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Evaluation of Morphological Traits in Cowpea [*Vigna unguiculata* (L.) Walp.] Genotypes Cultivated in North-East India

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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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ABSTRACT

The present study was conducted during the kharif season 2022 at the Vegetable Research Farm, located within the College of Horticulture and Forestry at Central Agricultural University in Pasighat, East Siang, Arunachal Pradesh, India to investigate “Evaluation of Morphological Traits in Cowpea [Vigna unguiculata (L.) Walp.] Genotypes Cultivated in North-East India”. These morphological traits demonstrated significant variation among the twenty locally accessible genotypes. Qualitative traits such as growth habit, twining habit, foliage colour, leaflet shape, flower colour, pod shape, pod colour, seed shape, seed colour were recorded. Quantitative characters such as days to 50% flowering, plant height (cm), leaf area (cm²), number of clusters per plant, number of pods per cluster, number of pods per plant, pod length (cm), pod width (cm), days to harvest, number of seeds per pod, 100 seed weight (g) and pod yield per plant (g) were studied. The mean performance revealed that CHF CP-12 gave highest pod yield per plant (589.19 g), highest 100 seed weight in CHF CP-12 (24.67 g), longest pod length in CHF CP-5 (32.77 cm), longest pod width in CHF CP-10 (1.07 cm), maximum number of clusters per plant was recorded in CHF CP-12 (14.16), maximum number of pods per plant in CHF CP-17 (11.80) and maximum leaf area was recorded in CHF CP-6 (229.30 cm²). The minimum number days taken for 50% flowering was found in genotypes CHF CP-9 (45.67).

Keywords: Cowpea; genetic diversity; landraces; variation; genotype.

1. INTRODUCTION

Cowpea (*Vigna unguiculata* (L.) Walp.) is a versatile and resilient leguminous crop of significant agricultural importance, cultivated for various purposes, including grain pulses, vegetables, and fodder, particularly in regions characterized by humid and semi-arid climates. Its ability to thrive in drought-prone conditions and nitrogen-fixing capabilities make it suitable for growth in nutrient-poor sandy soils [1]. Additionally, as a forage crop, cowpea is known for its rapid growth, high yields, and substantial biomass production [2]. It occupies a substantial portion of agricultural land, with 0.3 million hectares out of a total of 0.65 million hectares allocated to various pulse and vegetable cowpea types. Cowpea holds the distinction of being the most vital Kharif fodder and pulse crop, suitable for both irrigated and rainfed areas [3].

Cowpea's nutritional composition is noteworthy, boasting an average content of 16.63% crude protein, 48.15% neutral detergent fiber, 36.10% acid detergent fiber, 28.44% crude fiber, 10.54% ash, and 2.91% ether extract, in addition to 20.45 mg/g of sugar and 32.31 mg/g of starch [4]. Its seeds are a highly nutritious and cost-effective source of protein, serving both human and animal nutrition needs. Cowpea seeds contain approximately 25% protein and 64% carbohydrate, making them an exceptional source of green and dry fodder, particularly rich in lysine and tryptophan amino acids compared to other fodder crops [5].

Northeast India, renowned as one of the world's biodiversity hotspots, encompasses eight states: Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura. However, despite its vast geographical expanse, only 12% of the region is available for cultivation due to its predominantly hilly terrain. This geographical challenge is further compounded by significant health issues, including anaemia and child malnutrition. Surprisingly, despite these challenges, the region maintains a pulse yield (848 kg/ha) that surpasses the national average, owing in part to its naturally acidic soils [6].

The primary objective of this experimental study is to uncover valuable genetic variability within cowpea genotypes found in Northeast India. This study places particular emphasis on traits of agronomic significance, especially those related to yield-attributing parameters and nutritional quality. To achieve this goal, we conducted a comprehensive exploration of twenty distinct cowpea genotypes native to the region, in addition to one reference variety. Our investigation specifically targeted an in-depth assessment of their morphological characteristics. This research is vital for addressing the unique agricultural and nutritional challenges faced by Northeast India and enhancing cowpea's contributions to the region's food security and sustainable agriculture.

