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Characterization of Asian core-collection of groundnut for morphological traits

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Abstract

Asia region core collection with 504 accessions comprising 29 *fastigiata*, 230 *hypogaea* and 245 *Vulgaris* types were characterized for 14 morphological descriptors during 2000 rainy and 2000-01 post rainy seasons at Regional Research Station Raichur and Agricultural Research Station Kawadimatti, to asses the morphological diversity, to study the significant association between different traits and to know the importance of descriptor traits in the total variation. Frequency distribution of different descriptors indicated that erect type followed by procumbent-1 and decumbent-1 growth habit, alternate and sequential branching pattern, absence of stem pigmentation, subglabrous with one or two rows of hairs on the stem, light green followed by dark green leaf color, almost glabrous type of leaf surface, elliptic leaf shape, orange flower color, presence of stem pigment, 2-1 seeded pods followed by 2-3-1/2-1-3, slight to moderate beak and constriction, moderate reticulation, tan followed by red seed color dominated the core collection. The mean score for number of seeds per pod differed significantly in all three botanical varieties except growth habit, branching pattern and leaf color. But mean score for all the traits differed significantly with one or the other botanical variety. For most of the traits wider range was observed except flower color and leaf hairs and a significant association was observed between growth habit and branching pattern, growth habit and leaf color, branching pattern and leaf color in the entire collection. Between beak and pod reticulation, stem color and pod reticulation in the variety *fastigiata*. PCOA indicated that 12 out of 14 morphological traits exhibited significant correlation with either one of the botanical variety or with the entire collection appearing atleast once in the first five PCOA values. Shanon-Weaver diversity index revealed that flower color and leaf hairyness are monomorphic in nature. All the traits except growth habit, pod beak and pod reticulation in *fastigiata* and pod beak in *vulgaris* exhibited low diversity.

Key words: Groundnut, core collection, characterization

Introduction

Groundnut is an important oil seed legume presently cultivated in 107 countries located between 40's to 40'N with a world produce of 35.09 mt on 25.54 mha. In the Asia continent it is cultivated in 27 countries producing 23.40mt (66.88% of world) on 14.66 mha (55.44% of world). In Asia, India stands first on area (55.90% of Asia, 32.10% of world) and second on production (26% of Asia, 17.66% of world) after China with a productivity of 0.76 t per ha (FAO STAT 2001).

The genus Arachis exhibits a considerable amount of morphological diversity consisting of 30 to 50 species (Gregory *et al.,* 1973). These species differ regard various morphological descriptors like plant habit, stem, leaf, root, fruit and seed characteristics. A sound knowledge of various morphological traits in the breeding material helps classification, identification, naming and documentation of the entries in a crop. This hasten the process of utilization of genetic material in the crop improvement programmes. Wider variation is a prerequisite for the success of any crop improvement programme. To maintain wider variation in a crop, to prevent genetic erosion and to broaden the genetic base of the existing varieties/cultivars germplsams were collected and assembled in gene banks. As a consequence germplasm collections 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. For groundnut Upadhyaya *et al.* (2001) developed a regional core from a germplasm collection of 4738 accessions representing 21 Asian countries using Taxonomical, geographical and morphological descriptors to enhance the use of genetic resources in important programs in the region.

Mateials and method

In the present study regional core collection consisting of 504 accessions were evaluated during 2000 rainy and 2000-01 post rainy seasons at Regional Research Station Raichur and Agricultural Research Station Kawadimatti, for 14 morphological traits with the objective of assessing the morphological diversity, to study the association and to know the importance of these traits as a descriptors. The experiment received

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25 Kg N per ha, 75 Kg P2O5, 500 Kg Gypsum ha full irrigation (three irrigation in the rainy and five irrigation in the post rainy season) The observations were recorded from on healthy and competitive plants. Descriptors like growth habit, branching pattern were recorded at poding stage. Stem color and stem surface nature were recorded on mature plants. Leaf color, leaf shape and leaf surface nature were recorded at 60 days after sowing, flower color was recorded from fully opened flowers, peg color from the freshly developed pegs, pod beak, pod reticulation, pod reticulation and pod constriction from well developed and well cleaned pods. Number of seeds per pod was recorded from randomly selected well developed pods. Primary seed color was recorded within one month after harvest (IBPGR and ICRISAT 1992).

Frequency distribution and range for 14 morphological traits were calculated in each botanical variety and in the entire core collection and means of different traits were compared using Newman Keuls procedure (Newman,1939; Keul,1952). Association between different traits were estimated in the core collection. Principal Co-ordinate Analysis (PCOA) was performed on the data of morphological traits which explains the importance of each trait in polymorphism. The Shanon –Weaver diversity index(H') was calculated botanical varierty wise and in the entire core which is a measure of the phenotypic diversity of the different traits (Shanon and Weaver, 1949).

