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Characterization of Mini Core Collection of Groundnut (*Arachis hypogaea*) for Morphological Traits

G Yugandhar, M V C Gowda, R L Ravi kumar, H L Nadaf, R K Patil and S S Adiver
Department of Genetics and Plant Breeding, College of Agriculture,
University of Agricultural Sciences, Dharwad-580 005, Karnataka

ABSTRACT

Constant evaluation and characterization of the existent yet uncharacterized germplasm is useful for the development of new and better varieties. Minicore collection of groundnut was characterized based on ten morphological descriptors in the present study. Principal component analysis revealed that all characters except growth habit exhibited significant variation in mini core collection. Shanon-Weaver diversity index indicated that Virginia bunch recorded higher diversity for pod beak, pod constriction, pod reticulation and flower colour, Virginia runner for pod reticulation and leaf let shape, and Valencia for pod reticulation and stem pigmentation whereas Spanish bunch group did not showed diversity for any of the traits.

Key words : Characterization, Core collection, Frequency distribution, Ground nut, Principal component analysis, Shanon-Weaver diversity index. .

Groundnut is an important oil seed legume presently cultivated in 107 countries between 40°S and 40°N. The genus *Arachis* exhibit a considerable amount of morphological diversity consisting of 30 to 50 species (Gregory *et al,* 1973). These species differ with regard to various morphological descriptors like plant habit, stem, leaf, root, fruit and seed characteristics. A sound knowledge of various morphological traits in the breeding materials helps in classification, identification, naming and documentation of the entries in a crop. This hastens the process of utilization of genetic material in the crop improvement programme.

Germplasm is collected and assembled in gene banks in order to prevent genetic erosion and to broaden the genetic base of the existing varieties (or) cultivars. As a consequence, germplasm collection became huge repositories rendering them inaccessible for the economic evaluation to identify the superior sources. So, a sheer reduction in their size is very essential. Keeping this in view, Frankel (1984) proposed a core collection strategy, which is a fixed set of accessions chosen to be representative of the whole collection. Upadhyaya *et al.* (2002) suggested that mini core subset contains about one percent of total accessions but it is representative of the entire diversity of the collection. The present study reports about the characterization of mini core collection for various morphological traits.

MATERIAL AND METHODS

In the present study mini core collection consisting of 188 accessions, representative of different geographical origin as well as three breeding lines (R 9227, MN 1-28, MN 1-35) and four cultivars (GPBD-4, TAG 24, JL 24, M 28-2) were evaluated at Botanical garden of University of Agriculture Sciences, Dharwad. The experiment was laid out in a lattice square design (14 x 14) with two replications. Each genotype was grown in one row of 5 m length with a spacing of 30cm x 10cm, respectively.

Data was collected on all 195 genotypes and was used for the differentiation of the mini core collection based on descriptors of ten morphological characters. The descriptors like growth habit and branching pattern were recorded at poding stage. Stem pigmentation, stem hairiness and leaflet shape were recorded on mature plants whereas flower colour was recorded from fully opened flowers. Pod beak, pod constriction and pod reticulation were recorded from well developed and

well cleaned pods and primary seed colour was recorded within one month after harvest (IBPGR and ICRISAT, 1992).

RESULTS AND DISCUSSION

The frequency distribution for each character estimated in the mini core and subsets representing different botanical varieties are summarized in Table 1.

Growth habit:

Four classes of growth habits were observed in the mini core. As many as 76 accessions (38.9%) showed Decumbent-3 followed by 70 (35.8%) with Decumbent-2 growth habit. Similarly 33 (17%) had erect growth habit while 16 (8.2%) had Decumbent-1 growth habit. The Decumbent pattern was predominant in sub sp *hypogaea* (Virginia runner and Virginia bunch) and Valencia while Spanish bunch was characterized by the predominance of Decumbent-3 followed by erect branching.

Branching pattern:

It is the most important criteria employed in the classification of cultivated groundnut in to subspecies. As many as 96 accessions (49.2%) showed sequential, followed by 78 (40.04%) alternate, 17 (8.7%) and 4 (2.1%) with irregular without flowering on main stem and irregular with flowering on main stem, respectively. As expected, sequential branching type was predominant in Sub. Sp. *fastigiata* (Valencia & Spanish bunch) and alternate type in Sub. sp. *hypogaea* (Virginia runner & Virginia bunch).

Stem pigmentation:

Absence of stem pigmentation was observed in the maximum number of accessions except Valencia group where stem colour is present.

Stem hairiness:

It was scarce in 115 (59.0%) accessions and abundant in 80 (41.0%) accessions.