2. MATERIALS AND METHODS

The planting material consisted of twenty native cowpea genotypes cultivated in North-East India. The experiment was conducted at the Vegetable Research Farm, College of Horticulture and Forestry, Central Agricultural University, Pasighat, East Siang, Arunachal Pradesh, India during the 2022-2023 Kharif season. The research farm is situated at an altitude of 154 meters above mean sea level, with a latitude of N 28º 04'37.19" and a longitude of E 95º 19' 29.16". The climate in this region is characterized as humid and sub-tropical, with the highest rainfall occurring between June and September. The soil is sandy loam, with a pH level of 6.7 and an organic carbon content of 2.1%. Each genotype was planted in three replications, spaced at 80 cm X 40 cm, following a Randomized Block Design. Qualitative attributes such as growth habit, twining habit, foliage colour, leaflet shape, flower colour, pod shape, pod colour, seed shape, seed colour were recorded. Quantitative characters such as 50% flowering, plant height (cm), leaf area (cm²), number of clusters per plant, number of pods per cluster, number of pods per plant, pod length (cm), pod width (cm), days to harvest, number of seeds per pod, 100 seed weight (g) and pod yield per plant (g) were examined through a random sampling approach. The data collected during the experiment regarding these traits underwent statistical and biometrical analysis based on the variance analysis method presented by Gomez and Gomez (1984). Furthermore, by conducting individual plant observations, the mean value for each trait across all populations was calculated as follows:

$$\overline{Y}=\frac{1}{n}\left(\sum_{i=1}^{n} Yi\right)$$

Where,

$\overline{Y}$= Population mean
Yi = Individual value
n = Number of observations

3. RESULTS AND DISCUSSION

3.1 Description of the Genotypes for Qualitative Traits

The qualitative morphological characters observed for the twenty genotype along with one check variety were represented in Table 1 and Table 2. The characterization of genotypes for the following qualitative morphological traits were done using cowpea descriptors given by International Board for Plant Genetic Resources (IBPGR), 1983 [1] and guidelines for the conduct of tests for Distinctiveness, Uniformity and Stability in cowpea given by Plants Protection Varieties and Farmer's rights (PPV and FRA), 2001. CHF CP-1, CHF CP-2, CHF CP-3, CHF CP-4, CHF CP-5, CHF CP-6, CHF, CP-7, CHF CP-8, CHF CP-9, CHF CP-10, CHF CP-11, CHF CP-12, CHF CP-13, CHF CP-14, CHF CP-15, CHF CP-16, CHF CP-17, CHF CP-18, CHF CP-19, and CHF CP-20 were recorded as pole. There were no genotypes having erect, semi erect, horizontal growth habit. The twining habit of plants were observed visually and recorded as viny in all genotypes. The foliage colour of the plants was observed visually and recorded at 50% flowering as green, light green and dark green. CHF CP-1, CHF CP-5, CHF CP-7, CHF CP-11, CHF CP-13, CHF CP-14, CHF CP-17, CHF CP-19, and CHF CP-20 were recorded as green. CHF CP-2, CHF CP-6, CHF CP-15, and CHF CP-16 were recorded as light green. CHF CP-3, CHF CP-4, CHF CP-8, CHF CP-9, CHF CP-10, CHF CP-12, and CHF CP-18 were recorded as dark green. CHF CP-2, CHF CP-7, CHF CP-10, CHF CP-13, and CHF CP-15 were recorded as hastate. CHF CP-1, CHF CP-3, CHF CP-4, CHF CP-5, and CHF CP-18 were recorded as sub-hastate. CHF CP-6, CHF CP-8, CHF CP-9, CHF CP-11, CHF CP-12, CHF CP-16, CHF CP-17, and CHF CP-20 were recorded as sub-globose. CHF CP-14 and CHF CP-19 were recorded as globose. Purple flower colour was observed in CHF CP-3, CHF CP-6, CHF CP-9, and CHF CP-18. Light purple was observed in CHF CP-1, CHF CP-2, CHF CP-4, CHF CP-5, CHF, CP-7, CHF CP-8, CHF CP-10, CHF CP-11, CHF CP-12, CHF CP-13, CHF CP-14, CHF CP-15, CHF CP-16, CHF CP-17, CHF CP-19, and CHF CP-20. The straight pod shape was recorded in CHF CP-7, CHF CP-8, CHF CP-9, CHF CP-12, CHF CP-13, CHF CP-16, and CHF CP-17. Whereas curved pod shape was recorded in CHF CP-1, CHF CP-2, CHF CP-3, CHF CP-4, CHF CP-5, CHF CP-6, CHF CP-10, CHF CP-11, CHF CP-14, CHF CP-15, CHF CP-18, CHF CP-19, and CHF CP-20. CHF CP-1, CHF CP-2, CHF CP-5, CHF CP-7, CHF CP-11, CHF CP-12, CHF CP-14, CHF CP-15, CHF CP-16, CHF CP-17 and CHF CP-18 were observed as green. CHF CP-3, CHF CP-4, CHF CP-6, CHF CP-8, CHF CP-10, CHF CP-13, CHF CP-19, and CHF CP-20 were observed as dark green. CHF CP-9 and CHF CP-18 were observed as purple. CHF CP-2, CHF CP-3, CHF

