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# Estimates of variability, Heritability and Genetic Advance for Yield and Quality Traits in Vegetable Cowpea (*Vigna unguiculata* sub sp. *sesquipedalis* (L.) Verdcourt)

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**ABSTRACT: The phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability and genetic advance were estimated for the 19 quantitative characters in fifteen crosses of vegetable cowpea in an experiment conducted at the Department of Vegetable Science, College of Agriculture, Vellayani in 2022-23. The PCV values for all the characters were found to be higher than the GCV values but in smaller magnitude, which implied a lesser influence of environmental factors for these characters. The Highest PCV and GCV values were observed for pod weight (52.80 and 51.60, respectively), followed by pods per plant (43.25 and 32.88, respectively). The highest values for heritability and genetic advance were recorded for pod weight (95.80 and 104.22, respectively). High heritability estimates coupled with genetic advance for characters such as vine length, terminal leaf width, lateral leaf width, pod length, pod weight, number of seeds per pod, 100 seed weight, protein content and keeping quality suggest the relevance of additive gene action in the improvement of these traits.**

**Keywords:** Yard long bean, variability, GCV, PCV, heritability, genetic advance.

## INTRODUCTION

Vegetable cowpea or trailing type of yard long bean (*Vigna unguiculata* subsp. *sesquipedalis* (L.) Verdcourt) is a warm season leguminous crop widely cultivated in the tropical and semi-tropical regions of the world for vegetable purposes (Saidaiah *et al*., 2021). Yard long bean is extensively cultivated in many countries of South East Asia, such as Taiwan, Philippines, Indonesia, Thailand, India, Pakistan, Bangladesh and South China (Lakshmi, 2016; Merin, 2022). In India, it has emerged as a remunerative vegetable crop cultivated for its tender pods, especially in the Southern states. High productivity, high nutritive value, suitability in different cropping systems, high nitrogen fixation ability and drought tolerance features make it a cost-effective and preferred crop in the tropics. There is a rich diversity in vegetable cowpea varieties in Kerala since it has been cultivated since time immemorial. Being a self-pollinated crop, variability is often created in cowpea through hybridization between selected parents. A comprehensive understanding of the current genetic variability is necessary for the development of high-yielding cowpea varieties (Meenatchi *et al*., 2019; Kavyashree *et al.,* 2023). To assess the amount of progress anticipated from selection, one important aspect is the understanding of variability in the population resulting from both genetic and non-genetic factors. Determining genetic variability parameters provides information about the degree of variability found in a material, the heritable component of that variable, and the potential genetic advancement through effective selection. Many researchers have reported that high heritability combined with high genetic advance is more beneficial in forecasting the outcome of selection for yield and its constituent parts (Vinay *et al*., 2022; Zaki *et al*., 2022). Against this backdrop, the present study attempted to determine the phenotypic variability, heritability and genetic advance of 19 different traits related to yield in fifteen crosses of vegetable cowpeas.

## MATERIALS AND METHODS

The experiment material consists of five high yielding yard long bean varieties as lines and three cowpea varieties as testers. The lines as female parents and testers as pollen parents were laid in two crossing blocks in Kharif 2022 in the open field and in a rain shelter at Pepper Research Station, Panniyur, Kerala Agricultural University to produce 15 $F_1$ hybrids. The fifteen crosses and their eight parents were raised in Rabi 2022 in a randomized block design with three replications. One week after sowing, the seedlings grown in portrays were moved to the main field at a spacing of one meter by one meter, with a plot size of 10 $m^2$ in each replication. The following 15 significant yield characteristics were observed: vine length, branches per plant, terminal leaf length, terminal leaf

width, lateral leaf length, lateral leaf width, days to flowering, pod length, pod girth, pod weight, pods per plant 100 seed weight, seeds per pod, yield per plant, yield per plot, days to harvest, crop duration, protein content and keeping quality. The analysis of variance was performed using the treatment data to determine the genotypic variability. The phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability in a broad sense and genetic advance were estimated using the GRAPES (General R-based Analysis Platform Empowered by Statistics) statistical package by Gopinath *et al*. (2020).

## RESULTS AND DISCUSSION

Analysis of variance for different yield and yield attributing traits studied revealed the presence of significant variation between the genotypes for all the characters (Table 1). Thus, there is ample scope for improvement of different quantitative characters in the experimental material. The estimates of the genetic parameters such as mean, genotypic coefficients of variation (GCV), phenotypic coefficients of variation (PCV), broad-sense heritability and genetic advance for19 quantitative characters are furnished in Table 2.