Leaf characters:

Eleven classes were observed in the mini core. Wide Elliptic (36.4%), Oblong Elliptic (20.0%) and Narrow Elliptic (15.9%) shapes were predominant followed by Orbicular (9.2%), Obovate (6.2%) and Sub-Orbicular (5.6%) while others were less frequent (1 to 2.6%).

Flower colour:

The maximum number of accessions (35.3%) exhibited Golden Yellow followed by Canary Yellow (33.8%) and Lemon Yellow (30.8%). The Golden Yellow colour was quite frequent in Spanish bunch, Virginia runner and Virginia bunch while Canary yellow in Valencia types.

Pod and kernel traits are important as they largely determine the consumer preference and marketability of the produce.

Pod beak:

As many as 83 (42.5%) showed slight pod beak, 60 (30.7%) were beakless, 37 (19.0%) with moderate and 5 (2.5%) exhibited very prominent pod beak. The slight beak was more predominant in Valencia, Virginia runner and bunch but most of the Spanish bunch lacked the beak.

Pod constriction:

It is an interesting characteristic as it affects the developing seed. It was slight in 92 genotypes followed by 59 (30.2%) moderate, 30 (15.4%) deep and 2(1%) very deep and twelve (6.2%) exhibited no pod constriction. The slight pod constriction was predominant in all the four botanical varieties besides moderate followed by deep constriction also frequent in Virginia bunch.

Pod reticulation:

It contributes to the cleanness of pods at the time of harvest and has impact on quality and marketability of the produce. The moderate reticulation was predominant in all the four botanical types in addition, slight and prominent were also apparent in Valencia and Spanish bunch.

Seed colour:

Ten seed colours were observed in the mini core. Majority of the genotypes, i.e., 80(41%) exhibited tan followed by rose (25.6%), dark red (7.6%), light red (6.6%), dark purple (6.1%) and red (5.6%) while other categories were less

Table 1. Frequency distribution of accessions for different morphological characters in minicore of groundnut.

SL. No	Character	Descriptor	Mini Core		Valencia		Spanish Bunch		Virginia Runner		Virginia Bunch	
			Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
1	Growth habit	Decumbent-1	16	8.2	05	12.8	00	0	10	30.3	01	02.1
		Decumbent-2	70	35.8	20	51.3	08	10.7	17	51.5	25	52.1
		Decumbent-3	76	38.9	14	35.9	44	56.0	03	09.0	17	35.4
		Erect	33	17.0	00	00	25	33.3	03	09.0	05	10.4
		Total	195	100	39	100	75	100	33	100	48	100
2	Branching pattern	Alternate	78	40.0	04	10.3	10	13.3	28	84.8	36	75.0
		Sequential	96	49.2	29	74.4	56	74.7	03	9.0	08	16.7
		Irregular with flowers on main stem	4	02.0	02	05.1	00	0	01	03.0	01	02.1
		Irregular without flowers on main stem	17	08.7	04	10.3	09	12.0	01	03.0	03	06.3
		Total	195	100	39	100	75	100	33	100	48	100
3	Stem hairiness	Scarce	115	59.0	19	48.7	43	57.3	22	66.6	31	64.4
		Abundant	80	41.0	20	51.3	32	42.7	11	33.3	17	35.4
		Total	195	100	39	100	75	100	33	100	48	100
4	Stem pigmentation	Absence	150	76.9	09	23.8	69	92.0	28	84.8	44	91.7
		Presence	45	23.1	30	77.0	6	08.0	5	15.1	4	08.3
		Total	195	100	39	100	75	100	33	100	48	1000
5	Leaf let shape	Cuneate	02	01.0	00	00	01	01.3	1	3.03	0	0
		Elliptic	04	02.1	01	02.8	03	03.8	0	0	0	0
		Lanceolate	02	01.0	00	00	0	0	0	0	2	4.2
		Narrow-elliptic	31	15.9	04	08.3	16	21.3	6	18.1	5	10.4
		Oblong elliptic	39	20.0	14	35.9	10	13.3	4	12.1	11	22.9
		Obovate	12	06.2	01	02.8	05	06.7	5	15.1	1	2.1
		Orbicular	18	09.2	00	00	03	04.0	6	18.1	9	18.8
		Ovate	05	02.6	02	05.6	00	0	1	3.03	2	4.2
		Sub orbicular	11	05.6	03	08.3	05	06.7	1	3.03	2	4.2
		Wide elliptic	71	36.4	14	35.9	32	42.7	9	27.2	16	33.3
		Total	195	100	39	100	75	100	33	100	48	100

frequent (1 to 3.5%). Tan seed colour was predominant in Sub.sp *fastigiata* and rose in Sub.sp. *hypogaea*. Accessions with bright colours (light red, red, dark red and dark purple) were also observed in significant frequency in Valencia.

