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Genotypes Evaluation for Outperformed in Growth and Yield of Cowpea [*Vigna unguiculata* (L.) Walp.] in Varanasi Region of Uttar Pradesh

Preetinanda Mohanty[1], Chandra Bhushan[1], Mohammad Vaheed[1], Sameer Shrivastava[1], S.K. Verma[1], Sudhir Kumar Rajpoot[1]

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ABSTRACT

Background: Cowpea [*Vigna unguiculata* (L.) Walp.] is a versatile legume crop valued for its high nutritional content, drought tolerance and dual-purpose use as food and fodder. Each region has unique conditions, including varying climates, soil types and pest pressures. Despite its potential, limited information is available on the performance of diverse genotypes under the agro-climatic conditions of eastern Uttar Pradesh. In the Varanasi region, where climatic variability and soil constraints often limit legume productivity, identifying high-yielding and well-adapted cowpea genotypes is essential to enhance crop productivity, resource-use efficiency and sustainability of the cropping systems.

Methods: A field experiment was conducted during the *Kharif* season of 2021 and 2022 at the Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. Ten cowpea genotypes (PGCP-28, PGCP-63, PGCP-68, PGCP-69, PGCP-73, CP-6, CP-7, *Kashi Kanchan,* Pant *Lobia*-1 and Pant *Lobia*-5) were evaluated in a randomized block design with three replications. Data were recorded on various growth, yield and quality parameters and analysed using standard ANOVA procedures.

Result: Significant differences were observed among genotypes for most traits. Genotype PGCP-68 exhibited superior performance with the highest grain yield (1648 kg/ha), number of branches per plant (18.8), pods per plant (13.6), seeds per pod (14.8), 100 seed weight (19.2 g) and protein content (26.8%). PGCP-68 also recorded the highest total dry matter (43.6 g/plant) and harvest index (56.3%). Based on these findings, PGCP-68 was identified as the most promising genotype for cultivation in the Varanasi region.

Key words: Cowpea, Genotype, *Lobia*, Productivity, Varieties.

INTRODUCTION

Botanically cowpea [*Vigna unguiculata* (L.) Walp.] belongs to the family Fabaceae, having chromosome no. 2n = 22. Cowpea is an annual herbaceous plant with alternate trifoliate leaves that have ovate-shaped leaflets and well-developed tap root system. It can be short and bushy or trailing type. Most of the wild variants of the cowpea are found in Central Africa, where it is likely to have originated. It has now spread to a large number of nations worldwide. The total harvested area of cowpea for its dry grains is estimated to cover over 15 million hectares worldwide, yielding around 9 million metric tons (Olorunwa *et al*., 2023; Laosatit *et al*., 2024). The growing recognition of the potential of cowpea as a climate-resilient crop highlights its role in enhancing food security and nutrition (Lonardi *et al*., 2019). Globally, dry grain production, harvested area and yield of cowpea have steadily increased over the past years (https://www.fao.org/faostat/en/; Accessed 2024/07/17). While production is widely distributed, the largest proportion (95.4%) of global dry grain cowpea is produced in Africa, particularly West Africa followed by Asia (2.9%) with the America (1.3%) and Europe (0.5%) recording smaller shares. This resilient legume thrives in water-limited and soil-deficient environments with its high protein content, low carbon footprint, short growth period and productivity in marginal areas aligning with Sustainable Development Goals (SDGs), namely SDGs 2, 3 and 13. In India, cowpea is a minor pulse crop grown primarily in arid and semi-arid plains, covering approximately 3.9 million hectares and yielding 2.21 million tonnes annually (Giridhar *et al*., 2020).

It is mostly grown in the semi-arid and arid regions of Punjab, Haryana, Delhi and Uttar Pradesh as well as in sizeable quantities in Rajasthan, Karnataka, Kerala, Tamil Nadu, Maharashtra, Gujarat, Odisha, West Bengal and other states. Cowpea is grown in tropics for its tender green pods and shelled immature seeds used as vegetable and

[1]Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi-221 005, Uttar Pradesh, India.

Corresponding Author: Mohammad Vaheed, Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi-221 005, Uttar Pradesh, India.
Email: vaheedias@bhu.ac.in

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dry seeds used as pulse. It is grown for immature pods and mature grains. The haulms are also fed to livestock. Cowpea is known as drought hardy nature, its wide and droopy leaves keep soils and soil moisture conserved due to shading effect. It is also known as black-eyed pea or southern pea *etc*. and has multiple uses like food, feed, forage, fodder, green manuring and vegetable (Saravaiya *et al*., 2014). According to Davis *et al*. (2000), the mature cowpea seed has 24.5% protein, 63.6% carbohydrates, 1.9% fat, 6.3% fibre, 0.00074% thiamine, 0.00042% riboflavin and 0.00281% niacin. Green leaves contain between 3 and 4% of protein, immature pods between 4 and 5% and mature seeds between 25 and 30%.

