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Evaluation and Characterization of Cowpea (*Vigna unguiculata* L. Walp) Genotypes for Growth, Yield and Quality parameters in Prayagraj Agro Climatic Region

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A B S T R A C T

The experiment evaluation and characterization of cowpea (*Vigna unguiculata* L.Walp) genotypes for growth, yield and quality parameters in Prayagraj agro-climatic region was conducted at Field Experimental centre as well as in post graduate Seed Testing Laboratory, Department of Genetics and Plant Breeding, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.). India during *Kharif* season 2019. in order to standardize the best genotype of Cowpea. Thirteen genotype of cowpea(G_1 – CP-1, G_2 – CP-3, G_3 – CP-5, G_4 – CP-7, G_5 – CP-10, G_6 – CP-11, G_7 – CP-12, G_8 – CP-13, G_9 – CP-14, G_{10} – CP-15, G_{11} – CP-16, G_{12} – CP-17, G_{13} – PL-4) were evaluated by screening Seed yielding attributes *viz.*, field parameters include field emergence, days to 50% flowering, days to maturity, plant height, number of pods per plant, number of seeds per pod, number of nodules per plant, nodules fresh weight, seed yield per plant, seed yield per plot, biological yield and harvest index and different seed quality parameters *viz.*, germination percentage, root length, shoot length, seedling length, seedling fresh weight, seedling dry weight, seedling vigour index-I, seedling vigour index-II, 100 seed weight. It was found that all the genotype showed significance difference with lowest value (G_4 – CP-7) and the highest seedling length, seedling fresh weight, seedling dry weight; vigour index and yielding attributes were observed for G_3 – CP-5. Highest germination was observed in G_{11} – CP-16 and G_3 – CP-5.

Introduction

Cowpea (*Vigna unguiculata* L. Walp) belongs to the family Fabaceae and having chromosome number 2n=22 with genus *Vigna*. Cowpea is an important leguminous crop is believed to be originated in Central Africa. It is self-pollinated annual herb with a wide range of growth habit and response to photoperiod. In country, it is cultivated

mainly in Gujarat, West Bengal, Tamil Nadu, Andhra Pradesh, Kerala and Orissa. In Gujarat, it is mainly grow in Sabarkantha, Banaskantha, Mehasana, Patan, Ahmedabad, Kheda and Anand district and commonly known as "*chowli*" in this area. In India, the total area under beans cultivation is about 136 (M ha) with the production 1373 (MT) (Anonymous, 2018-2019).

In India, Cowpea is well adapted to arid and semi-arid areas due to its morphological as well as biochemical characteristics. The deep rooted system and its short duration life cycle are some of the factors that make cowpea very adaptable to hostile environments. Cowpea is adapted to high temperatures (20 – 35^{o}C) and grows well in a wide range of soil texture, from heave clays, if well drained, to sandy; it grows best in slightly acid to alkaline soils (pH 5.5 – 6.5). Cowpea grows under wide extreme of moisture condition and once established it is fairly drought tolerant (Gaiser and Graef, 2001). It is often grown in rain-fed agriculture receiving at least 600mm annual rainfall (Valenzuela & Smith, 2002).It requires very few inputs, as the plants root nodules are able to fix atmospheric nitrogen, making it a valuable crop for resource poor farmers and well-suited to intercropping with other crops. The whole plant is used as forage for animals, with its use as cattle feed likely responsible for its name.

Cowpea (*Vigna unguiculata* L.Walp) is an important legume widely cultivated in tropics and subtropics for forage, green pods and grains (Ali *et al.,* 2004). Cowpea is usually better adapted to drought, high temperature and other biotic stresses compared with other crops (Kuykendall *et al.,* 2000; Martins *et al.,* 2003). Protein content of cowpea seed is among the highest in cultivated legumes (Aremu *et al.,* 2007) and can serve as an excellent source of dietary protein in animal feeds. The mature grain contains 20 to 25% of protein, 1.3 to 1.5% lipid and 5.1 to 5.8% crude fiber (Tshovhote *et al.,* 2003).

