.X_3$	$1.0635X_1 + 0.7685X_3$	12.41	226.47
8	$X_1.X_4$	$1.0110X_1 + 0.9237X_4$	21.27	388.12
9	$X_1.X_5$	$1.1695X_1 + 0.6618X_5$	11.27	205.57
10	$X_2.X_3$	$0.9230X_2 + 0.7899X_3$	9.80	178.77
11	$X_2.X_4$	$1.0143X_2 + 0.9221X_4$	20.64	376.70
12	$X_2.X_5$	$1.2055X_2 + 0.6804X_5$	10.54	192.31
13	$X_3.X_4$	$0.3920X_3 + 0.8556X_4$	17.37	317.03
14	$X_3.X_5$	$0.6609X_3 + 0.5370X_5$	8.36	152.60
15	$X_4.X_5$	$0.9158X_4 + 0.7240X_5$	17.50	319.27
16	$X_1.X_2.X_3$	$1.3822X_1 + 0.6031X_2 + 0.6951X_3$	15.03	274.29
17	$X_1.X_2.X_4$	$1.0228X_1 + 1.0232X_2 + 0.9126X_4$	25.04	456.98
18	$X_1.X_2.X_5$	$1.0730X_1 + 1.1864X_2 + 0.6411X_5$	15.69	286.35
19	$X_1.X_3.X_4$	$1.0774X_1 + 0.8253X_3 + 0.9478X_4$	26.13	476.79
20	$X_1.X_3.X_5$	$1.8126X_1 + 0.5346X_3 + 0.2841X_5$	15.51	282.98
21	$X_1.X_4.X_5$	$2.1138X_1 + 0.6802X_4 + 0.1721X_5$	22.95	418.81
22	$X_2.X_3.X_4$	$0.9118X_2 + 0.8402X_3 + 0.9729X_4$	24.60	448.90
23	$X_2.X_3.X_5$	$1.3202X_2 + 0.7331X_3 + 0.5491X_5$	12.81	233.68
24	$X_2.X_4.X_5$	$1.9291X_2 + 0.7456X_4 + 0.3688X_5$	14.16	258.40
25	$X_3.X_4.X_5$	$0.7913X_3 + 0.9529X_4 + 0.6420X_5$	21.53	392.90
26	$X_1.X_2.X_3.X_4$	$1.3230X_1 + 0.6761X_2 + 0.7655X_3 + 0.9566X_4$	29.29	534.49
27	$X_1.X_2.X_3.X_5$	$2.1763X_1 + 0.5554X_2 + 0.4507X_3 + 0.2767X_5$	19.00	346.74
28	$X_1.X_2.X_4.X_5$	$2.1406X_1 + 1.9807X_2 + 0.4953X_4 - 0.2158X_5$	27.55	502.69
29	$X_1.X_3.X_4.X_5$	$3.7776X_1 + 0.3263X_3 + 0.4330X_4 - 0.7116X_5$	27.65	504.54
30	$X_2.X_3.X_4.X_5$	$1.9818X_1 + 0.8608X_3 + 0.7642X_4 + 0.2667X_5$	25.41	463.66
31	$X_1.X_2.X_3.X_4.X_5$	$3.7175X_1 + 1.5167X_2 + 0.3742X_3 + 0.3422X_4 - 0.8802X_5$	31.49	574.67

Conclusion

It has been well-established fact that more the genetically diverse parents used in hybridization programme, greater will be the chances of obtaining high heterotic hybrids and broad-spectrum variability in segregating generations (Arunachalm, 1981) [2]. These six characters accounted for more than 85% of total divergence in the material studied. It has also been observed that the most productive hybrids result from high yielding parents with a high genetic diversity. Therefore, in the present investigation based on high yielding genotypes and large inter-cluster distances, it is advisable to attempt crossing of the genotypes from cluster XIII with the genotypes of cluster V as well as XII, VII, X which may lead

to broad spectrum of favorable genetic variability for yield improvement in groundnut.

Keeping in view, the basic idea of saving time and labour in a selection programme, it would be desirable to base the selection of few characters. In the present study, selection index based on five characters gave maximum genetic gain and high efficiency over straight selection, but practically it is more cumbersome to use in the selection exercise. However, in practice, the plant breeder might be interested in maximum gain with minimum number of characters. In the present study, selection index based on four characters viz., pod yield per plant, number of matured pods per plant, 100-kernel weight and biological yield per plant ($X_1+X_2+X_3+X_4$) possessed the highest genetic gain and relative efficiency

(29.29g and 534.49%), which is more desirable and practically possible to use breeder than the index that includes more number of characters. Therefore, from this investigation, it is concluded that improvement of pod yield in groundnut could be achieved by selecting the parents with these four characters.

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