CP-6, CHF CP-18 and CHF CP-20 were recorded as elliptical. CHF CP-1, CHF CP-4, CHF CP-5, CHF CP-7, CHF CP-8, CHF CP-9, CHF CP-10, and CHF CP-13 were recorded as kidney-shaped. CHF CP-11, CHF CP-12, CHF CP-14, CHF CP-15, CHF CP-16, CHF CP-17 and CHF CP-19 were recorded as rhomboid. CHF CP-12 was recorded as white. CHF CP-1, CHF CP-4, CHF CP-5, CHF CP-8, CHF CP-14, CHF CP-15 and CHF CP-16 were recorded as brown. CHF CP-2, CHF CP-3, CHF CP-6, CHF CP-7, CHF CP-11, CHF CP-13, CHF CP-18, and CHF CP-19 were recorded as brick red. CHF CP-9 and CHF CP-20 were recorded as purple. CHF CP-10 and CHF CP-17 were recorded as black.

3.2 Evaluation of the Genotypes for Quantitative Traits

The analysis of variance (ANOVA) for twelve characters is given in Table 3. There were highly significant differences among the genotypes for all the characters under study, showing wide range of variation in twenty cowpea genotypes. The mean performance of the genotypes for twelve quantitative morphological characters was given in Table 4 and Table 5.

3.3 50 % Flowering

In the present investigation, the minimum days to 50% flowering was recorded in genotypes CHF CP-9 (45.67) followed by CHF CP-11 (45.67) and CHF CP-14 (47.33). The maximum number of days taken for 50% flowering was recorded in CHF CP-6 (66.00) followed by CHF CP-10 (65.70), CHF CP-8 (63.57) and CHF CP-4 (62.50) with a mean performance of 55.29. These findings also agreed with the work conducted by Verma et al. [12] and Singh and Bhakta [10].

3.4 Plant Height (cm)

The shortest plant height was recorded CHF CP-16 (162.50) and CHF CP-1 (173.00). The highest plant height was recorded in CHF CP-8 (201.00) followed by CHF CP-7 (198.00) and CHF CP-6 (194.00) with a mean performance of 184.76. These have similar findings with Kandel et al. [6].

3.5 Leaf Area (cm²)

The minimum leaf area was recorded in CHF CP-2 (57.51) followed by CHF CP-9 (84.08) with

Table 1. Qualitative morphological characters of twenty genotypes

Genotype	Growth habit	Twining habit	Foliage colour	Leaflet shape	Flower colour
CHF CP-1	Pole type	Viny	Green	Sub-hastate	Light purple
CHF CP-2	Pole type	Viny	Light green	Hastate	Light purple
CHF CP-3	Pole type	Viny	Dark green	Sub-hastate	Purple
CHF CP-4	Pole type	Viny	Dark green	Sub-hastate	Light purple
CHF CP-5	Pole type	Viny	Green	Sub-hastate	Light purple
CHF CP-6	Pole type	Viny	Light green	Sub-globose	Purple
CHF CP-7	Pole type	Viny	Green	Hastate	Light purple
CHF CP-8	Pole type	Viny	Dark green	Sub-globose	Light purple
CHF CP-9	Pole type	Viny	Dark green	Sub-globose	Purple
CHF CP-10	Pole type	Viny	Dark green	Hastate	Light purple
CHF CP-11	Pole type	Viny	Green	Sub-globose	Light purple
CHF CP-12	Pole type	Viny	Dark green	Sub-globose	Light purple
CHF CP-13	Pole type	Viny	Green	Hastate	Light purple
CHF CP-14	Pole type	Viny	Green	Globose	Light purple
CHF CP-15	Pole type	Viny	Light green	Hastate	Light purple
CHF CP-16	Pole type	Viny	Light green	Sub-globose	Light purple
CHF CP-17	Pole type	Viny	Green	Sub-globose	Light purple
CHF CP-18	Pole type	Viny	Dark green	Sub-hastate	Purple
CHF CP-19	Pole type	Viny	Green	Globose	Light purple
CHF CP-20	Pole type	Viny	Green	Sub-globose	Light purple