Several researchers have demonstrated considerable genotypic variability in cowpea for yield-related traits, physiological efficiency and adaptability across environments. Das *et al*. (2021) reported significant ($p<0.01$) variation among genotypes for pod yield (50-85 g plant^{-1}) and 100-seed weight (12-17 g) with heritability values exceeding 90%, indicating high genetic control over key yield traits. Similarly, Parmar *et al*. (2025) observed Genotypic and Phenotypic Coefficients of Variation (GCV = 8.7-21.5%; PCV = 10.1-23.8%), coupled with heritability up to 91% for yield and protein content, revealing substantial scope for selection of high-yielding genotypes. Singh *et al*. (2020) confirmed significant genotype × environment interactions ($p<0.01$) and identified genotypes GC-3 and RC-19 as stable across arid environments. Furthermore, Lata *et al*. (2024) demonstrated that under 80% PE (pre-emergence) irrigation, yields improved by 17-35% over sub- or full-irrigation regimes, with *Swarna Mukut* recording 12.6 t ha^{-1} and highest water-use efficiency. A recent synthesis by Vaishna *et al*. (2025) highlighted broad genetic diversity (Nei's distance 0.32-0.71) and yield potential of 0.8-2.5 t ha^{-1} (grain) and 5-14 t ha^{-1} (vegetable) types, underscoring the necessity of exploiting genotype variability for location-specific improvement. Collectively, these findings emphasize that identifying high-yielding and adaptable genotypes is crucial for optimizing productivity under diverse agro-ecological conditions.

In a traditional cropping system, there is a 90-day interval between the crops of rice and wheat. If a pulse crop like cowpea with a short lifetime, or one with a maturity period of fewer than 90 days, could be cultivated during this time period, the crop intensity of such systems might be boosted and also it is vital to establish the right agronomic manipulations for attaining higher yield when promising cultivars with higher yield potential are identified for a particular region. Similarly, in Varanasi region of Uttar Pradesh, it is necessary to assess the adaptation of promising cowpea types. For commercial cultivation, choosing a superior variety is essential and after evaluation, the best performing variety should be suggested to the farmers.

MATERIALS AND METHODS

The present investigation was carried out at Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh during *Kharif* season of 2021 and 2022. The experiment was laid out in randomized block design (RBD) with three replications. Each replication consist of 10 varieties/genotypes *viz*. Pant *lobia*-1, Pant *lobia*-5, PGCP-28, PGCP-63, PGCP-68, PGCP-69 and PGCP-73 were collected from G.B. Pant University of Agriculture and Technology, Pantnagar and other three varieties *viz*., CP-6, CP-7 and *Kashi Kanchan* were collected from IIVR, Varanasi. All the genotypes were randomized separately in each replication. The experimental field falls under sandy clay loam in texture and neutral in reaction with low in organic carbon and available nitrogen and medium in available phosphorus and potassium. Before sowing, 20 kg N ha^{-1}, 60 kg P_2O_5 ha^{-1} and 30 kg K_2O ha^{-1} were applied as basal dose. Sowing was done on 13 August and 15 August 2022 with a row spacing of 45 cm and plant spacing of 10 cm, maintaining 1.5 m distance between replications and 1.0 m between plots. Two hand weeding were done to keep the plots weed free for uniform growth of plants. Pods after attaining maturity were harvested, dried under shade for 2-3 days and seeds were separated manually.

Five representative plants were tagged in each plot for recording various observations at 20, 40 days after sowing (DAS) and at harvest. Growth parameters recorded included plant height (cm), number of leaves/trifoliate leaves, number of branches and total dry weight (g plant^{-1}). Plant height was measured from the base to the tip of the main shoot; total dry weight was obtained by oven-drying plants at 70°C to constant weight. The number of nodules per plant was recorded at 40 DAS by carefully uprooting plants and washing roots under running water, while nodule dry weight (mg plant^{-1}) was determined after drying nodules at 70°C to constant weight. Days to 50% flowering were recorded as the number of days from sowing to when half the plants in a plot had at least one open flower. Yield attributes recorded included pod length (cm), number of pods per plant, number of seeds per pod and 100-seed weight (g). Pod length was measured using a ruler from five randomly selected pods, number of pods per plant and seeds per pod were counted manually and 100-seed weight was recorded using an electronic balance at 12% moisture. The yield parameters included biological yield (kg ha^{-1}), grain yield (kg ha^{-1}) and harvest index (%) was calculated using the formulae:

