

Original Research Article

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Morphological Evaluation of Cowpea (*Vigna unguiculata*) L. Walp. Genotypes for Drought Tolerance & Yield Enhancement

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ABSTRACT

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The characterization and variability analysis of cowpea genotypes provides valuable information about parental selection for strengthening the future breeding programme in cowpea. Eleven cowpea genotypes are used in investigation. Genetic parameters like range, mean, standard error, variance, standard deviation calculated among nine quantitative traits and five qualitative traits of cowpea. Phenotypic coefficient of variation values was relatively higher than the genotypic coefficient of variation for all the traits studied. High heritability with high genetic advance was reported in plant height, days to 50 percent flowering, days to first flower maturity, number of pods per plant and single plant yield. While high heritability with low genetic advance was noted in number of seeds per plant, pod length, number of branches per plant and 100 seed weight. In addition, proline analysis was conducted to isolate the drought resistant cowpea genotype. Among the eleven genotypes, VBN 3 is identified as the superior genotype for yield enhancement as well as drought tolerance.

Introduction

Cowpea (*Vigna unguiculata* (L.) Walp) is a widely grown legume food crop of the tropics and sub tropics. It belongs to the family Leguminaceae and its Centre of origin is Africa. Cowpea is highly self-pollinated crop due to its pollinating ability it can be easily used for breeding studies. Genetic variability plays an important part in the success of any breeding programs. Identifying

drought-resilient genotypes is the most critical step toward sustaining crop yields under future climate pressures. Physiological, morphological, or phenological criteria could be implemented to select the improved adaptation to dry environments (Blum, 1988). Traditionally, variability is estimated by measuring variation in phenotypic or qualitative traits (leaf shape, time to maturity, plant type, flower color, seed type, seed color, seed size, hilum color) and quantitative agronomic

traits. It was aimed at identifying photo-thermo insensitive genotypes of traits suitable for hot arid environments.

Proline analysis in cowpea is commonly performed to assess the level of stress tolerance among different varieties. The estimation is generally carried out using the colorimetric method developed by Bates *et al.*, (1973) in which proline reacts with acid ninhydrin to produce a reddish-colored complex. The intensity of the color is measured using a spectrophotometer, typically at a wavelength of 520 nm, and the proline concentration is expressed in micromoles per gram ($\mu\text{mol g}^{-1}$) of fresh weight. The results of proline analysis provide information regarding the adaptive mechanisms of cowpea under adverse environmental conditions. The present study was carried out in eleven cowpea genotypes for 9 quantitative and 6 qualitative traits for drought tolerance and yield improvement.

Materials and Methods

The field experiment was conducted during April-July 2026 at Imayam Institute of Agriculture and Technology (IIAT). IIAT farm is located at 11.1029°N and 78.5676°E and 547 meters above mean sea level (MSL) and received annual rainfall of 669mm the minimum and maximum temperatures were 28.6°C and 39.7°C respectively. The soil texture of the field site was sandy loam soil with the pH 8.6. The experiment was laid out in Randomized Block Design with three replications.

The experimental materials consisting of eleven cowpea genotypes (Co1, Co2, Paiyur1, VBN1, VBN2, VBN3, Co(FC)8, Co5, Co(CP)7, Bisbee, Co6) were raised during May 2026. These eleven genotypes were obtained from National Pulse Research Institute (NPRC), Vamban.

Treatments were randomly arranged in each replication divided into 3 plots. The gross area of experiment was 150m² and cash plot size was 5*4 m. The row-to-row spacing with 45 cm and plant to plant distance was 15cm. Sowing was done by dibbling the seeds, row-to-row recommended package of practices were followed to raise a healthy crop and the necessary prophylactic measures were adopted against pest and disease.

Five randomly selected plants from each of the replications were tagged and observations were taken from these tagged plants at various stages of the crop

plant growth. Data were recorded for fifteen characters viz., Days to 50% flowering, Days to first flower maturity, Plant height (cm), Pod length (cm), Number of pods per plant, Number of seeds per pod, Number of branches per plant, 100 seed weight (gm), Single plant yield (gm/plant), flower colour, pod colour, seed coat colour, leaf texture, seed shape and terminal leaf shape. The mean data recorded from each replication was subjected to statistical analysis using OPSTAT and STAR statistical packages. The evaluation criteria for drought-resilient types are based on standard methods to assess proline analysis for drought tolerance, and the acid-ninhydrin colorimetric assay to screen the best genotypes for proline accumulation.

Result and Discussion

The present study indicates that all eleven cowpea genotypes showed considerable variation for the majority of the characters. The genotypes under study and frequency distribution of each descriptor for eleven cowpea genotypes were recorded. Cowpea genotypes were grouped into different classes based on observation recorded in the field at various stages of plant growth. Genetic variation in nine quantitative traits showed high variability in eleven cowpea genotypes

Among the eleven cowpea genotypes the superior traits were recorded in VBN3. It possesses the yield contributing character exhibit remarkable variability among the genotypes. The highest number of branches per plant was recorded in VBN3 (6.66), number of seeds per pod (12.36), 100 seed weight (18.08 gm), days to first flower maturity (54.16 days) followed by pod length (17.33 cm), days to 50 % flowering (40.67 days), number of pods per plant (39.33) and single plant yield (186.73 gm/plant).