Table 2. Qualitative morphological characters of twenty genotypes

Genotype	Pod shape	Pod colour	Seed shape	Seed colour
CHF CP-1	Curved	Green	Kidney	Brown
CHF CP-2	Curved	Green	Elliptical	Brick red
CHF CP-3	Curved	Dark green	Elliptical	Brick red
CHF CP-4	Curved	Dark green	Kidney	Brown
CHF CP-5	Curved	Green	Kidney	Brown
CHF CP-6	Curved	Dark green	Elliptical	Brick red
CHF CP-7	Straight	Green	Kidney	Brick red
CHF CP-8	Straight	Dark green	Kidney	Brown
CHF CP-9	Straight	Purple	Kidney	Purple
CHF CP-10	Curved	Dark green	Kidney	Black
CHF CP-11	Curved	Green	Rhomboid	Brick red
CHF CP-12	Straight	Green	Rhomboid	White
CHF CP-13	Straight	Dark green	Kidney	Brick red
CHF CP-14	Curved	Green	Rhomboid	Brown
CHF CP-15	Curved	Green	Rhomboid	Brown
CHF CP-16	Straight	Green	Rhomboid	Brown
CHF CP-17	Straight	Green	Rhomboid	Black
CHF CP-18	Curved	Purple	Elliptical	Brick red
CHF CP-19	Curved	Dark green	Rhomboid	Brick red
CHF CP-20	Curved	Dark green	Elliptical	Purple

Table 3. Analysis of variance for different morphological characters of cowpea

Sl. No.	Character	Mean sum of square		
		Replication	Genotype	Error
	Degree of freedom	**2**	**19**	**38**
1	Days to 50% flowering	8.74	136.65**	1.71
2	Plant height (cm)	2.18	320.86**	39.17
3	Leaf area (cm^2)	0.63	5555.94**	20.23
4	Number of clusters per plant	1.33	19.82**	0.47
5	Number of pods per cluster	0.02	0.61**	0.04
6	Number of pods per plant	0.31	272.36**	0.29
7	Pod length (cm)	4.13	52.76**	6.63
8	Pod width (cm)	0.00	0.06**	0.00
9	Days to harvest	0.16	153.34**	3.52
10	Number of seeds per pod	0.21	6.34**	0.06
11	100 seeds weight (g)	0.19	19.54**	1.26
12	Pod yield per plant (g)	12.05	43603.03**	54.27

*** Significant at 1% level of probability*

maximum leaf area were recorded in CHF CP-6 (229.30) followed by CHF CP-10 (190.22) with a mean performance of 145.34. These leaf areas have similar findings with Arya et al*.* [2].

3.6 Number of Clusters Per Plant

The minimum number of clusters per plant was recorded in CHF CP-6 (5.66) followed by CHF CP-8 (6.33) by and CHF CP-4 (6.50). The maximum number of clusters per plant were recorded in CHF CP-12 (14.16) followed by CHF CP-15 (13.37) and CHF CP-1 (12.74) with a mean performance of 9.18. These have similar findings with Terzopoulos et al*.* [11].

3.7 Number of Pods Per Cluster

The lowest number of pods per cluster was recorded in CHF CP-3 (1.60) followed by CHF CP-6 (1.85), CHF CP-8 (1.93) and CHF CP-13 (1.93). The highest number of pods per peduncle was recorded in CHF CP-12 (3.20) followed by CHF CP-15 (3.00) and CHF CP-17 (3.00) with a mean performance of 2.41. Similar findings were previously reported by Subedi et al*.* [10,12].