Biological yield (kg ha^{-1}) =

$$\frac{\text{Total above ground biomass per plot (kg)}}{\text{Net plot area (m}^2\text{)}} \times 10{,}000$$

Grain yield (kg ha^{-1}) =

$$\frac{\text{Weight of threshed seeds per plot (kg)}}{\text{Net plot area (m}^2\text{)}} \times 10{,}000$$

and adjusted to 12% moisture content. Harvest index (HI, %) was computed using the equation:

$$HI = \frac{\text{Economic yield (Grain yield)}}{\text{Biological yield}} \times 100$$

Protein content (%) in seeds was estimated from Nitrogen concentration determined by the Kjeldahl method (Moore *et al.,* 2010) and calculated as:

Protein content (%) = Total nitrogen (%) × 6.25

All data recorded were subjected to statistical analysis using the standard procedure for Analysis of Variance (ANOVA) as described by Gomez and Gomez (1984). The significance of treatments was tested by "F" test at 5% level of probability and where significant, the treatment means were compared using the Critical Difference (CD) at 5% probability level. Standard error of mean (SEm ±) was computed in all cases. Data analysis was carried out using OPSTAT (HAU, Hisar) and verified using SPSS v26 to ensure accuracy and homogeneity of variances.

RESULTS AND DISCUSSION

Impact of genotypes on growth parameters

Plant height

Significant differences were observed among all the varieties and genotypes for the selected growth parameters and are presented in Table 1. The average plant height at 20 DAS, genotype PGCP-28, recorded significantly maximum height (17.9 cm), which remained on a par with that of PGCP-68 and PGCP-63, respectively. At 40 DAS, maximum plant height was registered in genotype PGCP-68 (37.7 cm) over rest of the genotypes/varieties.

Whereas, at harvest variety CP-7 remain at par PGCP-68, recorded significantly maximum plant height over rest of the genotypes/varieties. Significantly lowest plant height was observed in CP-6 (39.0 cm) over the rest of genotypes/varieties except for Pant *lobia*-5 and PGCP-69, respectively. The observed variation in plant height might be attributed to the inherent genetic potential of the genotypes, environmental adaptability and interaction effects as supported by earlier studies. Bisikwa *et al.* (2014) reported significant varietal differences in cowpea plant height, where elite variety IT82D-889 (32.31 cm) and MU-93 (erect) (32.31 cm) recorded taller plants compared to local varieties such as Ebelat (28.10 cm) and Ichirikukwai (27.89 cm). The study also revealed that plant height increased by 7.8% under higher rainfall conditions, demonstrating the influence of genotyp-environment interaction on growth. Similarly, Patil *et al.* (2015) recorded significant differences among 20 cowpea genotypes with plant height ranging from 34.95 cm to 57.78 cm (mean 44.83 cm). The tallest genotype was C-152 (57.78 cm), while PGCP-14 (34.95 cm) was the shortest, indicating wide genetic variability for plant stature among genotypes. The variation in plant height observed in the present study is therefore consistent with previous findings, affirming that genotype plays a decisive role in growth expression and plant architecture.

Trifoliate leaves per plant

The average number trifoliate leaves per plant at 20 and 40 DAS genotype PGCP-68 registered maximum value over rest of the genotypes/varieties, except at 40 DAS the differences for trifoliate leaves were found non-significant with CP-6, PGCP-28, CP-7 and Pant *lobia*-5, respectively (Table 1). Variation in number of trifoliate leaves is might be due to genetic constitution and also might be due to better adaptability to weather conditions. Hence, cowpea harvested maximum photosynthetically active radiation (PAR) through improved canopy in terms of assimilatory surface area. Ahmad *et al.* (2017) found that cowpea varieties like UPC-626 produced the maximum number of leaves at different growth stages and increased phosphorus application contributed to higher leaf counts, emphasizing the roles of genetics and nutrition; in their experiments, leaf number increases of up to 80.90 at 60 DAS and 75.22 at 90 DAS compared to the lowest-yielding check were observed. Kandel *et al.* (2019) similarly reported that varietal differences were significant regarding leaf production, specifically at later stages, with highest leaf counts recorded for some genotypes. These findings collectively demonstrate that the number of trifoliate leaves per plant in cowpea is markedly influenced by genotype and management, with higher leaf numbers enhancing photosynthetic area and ultimately supporting pod and grain yield.