Results and discussion

The frequency distribution of the different descriptors botanical varieties wise revealed a wide variation for all the traits except for leaf surface nature and flower color (Table1).

Growth habit: Six classes of growth habits were observed. All the 29 (100%) accessions of *fastigiata*, nine accessions of *hypogaea* (3.9%) and 240 accessions (55.5%) of *vulgaris* exhibited erect type growth habit. Eighty-none accessions (25.65%) of *hypogea* and three accessions of *vulgaris* (1.12%) showed decumbent -2 type, *hypogaea* is the only variety in the core collection which displayed all six types of growth habits, decumbent-1 in 140(60.8%) accessions, procumbent-1 five accessions (2.17%) and decumbent-3 type17(7.39%) accessions.

Branching pattern: Sequential type was observed in all *fastigiata*, one *hypogaea* (0.43%) and 244(97.5%) accessions of *vulgaris*. Alternate type was exhibited by 229(99.5%) accessions of *hypogaea*

Stem color: Absence of stem pigmentation was observed in the maximum number of accessions (six *fastigiata*, 229 *hypogaea* and 239 *vulgaris*). While, 29 *fastigiata* accessions showed stem color.

Stem surface nature: Glabrous type with 1-2 rows of hairs along the main stem was observed predominantly (22 f*astigiata*, 218 *hypogaea* and 231 *vulgaris*) followed by hairy, very hairy with hairs covering almost all the surface.

Leaf color: Light green color noticed in all *fastigiata* and 232 (94.6%) accessions of *vulgaris* and green in 226 (98.20%) accessions of *hypogaea* type. Other color observed was dark green.

Leaf surface nature: All accessions of three botanical varieties exhibited glabrous type of leaf surface on both the sides.

Leaf shape: All accessions of three botanical varieties exhibited elliptic leaf shape, except one accession of *hypogaea* which was lanceolate type.

Flower color: All the accessions of three botanical varieties were monomorphic in nature for flower color having orange type.

Peg pigmentation: Only two accessions of *hypogaea* had no color, remaining 228 (99.13%) accessions of *hypogaea* and all accessions of *fastigiata* and *vulgaris* had peg pigmention.

Number of seeds per pod: Three classes were observed in the core collection class-1 with 2-1 seeded pods noticed in 2 (6.89%) *fastigiata*. 112 (48.69%) *hypogaea* and 242 (98.7%) of *vulgaris* accession. Class-2 with 2-3-1/2-1-3 seeded pods observed in one (3.40) *fastigiata*, 113(49.13) *hypogaea* and three (1.2%) accessions of *vulgaris* and class-3 with 3-2-1/3-1-2 seeded pods.

Pod beak: Slight and moderate beak character predominated the core collection. Slight beak was observed in 18(62.0%) *fastigiata*, 95(41.30%) *hypogaea* and 123 (50.2%) *vulgaris* accessions. Moderate beak in 11 (37.93) *fastigiata*, 113 (49.13%) *hypogaea* and 100 (40.8%) *vulgaris* accessions respectively. Other beak types were none and prominent type.

Pod constriction: Slight constriction (29 *fastigiata*, 204 *hypogaea* and 50 *vulgaris*) followed by moderate type (22 *hypogaea* and 190 *vulgaris*) were noticed to the maximum extent and the remaining accessions were either prominent or non type.

Pod reticulation: Moderate type (9 *fastigiata*, 210 *hypogaea* and 231 *vulgaris*) was observed in the maximum number of accessions followed by slight type (18 *fastigiata*, 8 *hypogaea* and 9 *vulgaris*). Other type observed was prominent type.

Primary seed color: Tan color was predominantly noticed (4 *fastigiata*, 200 *hypogaea* and 224 *vulgaris*) followed by red (23 *fastigiata*). Other colors were dark red, greyed orange and purple type.