3.8 Number of Pods Per Plant

The minimum number of pods per plant was recorded in CHF CP-6 (10.50) followed by CHF

Table 4. Mean performance of twenty cowpea genotypes and one check variety for quantitative morphological characters

Genotype	1	2	3	4	5	6
CHF CP-1	61.15	173.00	165.15	12.74	2.80	35.66
CHF CP-2	51.33	181.00	57.51	9.23	2.27	20.92
CHF CP-3	55.82	188.00	114.84	7.90	1.60	12.64
CHF CP-4	62.50	193.00	137.70	6.50	2.87	18.62
CHF CP-5	53.67	177.00	79.38	10.67	2.20	23.47
CHF CP-6	66.00	194.00	229.30	5.66	1.85	10.50
CHF CP-7	47.63	198.00	184.88	11.10	2.67	29.59
CHF CP-8	63.57	201.00	129.03	6.33	1.93	12.24
CHF CP-9	45.67	183.00	84.08	10.17	2.93	29.83
CHF CP-10	65.70	196.33	190.22	8.10	2.00	16.21
CHF CP-11	45.67	173.33	159.02	6.67	2.27	15.12
CHF CP-12	61.50	187.00	146.63	14.16	3.20	45.32
CHF CP-13	52.27	190.36	90.75	12.27	1.93	23.72
CHF CP-14	47.33	182.63	146.20	7.45	2.33	17.38
CHF CP-15	60.33	192.40	152.01	13.37	3.00	40.11
CHF CP-16	56.67	162.50	138.67	11.00	2.57	28.22
CHF CP-17	57.33	192.93	187.65	7.60	3.00	22.81
CHF CP-18	48.33	183.74	172.92	6.90	2.37	16.33
CHF CP-19	53.67	170.87	166.84	7.68	2.00	15.37
CHF CP-20	49.67	175.08	174.06	8.14	2.40	19.53
Mean	55.29	184.76	145.34	9.18	2.41	22.68
Min	45.67	162.50	57.51	5.66	1.60	10.50
Max	66.00	201.00	229.30	14.16	3.20	45.32
SEm±	0.74	3.61	2.60	0.40	0.12	0.31
C.V. (%)	8.87	12.70	11.60	27.99	31.39	8.92
CD at 5%	2.12	10.34	7.43	1.13	0.33	0.89

Days to 50% flowering 2. Plant height (cm) 3. Leaf area (cm²) 4. Number of clusters per plant 5. Number of pods per cluster 6. Number of pods per plant 7. Pod length (cm) 8. Pod width (cm) 9. Days to harvest 10. Number of seeds per pod 11. 100 seeds weight (g) 12. Pod yield per plant (g)

CP-8 (12.24) and CHF CP-3 (12.64). The maximum number of pods per plant was recorded in CHF CP-12 (45.32) followed by CHF CP-15 (40.11) and CHF CP-1 (35.66) with a mean performance of 22.68. These findings of the number of pods per plant with the work conducted by Subedi et al. [6].

3.9 Pod Length (cm)

The shortest pod length was recorded in CHF CP-6 (18.00) followed by CHF CP-4 (18.33) and CHF CP-2 (18.83). The longest pod length was observed in CHF CP-5 (32.77) followed by CHF CP-3 (31.70) with a mean performance of 25.25. The findings of these experiments had similar results to Gupta et al. [10].

3.10 Pod Width (cm)

The shortest pod width was recorded in CHF CP-2 (0.55) followed by CHF CP-3 (0.61) and CHF CP-7 (0.64). The longest pod width was observed in CP-10 (1.07) followed by CHF CHF CP-19 (1.04) and CHF CP-4 (0.99) with a mean performance of 0.78. The findings of these experiments had similar results to Gupta et al. [10].

3.11 Days to Harvest

The minimum number of days to harvest was recorded in CHF CP-2 (0.55) followed by CHF CP-3 (0.61) and CHF CP-7 (0.64). The highest number of days to harvest was recorded in CHF CP-6 (78.00) followed by CHF CP-10 (77.70) and CHF CP-15 (75.33) with a mean performance of 67.49. The findings of these experiments had similar results to Singh and Bhakta [10].

3.12 Number of Seeds Per Pod

The minimum number of plants was recorded in CHF CP-7 (6.60) followed by CHF CP-3 (7.00) and CHF CP-6 (8.00). The highest number of the plant was recorded in CHF CP-17 (11.80) followed by CHF CP-14 (11.60) CHF CP-18 (11.00) and CHF CP-1 (11.00) with a mean performance of 9.52. These conform with the work conducted by Singh and Bhakta [10].