Number of branches per plant

At 20 DAS, PGCP-68 being on a par with PGCP-28 recorded significantly maximum average number of branches per plant over rest of cowpea genotypes/varieties (Table 1). At 40 DAS and at harvest, PGCP-68 being on a par with CP-7, recorded significantly maximum average number of branches per plant over rest of cowpea genotypes/varieties. Variety Pant *lobia*-1, recorded lowest average number of branches per plant over rest of the cowpea genotypes/varieties, except for variety Pant *lobia*-5 and PGCP-69 at 40 DAS whereas, at harvest genotype PGCP-69, variety *Kashi Kanchan,* variety Pant *lobia*-5 and genotype PGCP-73 observed non-significant the differences among themselves. This variation is might be due to genetic constitution and also might be due to better adaptability to weather conditions. Similar findings were also observed by the results of Ahmad *et al.* (2017), which demonstrated significant differences in number of branches per plant among cowpea varieties, with UPC-626 producing the highest number of branches (up to 26.34 at 60 DAS), which was attributed to both genetic variation and Phosphorus nutrition. Application of 80 kg P_2O_2 ha^{-1} resulted in a significant increase in branching and UPC-626 recorded up to 5.94 branches per plant, outperforming other varieties. Similarly, Asati *et al.* (2018) reported that genotype Sel.N-1

produced a maximum of 11.25 branches per plant, significantly surpassing other genotypes, while the lowest count (8.83) was recorded for Pusa Komal. These findings support that genetic makeup and adaptability are key determinants of branch production in cowpea, correlating strongly with enhanced growth and yield attributes.

Total dry weight per plant

At 20 DAS, variety Pant *lobia*-5 and variety *Kashi Kanchan* remained at par with each other recorded significantly higher total average dry weight per plant than rest of cowpea genotypes/varieties (Table 1). While at 40 DAS and at harvest, genotypes PGCP-68 recorded significantly higher dry weight over rest of the genotypes/ varieties expect CP-7, PGCP-28 and CP-6 where, non-significant differences observed at harvest. The results are might be due to taller plants coupled with higher number of leaves and branches and higher number of pods at the time of harvest. This result is supported by Ahmad *et al*. (2017), who found that the cowpea variety UPC-626 accumulated the greatest dry matter (20.33 g at 60 DAS and 21.48 g at 90 DAS), attributed to its taller plants, greater leaf and branch numbers and higher Phosphorus nutrition improving biomass accumulation. Gereziher *et al*. (2018) likewise reported that *Kenkety* variety exhibited superior biomass production associated with higher pod and seed yields under moisture-stressed environments. These findings underscore that genetic constitution and vegetative vigour drive dry matter accumulation, which ultimately contributes to enhanced yield in cowpea.

The relationship between dry matter and grain yield among different cowpea varieties, displaying both parameters as bar graphs (Fig 1) for each genotype with an added linear regression trend line (y = 0.8073x + 13.32, R^2 = 0.2032). PGCP-68 stands out for having the highest dry matter and correspondingly high grain yield, while varieties such as Pant *lobia*-1 and CP-6 exhibit lower dry matter and grain yield values. Although the dotted trend line and the R^2 value indicate only a moderate positive correlation between dry matter accumulation and grain yield, the general pattern observed is that genotypes with greater biomass tend to achieve higher grain yields. This result suggests that improvement in total dry matter production may favourably impact grain yield in cowpea genotypes, though other physiological or genetic factors likely contribute to yield variability among varieties as evidenced by some genotypes deviating from the trend.

Number of nodules per plant and nodule dry weight

Average number of nodules per plant was recorded highest in genotype PGCP-69 (38.3), that remains at par with PGCP-68 (37.0), recorded significantly higher value than rest of the cowpea genotypes/varieties (Table 2). Average dry weight of nodules was observed highest in genotype PGCP-68, which remains significantly superior over rest of genotypes/ varieties. The similar results also studied by Dangi *et al*. (2020), who reported significant genotypic differences in

Table 1: Performance of different genotypes and varieties of cowpea for different traits (pooled data of two years).

Genotypes/ varieties	Plant height (cm)			No. of trifoliate leaves/plant			No. of branches/plant			Total dry weight/plant (g)		
	20 DAS	40 DAS	At harvest	20 DAS	40 DAS	At harvest	20 DAS	40 DAS	At harvest	20 DAS	40 DAS	At harvest
Pant *lobia*-1	14.6	19.8	47.1	8.8	33.1		5.7	6.7	8.3	1.1	10.5	28.5
Pant *lobia*-5	15.0	22.8	44.7	8.4	39.0		3.3	7.4	9.9	2.03	12.0	35.4
PGCP-28	17.9	26.2	56.0	8.9	46.2		6.1	8.2	10.5	2.0	20.0	38.8
PGCP-63	16.4	30.7	50.2	8.4	31.6		5.4	9.1	12.0	1.1	14.7	26.2
PGCP-68	17.5	37.7	61.0	10.2	47.4		6.2	10.1	14.8	2.4	26.9	43.6
PGCP-69	12.4	25.2	41.1	8.1	34.8		2.1	7.3	10.2	0.8	18.0	27.6
PGCP-73	13.6	29.1	53.6	8.3	28.2		2.5	8.1	9.4	1.0	13.2	31.7
CP-6	15.2	34.3	39.0	6.9	44.7		4.4	8.9	10.8	1.4	21.8	38.3
CP-7	10.1	28.7	66.1	8.8	42.2		4.3	9.4	12.3	1.2	24.2	40.4
Kashi Kanchan	13.9	24.8	59.2	9.2	37.3		4.1	8.0	10.0	2.4	16.3	36.6
SEm±	0.74	0.87	2.0	0.2	2.9		0.14	0.26	0.7	0.05	0.74	2.1
CD (P=0.05)	2.2	2.6	6.1	0.7	8.7		0.42	0.80	2.1	0.14	2.24	6.2