Table1. Frequency distribution of various morphological traits

Traits	*fastigiata*	*hypogaea*	*vulgaris*	Total
Growth habit				
1		140(60.8)		140(27.77)
3		5(2.17)		5(0.99)
4		59(25.65)	3(1.12)	62(12.3)
5		17(7.39)		17(3.37)
6	29(100)	9(3.91)	242(98.7)	280(55.5)
Branching pattern				
1		229(99.5)	1(0.48)	230(45.63)
2	29(100)	1(3.4)	244(99.5)	274(54.36)
Stem color				
1	6(20.6)	229(99.5)	239(97.5)	474(94)
2	23(79.3)	1(0.43)	6(2.4)	30(0.59)
Stem surface				
1		1(0.43)	2(.8)	3(0.59)
3	22(75.8)	218(94.98)	231(94.4)	471(93.45)
5	7(24.1)	11(4.7)	12(4.8)	30(5.9)
Leaf color				
2	29(100)	3(1.3)	232(94.6)	264(52.38)
3		226(98.2)	13(5.3)	239(47.42)
4		1(0.43)		1(0.19)
Leaf surface				
1	29(100)	230(100)	245(100)	504(100)
Leaf shape				
3	29(100)	229(99.50)	245(100)	503(99.8)
13		1(0.43)		1(0.19)
Flower color				
5	29(100)	230(100)	245(100)	504(100)
Peg color				
1		2(0.8)		2(0.39)
2	29(100)	228(99.13)	245(100)	502(99.6)
No. of seedsper pod				
1	2(6.89)	112(48.69)	242(98.7)	356(70.6)
2	1(3.4)	113(49.13)	3(1.2)	117(23.21)
3	26(89.6)	5(2.17)		31(6.15)
Pod beak				
1		8(3.4)	6(2.4)	14(2.77)
3	18(62.)	95(41.3)	123(50.2)	236(46.82)
5	11(37.93)	113(49.13)	100(40.8)	224(44.44)
7		14(6)	16(6.5)	30(5.95)
Pod constriction				
1		2(0.8)		2(0.39)
3	29(100)	204(88.6)	50(20.4)	283(56.15)
5		22(9.5)	190(77.5)	212(42.06)
7		2(0.8)	5(2)	7(0.13)

Pod reticulation				
3	18(62)	8(3.4)	9(3.6)	35(6.94)
5	9(31)	210(91.3)	231(94.2)	450(89.28)
7	2(6.8)	12(5.2)	5(2.04)	19(3.76)
Primary seed color				
1		1(0.43)		1(0.19)
2		2(0.8)		2(0.39)
7	4(13.79)	200(86.9)	224(91.4)	428(84.9)
9		9(3.9)		9(1.78)
12		1(0.43)		1(0.19)
13	23(79.3)	9(3.91)	19(7.7)	51(10.11)
14		8(3.4)	1(0.4)	9(1.78)
17	1(3.40)		1(0.4)	2(0.39)
18	1(3.4)			1(0.19)

Mean and range of the 14 morphological descriptors are given in the Table 2. The mean score for number of seeds per pod differed significantly in all three botanical varieties. On an average growth habit, branching pattern, leaf color were not significantly different between *fastigiata* and *vulgaris*, stem pigment, stem hairs, pod reticulation and primary seed color between *hypogea* and *vulgaris* and pod constriction between *fastigiata* and *vulgaris* not differed significantly. White flower color and leaf hairyness were monomorphic traits. Except branching pattern, peg pigmentation, leaf surface in *fastigiata* and *vulgaris*, pod constriction, leaf color and growth habit in *fastigiata* and all other traits exhibited wider range.

Table 2. Mean and Range for 14 different morphological traits in Asian core collection of Groundnut.

Traits	Mean Core collection	FST	HYPO	VUL	Range Core collection	FST	HYPO	VUL
GH	4.30	6.00	2.30	5.97	1-6	6-6	1-6	4-6
BP	1.54	2.00	1.00	2.00	1-2	2-2	1-1	2-2
STC	1.06	1.79	1.00	1.02	1-2	1-2	1-2	1-2
STH	3.10	3.48	3.09	3.08	1-5	3-5	1-5	1-5
LCL	2.47	2.00	2.99	2.05	2-4	2-2	2-4	2-3
LSH	3.02	3.00	3.04	3.00	3-13	3-3	3-13	3-3
LHR	1.00	1.00	1.00	1.00	1-1	1-1	1-1	1-1
FCL	5.00	5.00	5.00	5.00	5-5	5-5	5-5	5-5
PC	1.99	2.00	1.99	2.00	1-2	2-2	1-2	2-2
NOS	1.35	2.82	1.53	1.01	1-3	1-3	1-3	1-2
BK	4.07	3.76	4.16	4.03	1-7	3-5	1-7	1-7
CN	3.88	3.00	3.21	4.63	1-7	3-3	3-7	3-7
RT	4.93	3.88	5.03	4.97	3-7	3-7	3-7	3-7
PSC	7.80	12.48	7.50	7.53	1-18	7-18	1-14	7-17

GH: Growth habit, BP: Branching Pattern, STC: Stem color, STH: Stem hairs, LCL:Leaf color, LSH: Leaf surface nature, LHR: Leaf hariryness, FCL :Flower color, PC: Pod constriction, NOS: Number of seeds per pod, BK: Pod beak, CN : Pod constriction, RT: Pod reticulation, PSC: Primary seed color. FST: *fastigiata*, HYPO: *hypogaea*,VUL: *vulgaris*.