Number of superior cowpea varieties are released by different states, universities and ICAR institutes but no study has been carried out with respect to suitability of specific variety of cowpea for certain region. So, there is urgent need to evaluate the cowpea varieties released from states and national levels and made a certain recommendation to generate research evidences of different varieties with respect to their suitability under certain conditions to benefits the cowpea growers of Allahabad.

Materials and Methods

The experiment was conducted at Field Experimental centre as well as in post graduate Seed Testing Laboratory, Department of Genetics and Plant Breeding, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.). In order to standardize the best genotype of Cowpea, thirteen genotype of cowpea(G_1 – CP-1, G_2 – CP-3, G_3 – CP-5, G_4 – CP-7, G_5 – CP-10, G_6 – CP-11, G_7 – CP-12, G_8 – CP-13, G_9 – CP-14, G_{10} – CP-15, G_{11} – CP-16, G_{12} – CP-17, G_{13} – PL-4) are used as experiment to evaluate best genotype in prayagraj agro climatic condition for growth yield and seed quality parameters. After cleaning and grading, the seeds are placed on between paper method in laboratory and line method in field used for sowing.

The observation on the characters *viz.*

Field parameters

Field emergence (Kotowski, 1926), days to 50% flowering, days to maturity, plant height, no. of pods per plant, no. of seeds per pod, no. of nodules per plant, nodules fresh weight (Khan, 2006), seed yield per plant, seed yield per plot, biological yield and harvest index.

Quality parameters

Germination percent (ISTA, 2004), Root length (cm), Shoot length (cm), Seedling length (cm), Seedling Fresh weight (g), Seedling dry weight (g), Seedling Vigour index length, Seedling Vigor index mass (Baki and Anderson, 1973)and 100 seed weight were recorded. The experimental data recorded were subjected to statistical analysis for calculating analysis of variance, range, mean, critical difference and coefficient of variation for RBD design Panse and Sukhatme (1967) and for CRD design (Fisher, 1936).

In field

Field emergence (%)

One hundred seeds from each treatment in three replications will be used for field emergence studies. The seeds will be sown in well prepared at 3m deep. The field emergence count will be taken on the 4^{th}, 7^{th} and 10^{th} day after sowing and the emergence percentage will be calculated taking into account the number of seedlings emerged three centimeter above the soil surface **(**Kotowski, 1926).

$$\text{Field emergence (\%)} = \frac{\text{Total Number of seedling emerged}}{\text{Total no. of seeds sown}} \times 100$$

Days to 50% flowering

The numbers of days were count till the days of 50% flower initiation from the date of sowing.

Days to maturity

The numbers of days from plant sowing to plant harvest (physiological maturity) were count manually from each genotype.

Plant height (cm)

It was measured from ground level to the base of the top most fully opened leaf at harvesting stage. Average height of five plants was recorded in centimeters.

Number of pods per plant

The total numbers of pods from five randomly selected plants were counted manually from each genotype.

Number of seeds per pod

The total numbers of seeds from five randomly selected plant pods were counted manually from each genotype and divided by total number of pods.

Number of nodules per plant

Five plants from each genotype plot in three replication will be uprooted 30 days after seedling (DAS), and the extent of nodulation were estimated by carefully washing the roots and detaching the nodules before counting (Khan, 2006).

Nodules fresh weight (g)

After washing the root nodules from the field the nodules were detached from the plant roots and weighed in an electronic weigh balance for fresh weight of root nodules expressed in grams (g).

Seed yield per plant (g)

The seed weights of five randomly select plants were recorded of each plot.

Seed yield per plot (g)

The seed weight of total plants in a plot was recorded.

Biological yield

The biological yield refers to the total dry matter accumulation of a plant system.The biological yield of five randomly select plants were recorded of each plot.