nodulation, with nodules per plant ranging from about 23 to 47, where genotypes with higher nodulation also showed superior growth and yield parameters due to better nitrogen fixation.

Days to 50% flowering

Days to 50% flowering was varied statistically among the genotypes/varieties studied during the investigation. The lowest days for 50% flowering were recorded in the genotype CP-6 (36.00 days) which was at par with genotype CP-7 (Table 2). The genotype PGCP-68 recorded the highest days to 50% flowering (43.7 days), which was at par with Pant *lobia*-1 and *Kashi Kanchan,* respectively. This variation is influenced by intricate interactions of genetic and environmental factors such as temperature and photoperiod. Khanpara *et al*. (2016) observed a flowering range from 45.33 to 59.67 days among vegetable cowpea genotypes with significant genetic variability and heritability for flowering time, indicating its responsiveness to genetic control and breeding potential. Darai *et al.* (2023) reported days to 50% flowering between 49 and 68.5 days in seed-type cowpea genotypes, emphasizing the role of genetics and environment in modulating this trait under different agroecological conditions. Manohara *et al*. (2021) also documented a flowering range of 49 to 68.5 days under residual moisture conditions in rice-fallow areas, highlighting genetic variation among 23 genotypes and the significance of flowering time for adaptation in moisture-limited environments. These studies confirm that days to flowering is a complex trait shaped by genotypic differences and environmental interactions, supporting the observed variation in the present study.

Impact of genotypes on yield parameters

Number of pods per plant

The highest number of pods per plant was reported in genotype PGCP-68 (13.6) which remain at par with variety CP-7 (13.4) followed by genotype PGCP-28 (13.3) and varieties Pant *lobia*-5 (12.5) and CP-6 (11.9), respectively (Table 2). Whereas, PGCP-63 (6.07) recorded significantly lowest number of pods per plant. The findings of Parmar *et al*. (2025); Vaishna *et al.* (2025) and Kandel *et al*. (2019) support the observed differences in number of pods per plant in the studied cowpea genotypes. Parmar *et al*. (2025) highlighted significant genetic variability in seed yield and yield components across 31 cowpea genotypes, identifying specific lines and testers with high combining ability (CA) for traits such as seed yield, harvest index and protein content, which indirectly relate to pod development. Vaishna *et al.* (2025) reviewed the genetic diversity in cowpea and emphasized the importance of exploiting genotypic variation to improve yield and pod traits, underscoring the role of genetic diversity in enhancing crop productivity. Kandel *et al.* (2019) reported significant varietal differences in pod number per plant among cowpea genotypes evaluated in Nepal, with the highest pod numbers associated with superior yield and pod characteristics, confirming the influence of genetic factors on pod production. These studies corroborate that genetic traits regulating prolific flowering and pod development are fundamental in determining the number of pods per plant, aligning with the higher pod counts observed in genotypes PGCP-68, CP-7 and PGCP-28 in the present investigation.

Pod length

The average pod length was recorded highest in variety CP-6 (27.7 cm) over rest of genotypes/varieties evaluated (Table 2). Next in order to this, variety *Kashi Kanchan* which was remains on par with CP-7, recorded significantly higher pod length over rest of the remaining genotypes/varieties. Genotype PGCP-73 (14.7 cm), recorded significantly lowest pod length over the remaining genotypes/varieties except Pant *lobia*-1 and PGCP-63, respectively. The variation in pod length could be due to genotypic variations and influence of environment. Similar findings were also reported by Bhattarai *et al*. (2017) and observed the significant

