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IDENTIFICATION OF SUPERIOR GENOTYPES BASED ON MORPHOLOGICAL, PHYSIOLOGICAL AND AGRONOMIC TRAITS IN LOCAL AND EXOTIC COWPEA GERMPLASM

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Abstract

One hundred and thirty eight local as well as exotic accessions of cowpea were characterized and evaluated under field conditions at 33° 42 N latitude and 73° 08 E longitude at an altitude of 540 masl during summer 2000. The germplasm represents three continents (Asia, Africa, North America) and collected germplasm represents a wide ecogeographic range from dry mountainous regions to irrigated plains of Pakistan with altitude ranging from 0 to 1995 masl. Morphological traits (leaf shape, plant type, twinning tendency, flower color, immature pod color, mature pod color) and agronomic characters (chlorophyll contents, leaf area trifoliate^{-1}, days to first flower, days to 50% flowering, days to maturity, plant height, branches^{-1}, pods plant^{-1}, 100-seed weight and grain yield plant^{-1}) were recorded for presentation. For qualitative traits, a considerable level of variability was observed for most of the characters and these can be used for species relationship along with allozymes. High range and variance for all the agronomic characters except branches plant^{-1} indicated that improvement in cowpea could be successful by simple selection. The classification of germplasm gave rise to some elite lines for specific characters and the accessions for various characters and it was observed that some of these accessions possessed desirable genes for more than one character and hence these could be utilized directly or included in hybrid programme for varietal development. The accessions, 27075, 27094, IT 90K-277-2-1 were observed better for physiological traits, whereas 27001, 27120, 27124, IT 82F-16, IT 85F-867-5, IT 95K-181-9, 27108, 27011 and IT 93K-637-3 were observed better for yield contributing traits. It is suggested to use selected lines from local and exotic sources to develop physiologically efficient cultivars with high yield potential.

Introduction

Plant biodiversity provides a tremendous array of benefits to humanity. One component of biodiversity is plant genetic material (Anwar, 1999). Germplasm is a vital resource in generating new plant types having desirable traits that help in increasing crop production and thus improve the level of human nutrition. The genus *Vigna* is pantropical comprising of about 170 species, 120 in Africa, 22 in Indo-Pakistan subcontinent and south east Asia and a few from other parts of the world out of which 7 are cultivated (Ghafoor *et al.*, 2001; Ghafoor *et al.*, 2002).

Cowpea is an important tropical crop that is indigenous to Africa from where it was introduced to other tropical and sub-tropical countries (Cobley & Steele, 1976), most of which are found in Africa, Asia and America (Faris, 1965; Verdcourt, 1970; Anishetty & Moss, 1987). The nutritional value of cowpea lies in its protein contents of 20-50%. It is a cheap source of quality protein, phosphorus, iron and vitamins and therefore, an excellent substitute of meat, eggs and other protein sources (Carangal *et al.*, 1979). It is cultivated on marginal soils in Pakistan, especially in NWFP and Northern Punjab on an area of about 16.9 thousands hectares with an annual production of 7.8 thousand metric tones (Bashir, 1992).

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One of the approaches for building gene pool is to collect material from diverse geographical origins with a concentration of accessions from proposed centers of diversity in individual samples. Representative samples from the complete geographical range of the crop species can help to ensure conservation of co-adapted gene complexes (Frankel, 1984; Frankel & Soule,1981; Frankel *et al.*, 1995; Brown, 1978; Beuselinch & Steiner, 1992). The crop has a great potential in NWFP and Northern Punjab where it is already cultivated. By introduction of improved cultivars and cultural practices, the yield can be increased substantially. According to Shorter *et al.*, (1991) genetic improvements could be accelerated if physiological attributes were used as selection criteria. The present study was conducted to investigate the extent of genetic diversity on the basis of qualitative and quantitative traits and to identify superior genotypes.

Material and Methods

One hundred and thirty eight accessions of cowpea germplasm (local and exotic) were planted in an augmented design under field conditions at Plant Genetic Resources Institute (PGRI), National Agricultural Research Centre (NARC) Islamabad, during summer 2000 to study genetic diversity. This centre is situated at 33° 42 N latitude and 73° 08 E longitude at an altitude of 540 masl.

Germplasm was provided by the genebank of Plant Genetic Resources Institute (PGRI) National Agricultural Research Centre (NARC), Islamabad, which has been collected from different parts of the country. The exotic germplasm was obtained from International Institute of Tropical Agriculture (IITA), Nigeria (49 genotypes), University of Riverside, California, USA (4 genotypes) and China (1 genotype). The germplasm collected from the country represents a wide ecogeographic variation from dry mountainous regions to irrigated plains and sandy arid region of Pakistan. One check, local cowpea was included in this study after every 10 rows. One row of 4 m length was planted for each accession with 75 cm row spacing whereas plant spacing was 20 cm. Recommended cultural practices were followed throughout the crop season to get healthy crop. Pesticides were sprayed twice to save the crop from infestation of pests especially white fly, a vector for BICMV, CABMV. Plant and agronomic characters were recorded following IPGRI (Anon.,1983) descriptors for *Vigna* spp. For agronomic characters, 10 plants of each accession were sampled at random for data collection.