Harvest index

For grain crops, harvest index (HI) is the ratio of harvested grain to total shoot dry matter, and this can be used as a measure of reproductive efficiency. The HI of five randomly select plants were recorded of each plot.

$$\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$

In Laboratory

Germination per cent: For taking observation regarding seed germination. 100 seeds were kept blotting paper (BP method). The paper folds were kept in germination in an upright position at constant temperature 25^0C $\pm$ 2^0C and 80% RH. Three replications were made for each treatment with First count was taken on 4^{th} day and Final count made after 7 days of treatment.

Root, shoot, and seedling length: For recording seedling length, 10 seedlings from each sample were taken randomly. The length of roots, shoots and total seedling were measured. To find out the average length of roots, shoots and total seedling of the sample, mean often seedlings were taken.

Seedling fresh weight: For recording seedling fresh weight, 10 seedlings from each sample were taken randomly. The fresh weight of seedlings was weighted on electronic balance.

Seedling dry weight: For taking the observation of seedling dry weight, 10 seedlings were dried 100^0C temperatures for 1hours. The dried seedlings were weighted on electronic balance.

Seedling vigour index length: Seedling vigor index was calculated by adopting the method suggested by Abdul Baki and Anderson (1973).

Seedling vigor index length = Germination (%) x Total seedling length (cm.)

Seedling vigour index mass: Vigor index in terms of mass is determined by the multiplication of germination percentage with seedling dry weight on the day of final count.

Seedling vigor index mass= germination (%) X seedling dry weight

100 seed weight: Count 100 seeds by manually or electric seed counter from each variety and weighing on electronic balance.

Results and Discussion

According to the results, all studied traits were evaluated on their characters and there was completely significant difference between highest value and lowest value of cowpea seeds.

All growth and yield attributes viz., field emergence, days to 50% flowering, days to maturity, plant height (cm), no. of pods per plant, no. of seeds per pod, no. of nodules per plant, nodules fresh weight (g), seed yield per plant (g), seed yield per plot (g), biological yield (g) and harvest index (%) were observed by G_3 – CP-5significantly recorded maximum where found in lowest (G_4 – CP-7) (Table- 1).

All seedling characters *viz.* Germination percent, Root length (cm), Shoot length (cm),

Seedling length (cm), seedling fresh weight (g), seedling dry weight (g), Seedling Vigour index length, Seedling Vigor index mass and 100 seed weight were observed by G_3 – CP-5significantly recorded maximum where found in lowest (G_4 – CP-7) (Table- 2).

Significantly maximum percentage of field emergence (89.00%)was recorded by G_{11}– CP-16and it was followed by G_3– CP-5(87.00%), Minimum field emergence percentage was recorded by G_4– CP-7(78.00%).Similar results of field emergence percent was observed by Agbogidi and Egho (2011); Teame *et al.*,(2017)and Gbaguidi *et al.*,(2013).

Minimum days to 50% flowering(32.66)was recorded by G_8– CP-13 and it was followed by G_{12}– CP-17(32.66), Maximum days to 50% flowering were recorded by G_6– CP-11(62.66).Similar results of days to 50% flowering was observed by Ekpo *et al.*,(2012); Naim *et al.*,(2011); Dadson *et al.*, (2003)and Muhammad *et al.*, (1994).

Minimum days to maturity(72.00)was recorded by G_3– CP-5 and it was followed by G_{11}– CP-16(72.33), Maximum days to maturity were recorded by G_{10}– CP-15(84.66).Similar results of days to maturity was observed by Basavaraj *et al.*, (2013); Padulosil and Ng (1997); Ibrahima *et al.*, (2013)and Sharma *et al.*, (2015).

Maximum plant height at harvesting stage(117.46 cm)was recorded by G_9– CP-14and it was followed by G_{11}– CP-16(103.13 cm), Minimum plant height was recorded by G_2– CP-3(67.50 cm).Similar results of plant height was observed by Vural and Karasu (2007); Khan *et al.*, (2010) and Pasqueth (1998).