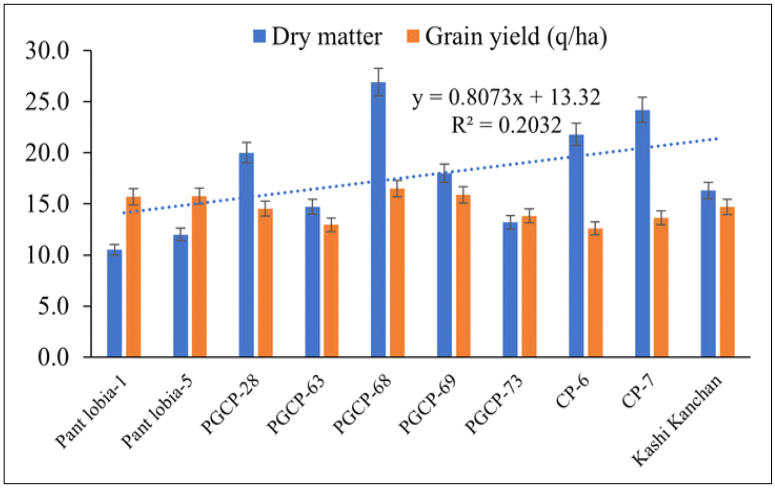


Fig 1: Relation between grain yield and dry matter of different cowpea varieties.

variation in pod length among different cowpea genotypes grown under upland conditions in western mid hills of Nepal. The genotype IT 86F-2062-5 recorded the longest pods measuring 21.00 cm, while IT 99K-573-2-1 had the shortest pods at 14.69 cm, indicating a wide genotypic influence on pod length. This variation was attributed to inherent genetic differences as well as environmental interactions. Similar to the present study, their findings showed that pod length varied considerably among genotypes, with genotypic characteristics playing a principal role in pod size determination. These results align with the observed highest pod length in variety CP-6 and next highest in *Kashi Kanchan* and CP-7, whereas PGCP-73 and some other genotypes recorded significantly shorter pods, indicating genetic and environmental effects on pod length.

Number of seeds per pod

Number of seeds per pod was recorded maximum in genotype PGCP-68 (14.8) than rest of cowpea genotypes except for variety CP-7 (13.3) and genotype PGCP-28 (13.1) where, the differences were observed non-significant among themselves (Table 2). Genotype PGCP-63 (8.2) remained on a par with that of PGCP-69 (8.5) and Pant *lobia*-1(10.0) recorded significantly lowest number of seeds per pod than rest of the cowpea genotypes/varieties. The seed of cowpea genotypes/varieties varied in seed coat colour and seed shape as shown in Plate 1. Similar results were also reported by Asati *et al*. (2018), reported that the cowpea genotype Sel. N-1 exhibited the highest number of seeds per pod (19.33), with significant variation among genotypes attributed to differences in genetic makeup and nutrient availability, confirming that seed count per pod is a heritable trait influenced by genotype selection. Dalorima *et al.* (2014) found improved varieties generally produced more seeds per pod (up to 15) with significant differences compared to local varieties, indicating that breeding and variety improvement can enhance seed set in cowpea. Dangi *et al.* (2020) highlighted significant differences in the number of seeds per pod among 13 cowpea genotypes under Prayagraj conditions, with seed counts ranging from approximately 9.85 to 16.13 seeds per pod, thus supporting the influence of genotypic variation on this yield component. This overall evidence confirms that number of seeds per pod in cowpea is strongly governed by genetic differences among varieties.

100-seed weight

Significantly maximum 100 seed weight was recorded in genotype PGCP-68 (19.2 g) than remaining cowpea genotypes/varieties tested (Table 2). Significantly lowest 100 seed weight was registered in Pant *lobia*-1(12.3 g) than remaining cowpea genotypes/ varieties except for CP-6 (12.5 g) where, the differences for 100 seed weight were non-significant. Gereziher *et al.* (2018) found significant diversity in 100 seed weight among cowpea varieties tested in southern Tigray and Ethiopia, reporting mean values from 13.99 g to 14.62 g, with variety differences attributed

Table 2: Performance of different genotypes and varieties of cowpea for various traits (pooled data of two years).