The vine length among different genotypes ranged from 287.33 cm to 597.33 cm, whereas the number of branches per plant ranged between 2.50 cm and 5.40 cm. The mean value for terminal leaf length and terminal leaf width was 14.19 cm and 8.22 cm, respectively, while that of lateral leaf length and lateral leaf width was 13.64 cm and 7.59 cm, respectively. The variability in vegetative characteristics of yard long bean was akin to the results of Hossain *et al*. (2013); Rambabu *et al*. (2016); Thangam *et al*. (2020). Days to first flowering ranged from 38.67 days to 50.33 days. High variability was observed in pod length that varied from 14.91 cm to 67.11 cm. Pod girth ranged between 2.84 cm and 3.56 cm and pod weight between 9.80 g and 38.60 g. The mean value for pods per plant was 90.49, and the range varied from 37.93-153.00 among genotypes. The range of number of seeds per pod and 100 seed weight (g) were 12.93- 19.53 and 10.33-20.17 respectively. High variability was noticed in yield per plant (g) and yield per plot (kg) that ranged between 131.99-1734.80 and 1.32-17.35 respectively. Similarly, the mean values of days to harvest varied from 51.03 days to 64.47 days, while crop duration from 99.20 days to 108.93 days. For flowering and yield traits, similar observations were reported by Thangam *et al*. (2020); Merin (2022). For protein content (%) the mean value recorded was 4.87. Wide variability was also observed for keeping quality (PLW %) that ranged between 18.90 and 34.52. Variability in different quality characters of yard long bean has been documented by Sivakumar (2012); Feba (2017); Merin (2022).

**Table 1: Analysis of variance (mean squares) of heterosis for different traits in yard long bean.**

| Characters | Replication | Treatments | Parents | Parents Vs Crosses | Crosses | Error |
|---|---|---|---|---|---|---|
| DF | 2 | 22 | 7 | 1 | 14 | 44 |
| Vine length | 8485.174** | 12858.204** | 32392.804** | 747.001 | 3955.990* | 1599.113 |
| Branches per plant | 10.167** | 2.729** | 2.770** | 8.706** | 2.281** | 0.670 |
| Terminal leaf length | 1.261 | 7.495** | 15.620** | 14.671** | 2.920* | 1.425 |
| Terminal leaf width | 0.435 | 7.718** | 17.144** | 0.592 | 3.514** | 0.709 |
| Lateral leaf length | 1.350 | 7.267** | 14.673** | 16.358** | 2.914** | 1.449 |
| Lateral leaf width | 0.777 | 8.310** | 18.663** | 0.329 | 3.704** | 0.743 |
| Days to flowering | 38.758** | 37.866** | 19.459** | 149.98** | 39.061** | 4.309 |
| Pod length | 6.374 | 6.386** | 1.137** | 1.986** | 2.930** | 4.636 |
| Pod girth | 0.028 | 0.113* | 0.225** | 0.036 | 0.062 | 0.057 |
| Pod weight | 0.5289 | 244.289** | 486.692** | 508.043** | 104.248** | 3.454 |
| Pods per plant | 5209.821** | 3271.103** | 1918.761* | 32434.979** | 1864.139** | 688.486 |
| Seeds per pod | 0.113 | 15.671** | 9.017** | 15.169** | 19.035** | 1.120 |
| 100 seed weight | 0.369 | 20.044** | 42.874** | 0.500 | 10.025** | 0.456 |
| Yield per plant | 898389.49** | 369799.33** | 322788.86** | 1884628.51** | 285102.49** | 84673.39 |
| Yield per plot | 52.081* | 29.682** | 33.370* | 125.833** | 20.969 | 11.683 |
| Days to harvest | 33.201** | 39.434** | 32.573** | 87.924** | 39.401** | 2.774** |
| Crop duration | 320.824** | 21.868** | 22.750* | 79.905** | 17.282* | 8.078 |
| Protein content | 0.044 | 1.459** | 1.434** | 0.606** | 1.533** | 0.024** |
| Keeping quality | 6.529 | 76.808** | 62.302** | 43.199** | 86.462** | 8.687 |

***Significant at p= 0.05; p= 0.01 levels respectively

The PCV values for all the characters were found to be higher than the GCV values but in smaller magnitude, which implied a lesser influence of environmental factors for these characters. Thouseem (2017); Darsana (2020); Nkhoma *et al*. (2020); Thangam *et al*. (2020) made similar observations. The PCV and GCV values ranged from 3.31 to 52.80 and 2.06 to 51.68, respectively. Heritability estimates expressed in percentage ranged from 26.00 % to 97.80 %, and estimates of genetic advance ranged from 2.63 to 104.