Similar kind of morphological differences among core collection of 1704 accessions were revealed by Upadhyaya *et al.,* (2003) for stem pigmentation, branching pattern, pod beak, pod constriction, pod reticulation, and seed colour which corroborated the findings of present study. Mallikarjuna Swamy *et al.,* (2006) also revealed similar kind of results from a study on Asian core collection of 504 accessions for branching pattern, stem colour, leaf shape, pod beak, pod constriction, pod reticulation and primary seed colour which are in agreement with the findings of the present study.

Principal component analysis:

Principal component analysis (PCA) of the data was performed to investigate the importance of different traits in explaining multivariate polymorphism. The percentage of variation explained by the principal components (PCs) and

Table 1 cont....

SL. No	Character	Descriptor	Mini Core		Valencia		Spanish Bunch		Virginia Runner		Virginia Bunch	
			Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
6	Flower colour	Lemon yellow	61	30.8	13	33.3	25	33.3	10	30.3	13	27.1
		Golden yellow	69	35.3	5	12.8	28	37.3	12	36.3	24	50.0
		Canary yellow	65	33.3	21	53.8	22	29.3	11	33.3	11	22.9
		Total	195	100	39	100	75	100	33	100	48	100
7	Pod beak	Absent	60	30.7	10	25.6	33	44.0	10	30.3	7	14.6
		Slight	83	42.5	20	51.2	23	30.7	16	48.4	24	50.0
		Moderate	37	19.0	6	15.4	14	18.7	7	21.2	10	20.8
		Prominent	10	5.1	2	5.1	3	4.0	0	0.0	5	10.4
		Very prominent	05	2.5	1	2.0	2	2.7	0	0.0	2	4.2
		Total	195	100	39	100	75	100	33	100	48	100
8	Pod constriction	None	12	6.1	5	12.8	3	4.0	1	3.0	3	6.3
		Slight	92	47.1	21	53.8	36	48.0	19	57.5	16	33.3
		Moderate	59	30.2	12	30.8	25	33.3	6	18.1	16	33.3
		Deep	30	15.4	1	2.6	11	14.7	6	18.1	12	25.0
		Very deep	21	1.0	0	0.0	0	0.0	1	3.0	1	2.1
		Total	195	100	39	100	75	100	33	100	48	100
9	Pod reticulation	Slight	53	27.1	10	25.6	25	33.3	8	24.2	10	20.8
		Moderate	83	42.5	14	35.9	35	45.7	13	39.3	21	43.8
		Prominent	41	21.0	10	25.6	12	16.0	7	21.2	12	25.0
		Very prominent	18	9.2	5	12.8	3	4.0	5	15.1	05	10.4
		Total	195	100	39	100	75	100	33	100	48	100
10	Seed colour	Tan	80	41.0	10	25.6	52	69.3	7	21.2	11	22.9
		Off white	5	2.5	1	2.6	3	4.0	0	0.0	1	2.1
		rose	50	25.6	0	0.0	7	9.3	20	62.5	23	47.9
		Dark red	15	7.6	6	15.4	4	5.3	2	6.2	3	6.3
		Red	11	5.6	7	17.9	1	1.3	1	3.1	2	4.2
		Light red	13	6.6	8	20.5	3	4.0	0	0.0	2	4.2
		Brown	5	2.5	0	0.0	0	0.0	2	6.2	3	6.3
		Dark purple	12	6.1	6	15.3	6	6.6	0	0.0	1	2.1
		Salmon with purple flecks	2	1.0	1	2.7	0	0.0	1	3.1	0	0.0
		Red with white flecks	2	1.0	0	0.0	0	0.0	0	0.0	2	4.2
		Total	195	100	39	100	75	100	33	100	48	100

Table 2. Total variance explained by PCA analysis in a mini core collection of groundnut for qualitative characters.

Principal Component	Initial Eigen values			Extraction sum of squared loadings		
	Total	Variance(%)	Cumulative (%)	Total	Variance (%)	Cumulative (%)
1	2.294	22.936	22.936	2.294	22.936	22.936
2	1.447	14.470	37.405	1.447	14.470	37.405
3	1.313	13.130	50.535	1.313	13.130	50.535
4	1.097	10.967	61.562	1.097	10.967	61.562
5	1.014	10.143	71.645	1.014	10.143	71.645
6	0.840	8.403	80.048			
7	0.797	7.974	88.022			
8	0.690	6.903	94.925			
9	0.507	5.075	100.00			

Table 3. Component matrix revealed by PCA analysis for qualitative characters in a mini core collection of groundnut.