Genotypes/ varieties	No. of nodules per plant	Nodule dry weight (g)	Days to 50% flowering	No. of pods per plant	Pod length (cm)	No. of seeds per pod	Biological yield (kg/ha)	Grain yield (kg/ha)	100-seed weight (g)	Harvest index (%)	N content in grain (%)	Protein content (%)
Pant *lobia*-1	33.0	0.36	42.7	8.2	15.5	10.0	3028	1568	12.3	51.8	4.00	25.0
Pant *lobia*-5	18.3	0.34	39.7	12.5	16.8	11.8	3224	1574	13.5	48.8	3.87	24.2
PGCP-28	19.3	0.28	38.3	13.3	17.0	13.1	2970	1451	15.8	48.9	4.05	25.3
PGCP-63	27.3	0.54	41.7	6.07	15.3	8.2	2940	1296	13.1	44.1	3.94	24.6
PGCP-68	37.0	0.63	43.7	13.6	18.2	14.8	3403	1648	19.2	48.4	4.29	26.8
PGCP-69	38.3	0.44	40.0	7.3	17.8	8.5	3355	1587	14.2	47.3	3.89	24.3
PGCP-73	18.7	0.31	39.5	9.5	14.7	11.0	2956	1383	17.8	46.8	3.86	24.1
CP-6	16.7	0.34	36.0	11.9	27.7	12.5	2886	1259	12.5	43.6	3.70	23.1
CP-7	19.0	0.24	37.7	13.4	24.6	13.3	2910	1364	13.7	46.9	3.97	24.8
Kashi Kanchan	17.0	0.53	41.7	10.7	25.3	12.2	3039	1469	13.0	48.3	4.22	26.4
SEm±	1.0	0.02	0.7	0.7	0.49	0.64	100	78	0.24	-	-	-
CD (P=0.05)	2.9	0.05	2.1	2.0	1.46	1.9	296	171	0.73	-	-	-

to genetic makeup and ecological adaptation, although hundred seed weight was not statistically significant among the tested genotypes. Giridhar *et al.* (2020) reported that cowpea varieties differed significantly for 100 grain test weight, with *Gomati* recording the highest value (up to 53.2 g) and *Kamini* showing the lowest (50.6 g) and that wider plant spacing further enhanced 100 grain weight, highlighting the role of both genotype and agronomic management in maximizing seed size. These findings confirm that 100-seed weight in cowpea is strongly impacted by genetic traits and growing conditions, supporting the observed maximal seed weight in PGCP-68 and minimal values in Pant *lobia-1* and CP-6.

Biological yield

Genotype PGCP-68 (3403 kg/ha) being on a par with that of variety Pant *lobia*-5 (3224 kg/ha) and genotype PGCP-69 (3355 kg/ha) recorded significantly highest value of biological yield than remaining cowpea genotypes/ varieties (Table 2). whereas, CP-6 (2886 kg/ha) recorded the lowest value. The findings are aligned with the studies of Giridhar *et al.* (2020) showed that plant spacing influenced cowpea biological yield with the widest spacing of 20 cm resulting in noticeably higher grain and stover yields due to reduced competition for light, moisture and nutrients, while the varieties did not significantly differ for biological yield attributes, indicating the impact of population density and agronomic management on biomass accumulation. Dangi *et al.* (2020) observed significant variability in biological yield among cowpea genotypes with the best-performing genotypes producing up to 4637 kg/ha, highlighting that biological yield is largely determined by genotypic potential for biomass and the expression of multiple growth and yield components. Manohara *et al.* (2021) reported high genetic variability in straw and seed yield among cowpea genotypes grown in rice-fallow conditions, emphasizing that straw yield and harvest index have a direct positive impact on seed yield and that selecting for higher biomass traits is beneficial for improving overall productivity under such environments. These findings together confirm that biological yield in cowpea is significantly affected by genotype, plant spacing and associated yield attributes.

Grain yield

Genotype PGCP-68 (1648 kg/ha) recorded significantly higher grain yield than remaining genotypes except for PGCP-69(1587 kg/ha), followed by Pant *lobia*-5 (1574 kg/ha) and Pant *lobia*-1(1568 kg/ha), respectively. Significantly lowest cowpea grain yield was registered with CP-6 (1259 kg/ha) than rest of the genotypes except for PGCP-63(1296 kg/ha), CP-7(1364 kg/ha) and PGCP-73 (1383 kg/ha), respectively. Darai *et al*. (2023) reported significant genotypic differences in grain yield among fourteen seed-type cowpea genotypes evaluated over two years with yields ranging from 934 kg/ha to 1449 kg/ha and the highest yields being directly associated with superior pod production, seed weight and plant height. Rout *et al*. (2023) similarly found significant variability in grain yield among fifteen varieties grown under Prayagraj conditions, where booster cowpea and *Kashi Kanchan* delivered the highest yield per plant and lower yields were linked to genotypes exhibiting fewer pods and seeds per plant. Both studies confirm that genetic constitution and yield attributes strongly influence grain yield potential, corroborating the present findings where PGCP-68, PGCP-69 and Pant *lobia*-5 exhibited superior performance, while CP-6 recorded the lowest yield due to limited expression of yield components.