Maximum number of pods per plant(13.46)was recorded by G_3– CP-5 and it was followed by G_{11}– CP-16(13.33), Minimum number of pods per plant was recorded by G_4– CP-7(5.80).Similar results of number of pods per plant was observed by Fageria *et al.*, (2011); Peksen (2004) and Babaji *et al.*, (2011).

Maximum number of seeds per pod(16.13)was recorded by G_3– CP-5and it was followed by G_{10}– CP-15(14.60), Minimum number of seeds per pod was recorded by G_4– CP-7(9.85).Similar results of number of seeds per pod was observed by Gulumser *et al.*, (1989); Sunil Kumar *et al.*, (2015)and Sharma *et al.*, (2013).

Maximum number of nodules per plant(46.66)was recorded by G_{11}– CP-16 and it was followed by G_8– CP-13(44.60),Minimum number of nodules per plant was recorded by G_7– CP-12(23.43).Similar results of number of nodules per plant was observed by Kuykendall *et al.*, (2000); Philipand Watters *et al.*, (1991)and Harris,(2014).

Maximum nodules fresh weight per plant(0.852 gm)was recorded by G_{11}– CP-16 and it was followed by G_3– CP-7(0.650 gm),Minimum nodules fresh weight per plant was recorded by G_7– CP-12(0.203 gm).Similar results of nodules fresh weight was observed by George *et al.*, (2014); Mehta *et al.*, (2010); Finch-Savage (1993) and Sarmadi *et al.*, (2014).

Significantly higher seed yield per plant and per plot of different cowpea genotypes (18.55 and 1613.90 g) was recorded by G_3– CP-5 and it was followed by G_{11}– CP-16(16.29 and 1295.80 g) respectively. Minimum seed yield per plant was recorded by G_4– CP-7(9.09 and 615.80 g) respectively. Similar results of seed yield was observed by Basaran *et al.*, (2011); Alhaji Hamza Ibrahim, (2008); Singh *et al.*, (2007) and Quaye *et al.*, (2011).

Maximum biological yield (4636.94 gm) was recorded by G_3– CP-5 and it was followed by G_{11}– CP-16 (3800.01 gm), Minimum biological yield was recorded by G_4– CP-7(2689.21 gm). Similar results of biological yield was observed by Shiringani and Shimeles (2011) and Ali *et al.,* (2004); Brahim *et al.,* (2006).

Maximum harvest index (34.80%) was recorded by G_3– CP-5 and it was followed by G_{11}– CP-16(34.10%), Minimum harvest index was recorded by G_4– CP-7(22.90%).Similar results of harvest index was observed by Singh (1997); Peksen and Artık (2004) and Chattopadhyay *et al.,* (2014).

Significantly higher percentage of germination (92.00%) was recorded by G_{11} – CP-16 and it was followed by G_3 – CP-5 (91.00%), Minimum percentage of germination was recorded by G_4 – CP-7 (83.00%). Similar finding was reported by Peksen *et al.,* (2004), Ndunguru and Summerfield (2005), Rojas *et al.,* (2000).

Maximum root length (16.42 cm)was recorded by G_{11}– CP-16 and it was followed by G_3– CP-5(15.40 cm),Minimum root length was recorded by G_4– CP-7(10.10 cm).Maximum shoot length (21.02 cm)was recorded by G_3– CP-5and it was followed by G_{11}– CP-16(19.42 cm),Minimum shoot length was recorded by G_4– CP-7(13.97 cm).Maximum length of seedling (36.42 cm)was recorded by G_3– CP-5 and it was followed by G_{11}– CP-16(35.84 cm), Minimum seedling length was recorded by G_4– CP-7(24.07 cm).

Root length is usually a good indicator for seed vigour measurement which may contribute towards better establishment of seedling. Similar results were observed by Serraj *et al.,* (2004), Rosenberg and Rinne (1986), Socioconsult (2006). Variations in shoot length for different genotypes might be due to the difference in genetic constitution of seeds. Such type of findings also reported by Sabaghpour *et al.,* (2003), Roberts *et al.,* (1988), Agrawal *et al.,* (1990). Seedling length is good indicator of seed vigour which indicated towards better plant establishment. Similar findings were reported by Socioconsult (2006), Rojas *et al.,* (2000).