Character	Components				
	1	2	3	4	5
Growth habit	0.243	9.162E-02	0.436	0.488	-0.382
Branching pattern	0.899	0.398	7.738E-02	-1.93E-02	6.868E-02
Stem hairiness	0.899	0.398	7.738E-02	-1.93E-02	6.868E-02
Stem pigmentation	-7.26E-02	-0.225	0.711	-0.213	0.101
Leaflet shape	-0.130	-4.19E-02	-0.446	0.284	0.685
Flower colour	1.986E-03	-7.402E-02	-0.544	0.265	-0.559
Pod beak	-0.460	0.607	0.117	0.142	0.101
Pod constriction	-0.353	0.584	-0.113	-0.124	-7.82E-02
Pod reticulation	-0.486	0.582	0.178	-2.86E-03	0.136
Seed colour	-0.148	-0.123	0.231	0.791	0.178

the eigen are given in Table 2. Out of nine, first five principal components contributed significantly and explained 71.65% of total variation. The principal component analysis indicated contribution of nine characters towards divergence by the principal components. The accessions were separated based on the stem hairiness and branching pattern by PC I, pod beak, pod constriction and pod reticulation (PC II), stem pigmentation, flower colour (PC III), seed colour (PC IV), flower colour and leaf let shape (PC V) as given in the Table 3. Growth habit did not contribute any variation in mini core subset.

Shannon-Weaver diversity index:

The diversity index (H') was calculated to measure the phenotypic diversity for ten morphological characters in mini core and four botanical types as given in the Table 4. Among the ten morphological traits, seed colour (0.914) had the highest H' value while it was low for stem hairiness (0.2955) in the mini core. Among four botanical types, seed colour in Valencia (0.911) and Virginia bunch (0.778) and leaf let shape in Spanish bunch (0.618) and Virginia runner (0.797) showed the highest H' values. The diversity index (H') was lowest for stem pigmentation in Spanish bunch

Table 4. Shannon-Weaver diversity indexes for qualitative characters in a minicore and botanical groups in groundnut.

Charcter	Mini core	Valencia	Spanishbunch	Virginia runner	Virginia bunch
Growth	0.5441	0.4246	0.4033	0.4754	0.4825
habitBranching	0.4381	0.3304	0.3236	0.2595	0.3370
patternStem	0.2955	0.2983	0.2978	0.2795	0.2823
hairinessStem	0.3302	0.5113	0.1469	0.2201	0.1622
pigmentationLeaf	0.7832	0.6546	0.6176	0.7972	0.7519
let shapeFlower	0.4879	0.3855	0.4736	0.4767	0.4884
colourPod	0.5558	0.5065	0.5574	0.4447	0.5742
beakPod	0.5319	0.4661	0.4959	0.4908	0.5789
constrictionPod	0.5496	0.5652	0.5119	0.5695	0.5518
reticulationSeed	0.9135	0.9111	0.4938	0.6894	0.7781
colourAverage± S.E.	0.54298 ± 0.012	0.50536 ± 0.026	0.43218 ± 0.0153	0.4696 ± 0.024	0.4984 ± 0.03

(0.147), Virginia bunch (0.162) and Virginia runner (0.22) while it was least for stem hairiness in Valencia (0.2983). The average diversity was maximum in Valencia (0.505), followed by Virginia bunch (0.498), Virginia runner (0.469) and least in Spanish bunch (0.432). Different subsets representing botanical types showed more diversity than mini core set for some morphological traits. Virginia bunch recorded higher diversity for pod beak, pod constriction, pod reticulation and flower colour, while Virginia runner registered higher diversity for pod reticulation and leaflet shape, and in Valencia for pod reticulation and stem pigmentation. Spanish bunch group did not showed higher diversity for any of the traits. Similar kind of Shanon-Weaver diversity index among core collection of 1704 accessions were revealed by Upadhyaya *et al.*, (2003) for seed colour in *fastigiata* and for pod beak in *hypogaea* group.

From the above results, it is clear that the different botanical types exhibited considerable amount of morphological diversity which was dependent upon the trait, the botanical group and among the botanical varieties, that could be exploited for developing cultivars with unique features that are required in the new plant variety protection regime as well as for development of new plant types in groundnut.

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