The superior genotype that followed by VBN3 is Co(CP)7. It possess superior traits in the Number of seeds per pod (13.47) followed by Number of branches per plant (6.33), 100 seed weight (13.17 gm), Single plant yield (180.10 gm/plant), Number of Pods per plant (37.67). Among the evaluated genotypes, Co(FC)8 marks the third highest mean performance among the genotypes. It recorded the superior trait in Single Plant yield (208.56 gm/plant), Plant height (111.35 cm) followed by Days to first flower maturity (58.36 days).

Phenotypic coefficient of variation values was relatively higher than the genotypic coefficient of variation.

Graph.1 Mean performance of eleven cowpea genotypes for nine quantitative traits

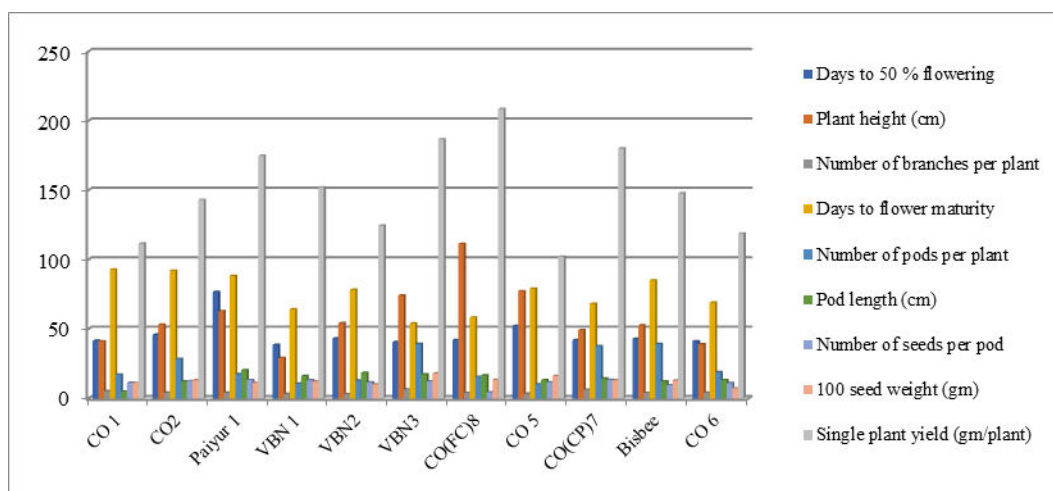


Fig: 1 Flower colour variation



Fig: 2 Terminal leaf shapes



Fig: 3 Pod length

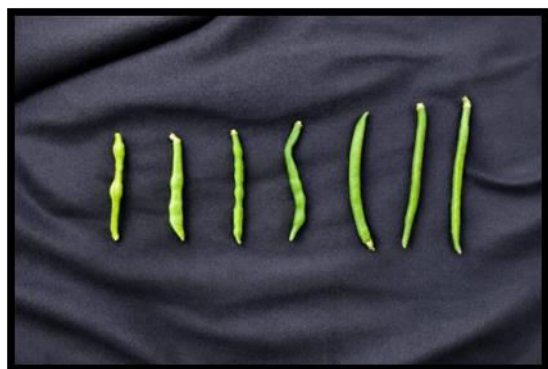


Fig: 4 Seed coat colour



Table.1 Morphological characterization of six qualitative traits in eleven cowpea genotypes

Genotypes	CO1	CO2	VBN1	VBN2	VBN3	Paiyur1	Bisbee	CO(CP)7	CO(FC)8	CO5	CO6
Seed coat color	Reddish brown color	Brown with irregular patches	Creamy white, white	Ivory, mottled	Light brown	Brown (or) reddish brown	Jet black, shiny black	Brown (or) reddish brown	Tun light brown	Yellowing with grey dotting	Cream colored
Seed shape	Kidney	Kidney	Kidney	Kidney	Kidney	Rhomboid to reniform	Globose round	Rhomboid	Globose, oval	Kidney	Kidney (small size)
Pod color	Light green to greenish white	Dark green pods	Greenish white	Light green	Creamy white, light green	Green to straw at maturity	Dark green to brownish black	Greenish white (or) light green	Dark green	Dark green	Dark green
Flower color	Violet	Violet	Yellow elite	Light purple	Light purple	Light purple	Light purple	Light to white, purple	Pale to dark purple	Violet	Violet (or) purple
Leaf shape	Broad, ovate	Broad ovate	Cuneate (wedge shaped)	Ovate (egg shape)	Spherical (or) spear shape	Ovate lanceolate	Broad sub - globose	Ovate lanceolate, sub globose	Broadly ovate to hastate	Ovate	Sub-globose
Leaf texture	Hairless, glossy	Hairless glossy	Glabrous	Glabrous	Glabrous	Smooth	Leathery glossy	Smooth	Moderately rough, veiny	Small	Thin papery