Maximum seedling fresh weight (5.87 gm)was recorded by G_3– CP-5 and it was followed by G_{11}– CP-16(5.42 gm), Minimum seedling fresh weight was recorded by G_4– CP-7(3.12 gm). Maximum seedling dry weight (0.674 gm) was recorded by G_3– CP-5and it was followed by G_{11}– CP-16(0.610 gm), Minimum seedling dry weight was recorded by G_4– CP-7(0.416 gm). Seedling fresh weight had significant correlated with seedling length. With increase in length of a seedling, this seems a sharp rise in fresh weight. These results were agreement with the finding of Babu *et al.,* (2010), Gawade (2008), Lev *et al.,* (2000). Seedling dry weight had significantly positively correlated with seedling length and seedling fresh weight. Similar results were reported by Kaur *et al.,* (2008), Lev *et al.,* (2000) and Saraf *et al.,* (1998).

Maximum seed vigor index length (3313.70) was recorded by G_3–CP-5 and it was followed by G_{11}– CP-16 (3297.95), Minimum seed vigor index length was recorded by G_4 – CP-7 (1998.32). Results of present finding were reported by Shaibu and Ibrahim (2016), Rosenberg and Rinne (1986), Ndunguru and Summer field (2005).

Significantly maximum seed vigor index mass (61.35) was recorded by G_3 – CP-5 and it was followed by G_{11}– CP-16 (56.16),Minimum seed vigor index mass was recorded by G_4 – CP-7 (34.43). Results of present finding were reported by Shaban (2003), Igbal (2015), Jomova *et al.,* (2005), Rojas *et al.,* (2000).

Table.1 Mean performance of 13 cowpea genotypes for 12 growth and yield characters

S.NO	Genotypes	Field Emergence percentage	Days to 50% Flowering	Days to Maturity	Plant height (cm)	Number of Pods Per plant	Number of Seeds per Pods	Number of Nodules per plant	Nodules Fresh weight (g)	Seed yield per plant (g)	Seed yield per plot (g)	Biological yield (g)	Harvest index
1	G_1	79	35.00	76.00	88.40	11.23	11.73	29.93	0.300	10.94	904.20	3391.59	26.66
2	G_2	83	35.33	74.66	67.50	10.83	10.46	32.66	0.373	10.19	797.80	3264.63	24.44
3	G_3	87	33.33	72.00	95.40	13.46	16.13	43.36	0.650	18.55	1613.90	4636.94	34.80
4	G_4	78	35.66	77.66	78.93	5.80	9.85	28.53	0.213	9.09	615.80	2689.21	22.90
5	G_5	84	35.33	75.33	83.70	6.13	10.90	34.86	0.483	11.89	1050.40	3453.24	30.42
6	G_6	82	62.66	83.33	94.83	9.66	12.75	29.73	0.280	11.29	997.06	3461.11	28.81
7	G_7	80	36.33	77.66	77.40	7.86	11.36	23.43	0.203	12.74	1120.70	3444.08	32.54
8	G_8	86	32.66	73.66	89.26	12.16	13.93	44.60	0.513	13.49	1165.00	3467.29	33.60
9	G_9	81	34.00	76.33	117.46	10.46	12.01	24.13	0.240	11.62	1010.20	3384.25	29.85
10	G_{10}	84	61.66	84.66	80.50	11.66	14.60	32.80	0.386	12.08	1080.86	3404.45	31.75
11	G_{11}	89	33.00	72.33	103.13	13.33	14.21	46.66	0.852	16.29	1295.80	3800.01	34.10
12	G_{12}	83	32.66	74.00	79.60	8.33	13.53	33.40	0.413	9.86	802.33	2948.69	27.21
13	G_{13}	85	36.33	76.33	74.80	9.00	11.62	32.13	0.320	11.32	960.51	3427.99	28.02
Grand Mean		83.15	38.77	76.46	87.00	10.00	12.55	33.56	0.402	12.26	1031.89	3444.12	29.62
C.D.(5%)		2.92	1.30	1.82	8.64	1.76	1.44	3.67	0.05	1.55	46.63	70.87	0.57
SE(m)		1.00	0.44	0.62	2.96	0.60	0.49	1.26	0.02	0.53	15.98	24.28	0.19
SE(d)		1.42	0.63	0.88	4.19	0.85	0.70	1.78	0.03	0.75	22.59	34.34	0.27
C.V.		2.09	1.98	1.41	5.89	10.46	6.83	6.49	7.69	7.51	2.68	1.22	1.14

