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Evaluation and Characterization of Groundnut (*Arachis hypogaea* L.) Germplasm Lines Following DUS Guidelines

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Short Research Article

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ABSTRACT

Crop variety identification is an essential link in seed detection, phenotype collection and scientific breeding. DUS testing is one of the important criteria to test varieties for distinctness, uniformity and stability. Effective plant breeding programme requires a basic understanding of the existence of genetic variability in a population. Evaluation and characterization of groundnut germplasm lines are

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important due to the increasing need for varietal development. Hence, in the present study morphological characterization of seventy six germplasm lines of RARS, Palem were carried out as per the descriptors provided by National Test Guidelines and UPOV for the conduct of DUS test. Out of sixteen characters under study, 2 characters were found monomorphic, three were dimorphic, nine were trimorphic and two characters were with tetramorphic, indicating that, all the characters were informative with respect to trait expression cum characterization. Based on the presence of wide variation in the groundnut germplasm lines, these can be further utilized in breeding programmes.

Keywords: Groundnut; DUS; morphological characterization; genotypes.

1. INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is a leguminous plant, that is widely cultivated in the tropics and subtropics between 40°N and 40°S latitudes. It is a valuable source of nutrients and a rich source of protein. It is an essential oilseed crop in India, holds the world's second largest producer, processor, and exporter of groundnuts, accounting for nearly 25-30% of global production after China. In India, it is cultivated in an area of 47.07 lakh ha with 101.8 lakh tonnes production and productivity of 2163 kg/ha in 2023-24 (Source: Ministry of Agriculture & Farmers Welfare, Govt. of India).

Morphological data plays an important role in management of genetic resources that are conserved in *ex-situ* gene-banks. Many tools are available to study the relationship among the cultivars, including various types of molecular markers; however, morphological characterization is the first step in the description and classification of germplasm.

Characterization of morphological variability facilitates identification of accessions with desirable characteristics such as earliness, disease resistance and improved ear trait etc. Hence, grouping of lines aids in avoidance of duplication in sampling populations for identification of varieties and hybrids (Saha et al*.,* 2024).

Genetic resources provide basic material for selection and improvement through breeding. Conservation and utilization of plant genetic resources are important components of any breeding programmes (Upadhyaya et al.,2008). The use of only few elite germplasm lines and/or cultivars in breeding programs reduces the genetic variation, leading to a narrow genetic base in the groundnut gene pool (Gupta et al., 2015). Improving the genetic potential of groundnut for qualitative and quantitative traits is one of the major objectives in most groundnut breeding programs (Upadhyaya et al., 2005). The differences in morphology act as an initial basis to differentiate one variety from other variety.

The Government of India has enacted Plant Varieties and Farmers' Rights Act, 2001 for providing protection to plant varieties based on distinctiveness, uniformity and stability test (DUS test). The characters used for DUS test are primarily morphological characters being scored in the field and laboratory or with specific markers in the field during various growth stages of the crop varietal characterization *viz.,* seed, seedling, vegetative stage, reproductive stage and maturation stage. The morphological descriptors in sequential manner are useful and convenient to distinguish the different varieties (Karthikeyan et al., 2023). Keeping this in view, the present study was carried out to differentiate 76 groundnut germplasm lines based on morphological markers as per DUS characterization.

2. MATERIALS AND METHODS

The experiment was conducted during *Rabi,* 2022 and 2023 at Regional Agricultural Research Station, Palem, Telangana. A total of 76 germplasm lines of RARS, Palem (Table 1) were evaluated in a randomized block design (RBD) with two replications and a plot size of 2 rows and 5meter length by adopting a spacing of 30 cm x 10 cm and grouped with the help of a descriptors provided by National Test Guidelines and UPOV for the conduct of DUS test. The recommended agronomic practices were followed for raising the crop. Data pertaining to 16 characters were recorded *viz*., Plant growth habit, leaflet size, leaflet color, stem pubescence, flower presence on main axis, flower arrangement on side branches, time of maturity, pod constriction, pod reticulation, pod-number of

kernels, pod-presence of beak, shelling percentage, kernel color and weight of 100 kernels.