Harvest index

Highest value of harvest index was obtained in Pant *lobia*-1 (51.8%) whereas, lowest value of harvest index was registered with CP-6 (43.6%) (Table 2). Ahmad *et al*. (2017) reported a harvest index range of 40.2% to 51.4% among different cowpea cultivars, higher harvest index associated with varieties showing improved partitioning of assimilates towards grain yield, reflecting genotypic differences in efficiency of biomass utilization. Giridhar *et al*. (2020) observed harvest index values ranging from approximately 40% to 52% in cowpea varieties subjected to different plant densities,

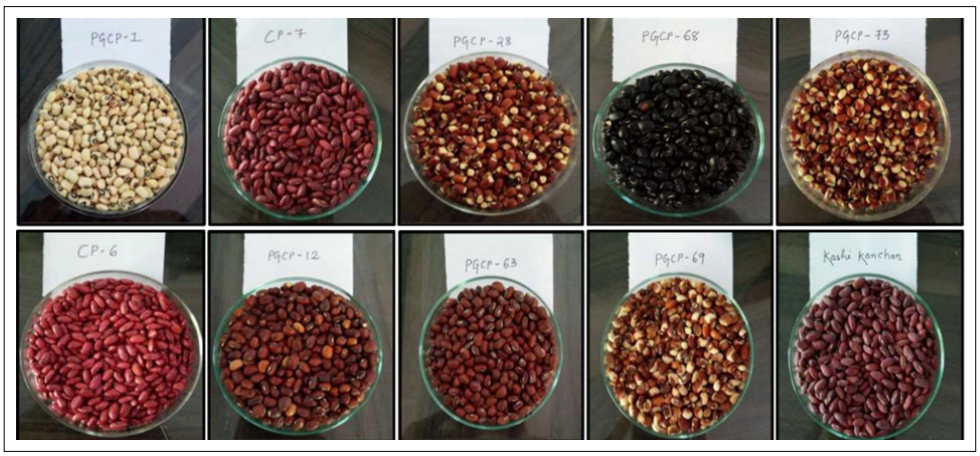


Plate 1: Photographs showing variation in seeds of different cowpea genotypes/varieties.

where varieties with higher grain yields had correspondingly higher harvest indices, indicating the importance of both genotype and agronomic management in improving harvest efficiency. Dangi *et al*. (2020) found significant variation in harvest index among cowpea genotypes grown under Prayagraj conditions with values from 41.5% to 53.3%, demonstrating the role of genetic variability in assimilate partitioning and yield potential. These findings support the present results showing the highest harvest index in Pant *lobia*-1 and lowest in CP-6, linked to differences in grain and biological yield among tested genotypes.

Impact of genotypes on quality parameters

Nitrogen content in grain

Highest value of nitrogen (N) content in grain registered in PGCP-68 (4.29%), whereas, lowest value of N content in grain was observed in CP-6 (3.70%) (Table 2). Nitrogen content in cowpea grain varies significantly among genotypes and is influenced by efficient nutrient uptake and utilization. Parmar *et al*. (2025) reported Nitrogen content ranging between 3.45% and 4.30% across diverse genotypes, highlighting genetic potential for improved N accumulation. Similarly, Kandel *et al*. (2019) observed Nitrogen content ranging from 3.5% to 4.3% linked to genotype and soil nutrient availability. Giridhar *et al*. (2020) also documented Nitrogen content variations linked to genotypic differences and agronomic factors, supporting the observed superior N content in PGCP-68 (4.29%) and lower content in CP-6 (3.70%) in this study.

Protein content in grain

Maximum protein content was registered in genotype PGCP-68 (26.8%) whereas, minimum value for protein content was noticed in CP-6 (23.1%) (Table 2). Protein content in cowpea grain is largely governed by genetic constitution and environmental interactions. Parmar *et al*. (2025) reported protein content variation from 22.5% to 27.0%, where genotypes exhibiting higher protein were linked with efficient Nitrogen assimilation capacities. Dangi *et al*. (2020) demonstrated genotypic variability for protein content (23%-27%) among cowpea genotypes, suggesting breeding potential for protein enhancement. Giridhar *et al*. (2020) confirmed these findings with protein content differences attributable to genetic and management factors. These results corroborate the higher protein content in PGCP-68 (26.8%) and lower in CP-6 (23.1%) recorded in the present study.

CONCLUSION

On the basis of above results, it can be concluded that the genotype PGCP-68 is superior to all other treatments on the basis of growth, yield and quality parameters. So, for commercial cultivation by the farmers of Varanasi region, cowpea genotype PGCP-68 is recommended. Future studies should focus on multi-location trials of promising genotypes like PGCP-68 to assess their stability across diverse agro-climatic zones. Integration with improved agronomic practices and stress tolerance screening could further enhance yield potential and adaptability. Additionally, exploring value-added traits like micronutrient content will strengthen cowpea's role in sustainable cropping systems.

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Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript.

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