Morphological plant traits were recorded for leaf shape, plant type, twinning tendency, flower color, immature pod color, mature pod color. Leaf shape was taken as ovate, lanceolate narrow, lanceolate broad and rhombic. Plant type was recorded as erect, prostrate, pronounced and spreading type. Twinning tendency was observed visually as presence or absence. Flower color was recorded at full blooming, when flowers fully opened. Green pod and mature color was observed at particular stage of the pods.

Days to first flower, days to 50% flowering and days to maturity were recorded on line basis and represent one value for each accession. Other quantitative data like, chlorophyll contents, leaf area trifoliate^{-1}, plant height, number of branches, pods plant^{-1}, grain yield plant^{-1} were recorded on 10 plants sampled at random and then averaged for analyses. The weight of 100 seeds were determined with the help of an electric balance.

The data were averaged and subjected to simple statistics including means, standard deviation and range using computer software MS Excel 2000. The promising accessions were identified on the basis of their performance for future utilization by the breeders working on cowpea.

Results and Discussion

Classification for qualitative traits presented in Table 1 revealed that the ovate leaf shape was predominant followed by lanceolate leaf shape. Most of the accessions were erect having twinning tendency. Qualitative characters are important for plant description and are mainly influenced by the consumers preference, socio-economic scenario and natural selection (Kurlovich, 1998; Nakayama *et al.*, 1998). Erect plant types could be exploited for breeding genotypes under irrigated areas whereas prostrate types with high twinning tendency could be exploited for developing superior cultivars for rainfed area that will help in moisture conservation. For qualitative traits, a considerable level of variability was observed for most of the characters and these can be used for species relationship along with allozymes (Pasquet, 1999). Plants with ovate and rhombic leaf shape are expected to be the best for moisture absorption and synthesis of food proteins while, lanceolate leaf shape in most cases were found to be drought tolerant and hence the plants with these characters could be utilized for breeding and hybridization of local and exotic cowpea in rainfed conditions. These results are similar to those reported by Sonawane & Patil (1991) and Dwivedi *et al.*, (1999).

Basic statistics for quantitative characters presented in Table 2 revealed high variance for all the characters except number of branches where, a low variance was observed. High range and variance indicated that improvement in cowpea could be successful by simple selection for most of the characters whereas, for branches, there is a need to explore more germplasm through expeditions or acquisition. A wide range of variability was observed in leaves, number of branches, days to flowering and maturity by Dwivedi *et al.*, (1999). Leaf area trifoliate^{-1}, plant height bearing characters was found to be suitable for selection of high yielding lines, these lines can be used in hybridization programs. This character with low genetic variance needed to be improved by acquiring germplasm from other sources or using breeding techniques like wide hybridization or mutation.

Evaluation and classification of broad base germplasm needs to be built up by making extensive local collection and obtaining germplasm from abroad to develop a sound breeding programme (Jain *et al.* 1975; Ghafoor *et al.* 1992). Laghetti *et al.*, (1998) advocated that maximum genetic conservation would be achieved by sampling population from as many environments as possible. The classification of germplasm as presented in Table 3 gave rise to some elite lines for specific characters and the accessions for chlorophyll contents (6), leaf area (8), days to first flower (6), days to 50% flowering (24), days to maturity (14), plant height (19), pods (12), seed weight (13) and grain yield (11). It was observed that some of these accessions possessed desirable genes for more than one character and hence these could be utilized directly or included in hybrid programme for varietal development. Selection on the basis of best performance has already been suggested by many researchers like Donald, (1962), Lal, (1967), Singh, (1977), Singh *et al.*, (1980) and Khan & Malik (1989).

The accessions which proved better for more than two traits were identified for future utilization as presented in the Table 4. Out of these, 27075, 27094, IT 90K-277-2-1 were observed better for physiological traits, whereas 27120, 27124, 27001, IT 82F-16, IT 85F-867-5, IT 95K-181-9, 27108, 27011 and IT 93K-637-3 were observed better for yield contributing traits. Out of these 12 accessions, 7 were local and others were exotic from IITA, Nigeria. It is suggested to use selected lines from local and exotic sources to develop

Table 1. Summary of statistics for qualitative traits in cowpea.

Traits	Frequency	Percentage	Traits	Frequency	Percentage
Leaf shape			**Flower color**		
Ovate	96	69.57	White	43	31.16
Lanceolate narrow	10	7.25	Purple	82	59.42
Lanceolate broad	29	21.01	Yellow	30	9.42
Rhombic	3	2.17			
Plant type			**Immature Pod color**		
Erect	93	67.39	Green color	85	61.59
Prostrate	34	24.64	Light green	38	27.54
Pronounced	5	3.62	Purple green tip	8	5.79
Spreading	6	4.35	Light green tip	7	5.08
Twinning tendency			**Mature pod color**		
Present	128	92.75	Cream color	21	15.22
Absent	10	7.25	Spotted cream color	10	7.25
			Brown	75	54.34
			Spotted green	21	15.22
			Violet color	11	7.97

Table 2. Range, means and variance in 138 accessions of cowpea for ten physiological and agronomic traits.