3. RESULTS AND DISCUSSION

In the present study, 76 groundnut germplasm lines were evaluated and characterized to establish distinctiveness among the germplasm lines and these were presented below (Table 2) as per the national test guide lines for the conduct of DUS test in groundnut (Anonymous, 2009). The genotypes were studied on 16 morphological characteristics including 11 quality characteristics and 5 quantitative characteristics**,** showed wide range of variability. The frequency distribution for all the characters under study was also computed. For the plant growth habit, among the 76 germplasm lines studied, 33 were observed as erect, 40 were of semi spreading type and 3 genotypes (PGP 41, PGP 55 and PGP 73) were spreading growth habit. While studying leaflet size, observed Small (<4.0 cm) size in 65 genotypes, medium (<4. 0-6.0cm) size in 7 genotypes and none of the genotypes were observed in large leaf let size (>6 cm). The leaf let color of 23 genotypes were light green color, 19 were green color and 34 genotypes were observed as dark green leaflet color. Similar research findings were reported in crops like pearl millet (Arunkumar et al., 2004), Jute (Kumar et al., 2006), Lucerne (Dumbre et al., 2007) and maize (Yadav and Singh, 2010) for varietal identification. Based on the study on stem pubescence the genotypes were grouped as absent (18 no.), Sparse (47 no.) and medium (11 no.).

Based on the flower character, the studied 76 germplasm lines of groundnut were grouped into two categories as flower present on the main axis and Flower: Arrangement on side branches and observed that 71 genotypes were having flower present on the main axis and 5 genotypes were observed as flower absent on main axis. Same as in flower arrangement on side branches were categorized into sequential, alternate and irregular. Out of 76 genotypes 71 showed sequential, 3 (PGP 25, PGP 26 and PGP 38) were alternate and 2 genotypes (PGP 96 and PGP 123) showed irregular arrangement of flower (Gupta et al., 2010). Distinctness in Indian soybean (*Glycine max*).

Based on days to maturity, genotypes were grouped as Early (90-10 days) (2 no.), Medium (101-110 days) (71 no.) and Late (111-120 days) (3 no.) duration. Flowering traits are an important component for early maturity (Upadhyaya and Nigam, 1994) and likely for early harvest. The latter helps in avoidance of late season biotic and abiotic stress factors and also makes possible for a second crop.

Pod characters *viz*., pod constriction, pod reticulation, pod-number of kernels, pod-presence of beak and pod shelling percentage were studied. Among the 76 genotypes, pod constriction was observed as absent in 32 genotypes, shallow in 20 and medium in 24 genotypes. The pod reticulation was observed as prominent in 19 genotypes, medium in 24 genotypes and absent in 33 genotypes. Pod-number of kernels >60 % 2 seeded observed in 76 genotypes. The pod beak was present in 20genotypes and was absent in rest of the varieties. The Shelling percentage >75 was observed in 5 genotypes, medium (66-75) in 62 and Low (<66) in 9 genotypes. Shelling percentage is an index of the percentage of grains or seeds (Dapaah et al., 2014) and is one of the important selection criteria in groundnut breeding (Anothai et al. 2008).

The seed morphological characters *viz*., testa color, kernel color, kernel shape and 100 kernel weight were easy to measure and classified the groundnut varieties into few broad categories. Testa color was observed as uniform in all the genotypes studied. Based on kernel color the genotypes were grouped as, off white (1-PGP 20), tan (22), rose (52) genotypes and dark red 1 genotype (PGP 47). Based on the seed shape, the studied 76 genotypes were grouped as spheroid in 18 genotypes, cylindrical in 23 and 35 genotypes as fusiform. Maximum weight (>65 g) per 100 seeds were recorded in (PGP 151), low seed weight (>36g) were observed in 61 varieties, medium 100 seed weight (36-50g) were observed in 36 genotypes and high seed weight (51-65 g) observed in 17 genotypes. These results were in conformity with the findings of Karthikeyan et al., 2023; Rajgopal et al., 2004 in groundnut and Patra et al., (2010) in rice revealed the use of seed characters for the identification of varieties.

Studies have revealed a substantial amount of diversity present in groundnut germplasm lines, particularly in traits such as pod-number of kernels, shelling percentage, testa color, kernel color, kernel shape and 100 kernel weight. These traits play an important role in determining market and consumer preferences, making them desirable targets for improvement.