Table.2 Mean performance of 13 cowpea genotypes for 9 seedlings attributes

S.No.	G	Germination %	Root Length (cm)	Shoot Length (cm)	Seedling Length (cm)	Seedling Fresh Weight (gm)	Seedling Dry Weight (gm)	Seedling Vigor Index length	Seedling Vigor Index mass	100 seed weight
1	**G_1**	84	10.50	15.09	25.59	3.12	0.434	2149.62	36.44	9.10
2	**G_2**	87	11.85	16.34	28.19	4.15	0.481	2452.62	41.87	11.12
3	**G_3**	91	15.40	21.02	36.42	5.87	0.674	3313.70	61.35	12.40
4	**G_4**	83	10.10	13.97	24.07	3.35	0.416	1998.32	34.43	8.17
5	**G_5**	88	12.75	16.02	28.77	4.68	0.502	2533.80	44.19	9.81
6	**G_6**	86	11.84	15.62	27.46	3.95	0.466	2363.97	40.07	10.53
7	**G_7**	84	10.95	14.36	25.31	3.51	0.441	2125.22	36.99	9.61
8	**G_8**	89	14.45	18.56	33.01	4.94	0.570	2939.47	50.71	11.70
9	**G_9**	85	11.17	16.10	27.27	4.45	0.508	2319.25	43.26	10.21
10	**G_{10}**	89	13.42	17.03	30.45	4.58	0.537	2709.49	47.83	11.39
11	**G_{11}**	92	16.42	19.42	35.84	5.42	0.610	3297.95	56.16	12.16
12	**G_{12}**	86	11.52	15.37	26.89	3.69	0.460	2314.20	39.62	10.80
13	**G_{13}**	90	14.10	17.60	31.70	5.07	0.547	2852.07	49.27	12.03
Grand Mean		**87.23**	**12.65**	**16.65**	**29.30**	**4.36**	**0.511**	**2566.89**	**44.78**	**10.69**
C.D.(5%)		2.69	0.93	1.63	2.02	0.53	0.07	195.05	5.92	0.40
SE(m)		0.94	0.32	0.57	0.70	0.18	0.02	68.34	2.07	0.14
C.V.		2.15	5.16	6.85	4.82	8.53	9.71	5.32	9.24	2.67

Significantly higher 100 seed weight (12.40 gm) was recorded by G_3– CP-5 and it was followed by G_{11}– CP-16(12.16 gm), Minimum 100 seed weight was recorded by G_4– CP-7(8.17 gm). 100-seed weight was principal yield contributing traits. Similar

results have been also reported by Henry *et al.*, (2003), Verma *et al.*, (2005), Dharmalingam *et al.*, (1989), Stahr (2012).

In conclusion, the evaluation of genotypic performance of different genotype of cowpea, significantly in both field and lab conditions. Total 13genotypes check in this experiment and observe G_3(CP-5) followed by G_{11} (CP-16), and G_{13} (Pant lobia-4) significantly increased the growth, yield and quality parameters of cowpea. Among the all 13genotypes of cowpea CP-5 showed maximum quality and yielding characters and find out all characters lowest in G_4 (CP-7). These conclusions are based on the results of six months investigation and therefore further investigation is needed to arrive at valid recommendations.

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