Phenotypic correlation was estimated for 14 morphological traits. Any correlation co-efficients with more than 502 d.f with an absolute value greater than 0.1 will be significant at p=0.0001, however the proportion of variance in one trait that can be attributed to its linear relationship with a second trait is indicated by the square of the correlation co-efficient (Snedecor and Cochran 1980). Considering this criterion the correlation co-efficient with an absolute value greater than 0.7 has been suggested to be as meaningful (Skinner et al. 1999), so that more than 50% of variation in one trait is predicted by the other. In our study we found such meaningful relationship in the core collection between growth habit and branching pattern (r- 0.913); growth habit and leaf color (r= -0.877) and between branching pattern and leaf color (r= -0.928) (Table.3)

Table 3. Correlaion coefficients for 14 different mporphological traits in asian core collection of groundnut.

Traits	GH	BP	STC	STH	LCL	LSH	STRL	PC	NOS	BK	CN	RT	PSC
GH	1.000	0.913**	0.204**	0.060	-0.877**	-0.026	0.026	0.088*	-0.388**	0.032	0.622**	-0.085	0.184**
BP		1.000	0.214**	0.037	-0.928**	-0.049	0.049	0.069	-0.387**	-0.066	0.596**	-0.139	0.089*
STC			1.000	0.148**	-0.223**	-0.011	0.011	0.016	0.368*	-0.113**	-0.134**	-0.469**	0.514**
STH				1.000	-0.062	0.169**	0.010	0.014	0.115**	0.100*	0.003	-0.029	0.120**
LCL					1.000	-0.042	0.042	-0.066	0.343**	0.050	-0.559**	0.105	-0.106
LSH						1.000	0.002	0.003	0.091	0.081	-0.038	0.139	0.106*
STRL							1.000	-0.003	-0.063	-0.037	-0.049	-0.005	0.124**
PC								1.000	-0.024	0.002	0.054	-0.006	0.174**
NOS									1.000	0.049	-0.467	-0.160	0.274**
BK										1.000	0.114**	0.322**	0.055
CN											1.000	0.123**	-0.120**
RT												1.000	-0.198**
PSC													1.000

GH: Growth habit, BP: Branching Pattern, STC: Stem color, STH: Stem hairs, LCL:Leaf color, LSH: Leaf surface nature, LHR: Leaf hariryness, FCL :Flower color, PC: Pod constriction, NOS: Number of seeds per pod, BK: Pod beak, CN : Pod constriction, RT: Pod reticulation, PSC: Primary seed color.

Principal co-ordinate analysis helps to know the importance of each trait in the multivariate polymorphism in the present study per cent variation of first five PCOA was 91.15% in the entire core subset, 97.03% in *fastigiata*, 84.9% in *hypogaea* and 80.58% in *vulgaris* groups. The first and most important co-ordinate PCOA1 had variation of 32.20% in entire collection, 47.85% in *fastigiata*, 39.51% in *hypogaea* and 22.82% in *vulgaris* types. Out of 14 different morphological traits, 12 were observed atleast once in the first five PCOA scores either in one of the botanical variety or in the entire core collection. The traits were growth habit, branching pattern, stem color, leaf color, number of seeds per pod, pod constriction, stem hairs, pod beak, pod reticulation and primary seed color (Table 4).

The Shanon Weaver diversity index (H') was studied among three botanical varieties. A low H' indicated an extremely unbalanced frequency class for an individual trait and a lack of genetic diversity. The traits leaf hair and flower color exhibited zero diversity indicating monomorphic nature. Growth habit (H' = 0.458) and beak (H' = 0.435) exhibited wider diversity. Pod reticulation (H'=0.360) in *fastigiata* and pod beak in (h'=0.426) in *vulgaris* had highest diversity and for others diversity indexes were very low (data not shown).

Table 4. Principal components and Latent vectors of various traits in the entire core collection and botanical varieties

Botvar/core	Latent roots	PCOA(first five)
FST	2.88	97.03
HYPO	8.72	84.91
VUL	6.76	80.58
CORE	48.24	91.15

From the above investigation it is clear that the morphological traits exhibited considerable amount of diversity which was dependent upon the traits and the botanical group and among the botanical varieties. Diversity across the traits was highest in the *vulgaris* group. All together 12 traits out of 14 contributed to the total variation indicating importance of these traits as descriptors. Significant meaningful association was observed between three traits, growth habit, branching pattern and leaf colo,r in the entire core collection and between the traits pod beak and pod reticulation, between stem color and pod reticulation. and between stem color and pod reticulation. This indicates the the interdependance of these traits to an extent of more than 50% in their expression, which can be considered during further selection programmes. Over all the core collection provides a wider variation for most of the morphological traits which can be exploited for the development of new plant types in groundnut.

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