Traits	Minimum	Maximum	Mean ± SE	Variance
Chlorophyll contents (mg)	13.00	47.70	25.77 ± 0.50	34.51
Leaf area trifoliate leaves^{-1}	19.02	608.44	254.78 ± 9.97	13709.77
Days to first flower	35	94	45.78 ± 0.64	56.01
Days to 50% flowering	41	101	54.38 ± 1.00	138.88
Days to maturity	55	116	75.38 ± 1.03	145.62
Plant height (cm)	15.2	176.8	101.17 ±2.93	1183.89
Number of branches plant^{-1}	3.0	11.2	7.04 ± 0.14	2.54
Pods plant^{-1}	0.50	50.1	16.56 ± 0.83	93.94
100 seed weight	0.95	26.53	10.71 ± 0.50	34.08
Grain yield	0.27	31.52	8.50±0.50	33.97

Table 3. Selection of promising genotypes on the basis of individual characters.

Traits	Ranges	Selected accessions
Chlorophyll contents (mg)	> 35	27075, 27078, 27120, 27124, 27161, IT90K-277-2-1
Leaf area trifoliate leaves^{-1}	> 450	27001, 27012, 27075, IT82F-16, IT85F-867-5, IT90K-277-2-1, IT94U-461-4, IT97U-440-3
Days to first flowering	< 40	27001, 27094, 27099, 27108, IT85F-1380-1, IT95K-181-9
Days to 50% flowering	< 45	27001, 27011, 27025, 27038, 27042, 27052, 27078, 27098, 27099, 27122, 27124, 27125, 27141, 27143, 27151, 27156, 27170, IT84D-449, IT85F-867-5,IT90K-277-2-1, IT93K-734,IT94U-440-3-1, IT96D-740, UCR-8517
Days to maturity	< 60 days	27047, 27082, 27091, 27105, 27001, 27003, 27005, 27006, 27008, 27009, 27088, 27097, 27110, 27115
Plant height(cm)	< 70	27088, 27106, 27118, 27141, 27144, 27147, 27150, 27161, 27172, Cowpea (LS) local cowpea, IT845-2246-4, IT93U-2045-29, IT94U-440-3-1, IT95K-181-9, IT95K-193-12, IT95K-207-21, IT96D-651, IT96D-772, VN-98
Pods plant^{-1}	> 30	27008, 27011,27104, 27108, 27110, 27120, 27170, IT82F-16, IT84-S-448, IT85F-2687, IT90K-277-2, IT91K-118-20
100 seed weight	> 20	27022, 27027, 27042, 27088, 27093, 27109, 27124, 27140, 27141, IT82F-16, IT85F-2687, IT93U-2045-29, IT95U-456-3
Grain yield (g)	> 15	27003, 27009, 27044, 27082, 27097, 27123, 27147, 27167, 27171, IT84D-448, IT93K-637-3

Table 4. Identification of physiologically efficient high yielding local as well as exotic accessions of cowpea for future utilization.

Accession	Source	Traits for which selected
27075	Pakistan	Chlorophyll contents, leaf area trifoliate leaves^{-1}, days to 50% flowering, days to maturity
27094	Pakistan	Chlorophyll contents, days to first flower, days to 50% flowering, days to maturity
27120	Pakistan	Chlorophyll contents, days to 50% flowering, pods plant^{-1}
27124	Pakistan	Chlorophyll contents, days to 50% flowering, pods plant^{-1}, 100 Seed weight
IT90K-277-2-1	IITA	Chlorophyll contents, leaf area trifoliate leaves^{-1}, days to 50% flowering
27001	Pakistan	Leaf area trifoliate leaves^{-1}, days to first flower, days to 50% flowering, days to maturity, number of branches, pods plant^{-1}
IT82F-16	IITA	Leaf area trifoliate leaves^{-1}, pods plant^{-1}, 100 seed weight
IT85F-867-5	IITA	Leaf area trifoliate leaves^{-1},days to 50% flowering, pods plant^{-1}
IT95K-181-9	IITA	Leaf area trifoliate leaves^{-1}, plant height, pods plant^{-1}
27108	Pakistan	Days to first flower, days to maturity, pods plant^{-1}
27011	Pakistan	Days to first flower, days to maturity, number of branches, pods plant^{-1}
IT93K-637-3	IITA	Days to 50% flowering, pods plant^{-1}, grain yield

IITA = International Institute of Tropical Agriculture, Ibadan, Nigeria.

physiologically efficient cultivars with high yield potential. From the present investigation, it was concluded that cowpea germplasm preserved in the genebank of PGRI displayed a wide range of variance for most of the traits studied and that there were few accessions with unique characters. This could enable the breeders to identify, select and combine landraces to obtain important traits in one line with a broad genetic base.

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