Table 1. List of genotypes used for the study of distinctiveness, uniformity and stability test

S.No.	Genotype	S.No.	Genotype	S.No.	Genotype
1	PGP -6	27	PGP-42	53	PGP -87
2	PGP- 9	28	PGP -43	54	PGP -91
3	PGP -11	29	PGP -44	55	PGP -94
4	PGP -13	3	PGP -45	56	PGP -96
5	PGP -15	31	PGP -47	57	PGP -97
6	PGP -16	32	PGP -49	58	PGP -99
7	PGP -17	33	PGP -51	59	PGP -102
8	PGP -19	34	PGP -52	60	PGP -108
9	PGP -20	35	PGP-53	61	PGP -109
10	PGP -22	36	PGP -54	62	PGP -110
11	PGP -23	37	PGP -55	63	PGP -114
12	PGP -25	38	PGP -56	64	PGP -115
13	PGP -26	39	PGP -59	65	PGP -120
14	PGP -27	40	PGP -60	66	PGP -121
15	PGP -29	41	PGP -61	67	PGP -122
16	PGP -31	42	PGP -62	68	PGP -123
17	PGP- 32	43	PGP-64	69	PGP -128
18	PGP-33	44	PGP -75	70	PGP -129
19	PGP-34	45	PGP -67	71	PGP -130
20	PGP-35	46	PGP -68	72	PGP -134
21	PGP-36	47	PGP -70	73	PGP -136
22	PGP-37	48	PGP -71	74	PGP -151
23	PGP-38	49	PGP -73	75	PGP -154
24	PGP-39	50	PGP -76	76	PGP -155
25	PGP-40	51	PGP -85		
26	PGP-41	52	PGP -86		

Table 2. Frequency distribution of Groundnut germplasm lines for DUS characters

S.No.	Characteristics	State	Note	No. of genotypes	Frequency distribution %
1	Plant: Growth habit	Erect	1	33	43.42
		Semi spreading	2	40	52.63
		Spreading	3	3	3.95
2	Leaflet: Size (fully developed basal leaflet)	Small (<4.0 cm)	3	69	90.78
		Medium (<4. 0 – 6.0cm)	5	7	9.21
		Large(>6.0cm)	7	0	5.26
3	Leaflet:Colour	Light green	1	23	30.26
		Green	2	19	25.00
		Dark green	3	34	44.74
4	Stem:Pubesence	Absent	1	18	23.68
		Sparse	3	47	61.84
		Medium	5	11	14.47
5	Flower:Presence on main axis	Absent	1	5	6.58
		Present	9	71	93.42
6	Flower: Arrangement on side branches	Sequential	1	71	93.42
		Alternate	2	3	3.95
		Irregular	3	2	2.63
7	Time of maturity (For curing)	Very early (<90 days)	1	0	0.00
		Early (90-10 days)	3	2	2.63
		Medium (101-110 days)	5	71	93.42
		Late (111-120 days)	7	3	3.95
		Very late(>120 days)	9	0	0.00

S.No.	Characteristics	State	Note	No. of genotypes	Frequency distribution %
8	Pod: Constriction	Absent	1	32	42.11
		Shallow	3	20	26.32
		Medium	5	24	31.58
		Deep	7	0	0.00
9	Pod: Reticulation	Absent	1	33	43.42
		Medium	3	24	31.58
		Prominent	5	19	25.00
10	Pod: Number of kernels (on100 pod basis)	>60 % 2 seeded	1	76	100.00
		>60 % 3 seeded	3	0	0.00
		>60 % 4 seeded	5	0	0.00
11	Pod: Presence of beak	Absent	1	56	73.68
		Present	9	20	26.32
12	Pod: Shelling percentage	Low (<66)	3	9	11.84
		Medium(66-75)	5	62	81.58
		High (>75)	7	5	6.58
13	Testa colour	Uniform	1	76	100.00
		Variegated	9	0	0.00
14	Kernel: Colour of testa (varieties wit monochrome testa only)	White (1 A 1)	1	0	0.00
		Off white (1 A 2)	2	1	1.32
		Tan (12 E 4)	3	22	28.95
		Rose (Grayish red 8 B3)	4	52	68.42
		Purple (14 F 4)	5	0	0.00
		Dark purple(14 F 7)	6	0	0.00
		Salmon (6 A 4)	7	0	0.00
		Red (10 B 7)	8	0	0.00
		Dark red (11 C 8)	9	1	1.32
15	Kernel: Shape	Spheroid	1	18	23.68
		Cylindrical	2	23	30.26
		Fusiform	3	35	46.05
16	Kernel: Weight of 100 kernels (about 9 % moisture)	Low (<36 g)	3	22	28.95
		Medium (36-50 g)	5	36	47.37
		High (51-65 g)	7	17	22.37
		Very high (>65 g)	9	1	1.32

4. CONCLUSION

Frequency distribution of traits for DUS characterization of groundnut germplasm lines indicated that wide variation existed among different genotypes which could be better utilized in the selection of parents based on their specific requirement for further breeding programmes. The diversity among the different genotypes could be utilized for cultivar improvement and germplasm conservation programs aimed at improving productivity of groundnut.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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