Table 5. Mean performance of twenty cowpea genotypes for quantitative morphological characters

Genotype	7	8	9	10	11	12
CHF CP-1	30.30	0.67	75.20	11.00	16.87	356.63
CHF CP-2	18.83	0.55	64.33	9.33	18.44	188.29
CHF CP-3	31.70	0.61	65.18	7.00	17.67	139.09
CHF CP-4	18.33	0.99	76.50	10.08	18.00	223.47
CHF CP-5	32.77	0.65	64.67	9.20	17.33	281.60
CHF CP-6	18.00	0.85	78.00	8.00	16.67	96.60
CHF CP-7	25.80	0.64	60.37	6.60	16.67	242.65
CHF CP-8	26.33	0.79	75.43	10.06	19.33	122.38
CHF CP-9	25.67	0.77	56.67	10.04	20.33	328.15
CHF CP-10	24.00	1.07	77.70	9.60	19.33	197.72
CHF CP-11	24.33	0.72	55.67	9.80	21.67	199.57
CHF CP-12	23.34	0.82	70.50	9.60	24.67	589.19
CHF CP-13	24.67	0.87	65.27	9.80	13.91	260.87
CHF CP-14	26.03	0.67	61.33	11.60	18.33	208.60
CHF CP-15	28.10	0.76	75.33	10.00	17.33	481.32
CHF CP-16	25.53	0.72	68.67	10.20	22.33	395.15
CHF CP-17	26.27	0.63	70.33	11.80	23.33	296.53
CHF CP-18	26.67	0.91	58.33	11.00	19.33	228.62
CHF CP-19	29.00	0.95	66.67	7.00	20.33	192.08
CHF CP-20	19.34	1.04	63.67	8.60	19.67	214.81
Mean	25.25	0.78	67.49	9.52	19.08	262.17
Min	18.00	0.55	55.67	6.60	13.91	96.60
Max	32.77	1.07	78.00	11.80	24.67	589.19
SEm±	1.49	0.02	1.08	0.15	0.65	4.25
C.V. (%)	38.25	18.22	10.42	9.97	22.07	10.54
CD at 5%	4.26	0.06	3.10	0.42	1.86	12.18

1. Days to 50% flowering 2. Plant height (cm) 3. Leaf area (cm²) 4. Number of clusters per plant 5. Number of pods per cluster 6. Number of pods per plant 7. Pod length (cm) 8. Pod width (cm) 9. Days to harvest 10. Number of seeds per pod 11. 100 seeds weight (g) 12. Pod yield per plant (g)

3.13 100 Seeds Weight (g)

The lowest 100 seed weight was recorded in CHF CP-13(13.91) followed by CHF CP-6 (16.67), and CHF CP-7 (16.67). The highest 100 seed weight was recorded in CHF CP-12 (24.67) followed by CHF CP-17 (23.33) and CHF CP-11 (21.67) with a mean performance of 18.96. Similar findings were recorded by Singh and Bhakta [9].

3.14 Pod Yield (g)

The lowest pod yield per plant was recorded in CHF CP-6 (96.60) followed by CHF CP-8(122.38) and CHF CP-3 (139.09). The highest pod plant was recorded in CHF CP-12 (589.19) followed by CHF CP-15 (481.32) and CHF CP-16 (395.15) with a mean performance of 262.17. The result found confirmed with the finding of Verma et al. [13].

4. CONCLUSION

In conclusion, our study has shed light on the substantial variations in both qualitative and quantitative morphological characteristics among the cowpea genotypes native to Northeast India. These observed traits provide a valuable resource for future breeding programs aimed at enhancing cowpea yield and nutritional quality in the region.

Notably, the genotype CHF CP-12 displayed the highest values for cluster per plant, number of pods per cluster, number of pods per plant, pod length, 100 seed weight, and pod yield per plant. These findings hold promise for harnessing the potential of these genotypes to achieve higher yields in future breeding initiatives.

Furthermore, our investigation unveiled that genotypes CHF CP-11 and CHF CP-9 exhibited the shortest duration for the appearance of the

first flower, days to reach 50% flowering, and the minimum days required for harvest. This indicates that these genotypes possess the valuable characteristic of early maturity, making them instrumental in efforts to achieve more efficient and timely crop production.

In summary, the diverse cowpea genotypes found in North-East India offer a wealth of possibilities for crop improvement, addressing the region's unique agricultural challenges, and contributing to food security and sustainability. By harnessing the genetic variability and desirable traits identified in this study, we can pave the way for the development of improved cowpea varieties that will play a crucial role in enhancing agricultural productivity and nutrition in this biodiverse and geographically challenging region.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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