Table.2 Estimates of genetic parameters for nine quantitative traits in cowpea

Characters	PCV (%)	GCV (%)	h ² (%)	GA	GAM (%)
Days to first flower maturity	18.13	17.98	98.34	27.67	36.74
Days to 50% flowering	23.36	23.23	98.87	21.94	47.57
Plant Height (cm)	39.33	38.04	93.52	44.39	75.77
No. of pods/plant	49.17	47.55	93.49	20.58	94.71
No. of seeds/pod	26.22	21.91	69.81	4.20	37.71
Pod length (cm)	29.89	27.18	82.64	7.36	50.90
No. of branches/plant	30.32	28.87	90.61	2.42	56.60
100 Seed weight (gm)	23.75	23.19	95.31	5.82	46.64
Single plant yield (gm/plant)	22.87	22.84	99.73	70.48	46.98

Table.3 Drought tolerant parameters of eleven cowpea genotypes

Treatments	Chlorophyll stability index (%)	Total chlorophyll content (mg/g)	Proline (mg/g)
CO 1	94	0.87	1.4
CO 2	87	0.75	1.2
VBN 1	85	0.67	1.2
VBN 2	70	0.42	1.1
VBN 3	75	0.52	1.2
Paiyur 2	98	0.98	5.5
Bisbee	96	0.90	3
CO(CP)7	80	0.57	1.3
CO(FC)8	90	0.82	1.3
CO 5	83	0.62	1.4
CO 6	92	0.49	0.7
Mean	86.36	0.69	1.75
SD	25.9	0.22	1.23
CD	0.01**	0.01**	0.01**

The PCV ranges 18.13 – 49.17 percent for nine quantitative traits. The genotypic coefficient of variation which gives extend of genetic variability ranges 17.98 – 47.55 percent for various traits. The high GCV traits number of pods per plant and plant height were recorded. The highest PCV recorded in number of pods per plant, plant height, Number of branches per pod. Here PCV is greater than GCV therefore, the environment influences the expression of the trait Nalawade *et al.*, (2021).

The highest heritability value was registered by days to 50 percent flowering, single plant yield and plant height indicating preponderance of additive gene expression of this trait and they can be improved through individual plant selection. The highest genetic advance value was relatively higher in days to 50 % flowering (27.67 days), days to first flower maturity (21.94 days), plant height (44.39 cm). Higher heritability and higher genetic advance denote additive gene action predominates so that traits can be recommended for early generation selection in future cowpea breeding, while high heritability with low genetic advance indicates the predominance of non-additive gene action in trait expression that can be forwarded for later generation selection Menssen *et al.*, (2017).

Drought tolerant parameters were illustrated in table 3. In that the maximum chlorophyll content value had been recorded in VBN3 (0.98 mg/g) followed by Co(FC)8 (0.90 mg/g) and Co(CP)7 (0.87 mg/g) whereas the lowest value in VBN 1 (0.42mg/g) Carvalho *et al.*, (2019). The maximum Chlorophyll Stability Index has been observed in VBN3 (98%) followed by Co(FC)8 (96%) and Co(CP)7 (94%) and the lowest value have been recorded in VBN 1 (70%). The study validates proline regulation as a critical metabolic marker for stress tolerance; highest proline accumulation recorded in VBN 3 (5.5mg/g) followed by Co(FC)8 (3mg/g) and Co(CP)7 (1.4mg/g) and the lowest value has been recorded in CO6 (0.7mg/g).

By the variability analysis for quantitative traits and qualitative traits, it is concluded that VBN3 is the best superior parental genotype for both drought tolerance and yield enhancement. VBN 3, Co(CP)7 and Paiyurlare considered as superior parents for the yield improvement while VBN 3, Co(CP)7, Co(FC)8 is recommended as parental material for stress resistance breeding particularly drought in future cowpea breeding programme.

Author Contributions

R. Suguna: Investigation, formal analysis, writing—original draft. S. Keerthana: Validation, methodology, writing—reviewing. R. Anuja:—Formal analysis, writing—review and editing. K. Atchaya: Investigation, writing—reviewing. S. Dharani: Resources, investigation writing—reviewing. R. Gayathri: Validation, formal analysis, writing—reviewing. R. Geerthana: Conceptualization, methodology, data curation, supervision, writing—reviewing the final version of the manuscript. B. Glory Grace Praveena: Investigation, formal analysis, writing—original draft. D. Harshavarthini: Validation, methodology, writing—reviewing. S. Yuvadharanipriya:—Formal analysis, writing—review and editing.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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