The PCV and GCV were moderate (15.03 and 12.57, respectively), heritability was very high (70.00 %), and genetic advance was moderate for vine length. For branches per plant, high PCV and GCV values (28.61 and 20.36, respectively), along with moderate heritability (50.60%) and high genetic advance, were reported (29.84) coupled with moderate heritability

(56.60 %) and genetic advance were observed for lateral leaf length. The estimates of PCV and GCV were high (22.94 and 20.09, respectively), along with high heritability (76.70 %) and genetic advance (36.23) for lateral leaf width. Days to first flowering showed low GCV (9.74) and PCV (8.55) values, together with high estimates of heritability (76.90 %) and moderate estimates of genetic advance (15.45) in conformity with studies of Saidaiah *et al*. (2021); Sudhamani *et al*. (2022); Sunil *et al* (2023). For leaf length and width, Vamshi *et al.* (2022); Wadghane *et al*. (2022) and for branches per plant Darsana (2020); Vamshi *et al.* (2022) also reported similar results. High heritability for vine length and days to flowering in cowpea has been observed by Paghadar *et al.* (2019); Ahmed *et al.* (2021); Afrose *et al.* (2023).

**Table 2: Genetic parameters for yield and quality characters in yard long bean.**

| Characters | Range | | Mean | Coefficient of variation (%) | | Heritability (%) | Genetic advance (%) |
|---|---|---|---|---|---|---|---|
| | Min | Max | | PCV | GCV | | |
| Vine length (cm) | 287.33 | 597.33 | 499.01 | 15.03 | 12.57 | 70.00 | 21.66 |
| No. of branches per plant | 2.50 | 5.40 | 3.94 | 28.61 | 20.36 | 50.60 | 29.84 |
| Terminal leaf length (cm) | 9.28 | 15.72 | 14.19 | 12.74 | 9.70 | 58.00 | 15.22 |
| Terminal leaf width (cm) | 6.32 | 13.57 | 8.22 | 20.44 | 17.80 | 75.80 | 31.92 |
| Lateral leaf length (cm) | 8.86 | 15.17 | 13.64 | 13.15 | 9.89 | 56.60 | 15.32 |
| Lateral leaf width (cm) | 5.40 | 13.07 | 7.59 | 22.94 | 20.09 | 76.70 | 36.23 |
| Days to first flowering | 38.67 | 50.33 | 44.34 | 9.74 | 8.55 | 76.90 | 15.45 |
| Pod length(cm) | 14.91 | 67.11 | 38.90 | 38.52 | 38.10 | 97.80 | 77.62 |
| Pod girth(cm) | 2.84 | 3.56 | 3.16 | 8.78 | 4.47 | 26.00 | 4.70 |
| Pod weight(g) | 9.80 | 38.60 | 18.18 | 52.80 | 51.68 | 95.80 | 104.22 |
| Pods per plant | 37.93 | 153.00 | 90.49 | 43.25 | 32.88 | 57.80 | 51.48 |
| No. of seeds per pod | 12.93 | 19.53 | 17.24 | 13.81 | 12.43 | 81.00 | 23.05 |
| 100 seed weight (g) | 10.33 | 20.17 | 14.94 | 17.01 | 16.43 | 93.30 | 32.69 |
| Yield per plant (g) | 131.99 | 1734.80 | 1010.68 | 40.57 | 29.26 | 52.00 | 43.46 |
| Yield per plot (kg) | 1.32 | 17.35 | 9.88 | 41.11 | 23.75 | 33.40 | 28.26 |
| Days to harvest | 51.03 | 64.47 | 58.15 | 6.90 | 6.24 | 81.70 | 11.62 |
| Crop duration | 99.20 | 108.93 | 105.61 | 3.31 | 2.06 | 38.60 | 2.63 |
| Protein content (%) | 4.20 | 6.37 | 4.87 | 21.79 | 18.71 | 73.80 | 33.11 |
| Keeping quality (PLW %) | 18.90 | 34.52 | 25.63 | 14.12 | 13.77 | 95.10 | 27.68 |

High estimates of PCV (38.52), GCV (38.10), heritability (97.80 %) and genetic advance (77.62) were expressed for pod length. For pod girth, low values were recorded for PCV (8.78), GCV (4.47), heritability (26.00 %) and genetic gain (4.70). The PCV and GCV were high (52.80 and 51.68, respectively) for pod weight coupled with high heritability (95.80 %) and genetic gain (104.22). Pods per plant exhibited high PCV (43.25), GCV (32.88) and genetic advance (51.48), along with moderate heritability (57.80 %). Moderate values of PCV (13.81), GCV (12.43) and genetic gain (23.05) with high heritability (81.00 %) were expressed for the number of seeds per pod. Regarding 100 seed weight, moderate estimates of PCV (17.01) and GCV (16.43), along with high estimates of heritability (93.30 %) and genetic advance (32.69) were expressed. Similar observations were given by Gerrano *et al*. (2015); Barik *et al.* (2023) for pod length, Zaki *et al*. (2022) for pod weight, Araméndiz-Tatis *et al*. (2018); Meenatchi *et al.* (2019); Owusu (2021) for pods per plant, Shanko *et al.* (2014); Paghadar *et al*. (2019); Sudhamani *et al*. (2022) for seeds per pod, and Kavyashree *et al*. (2023) for 100 seed weight. Among different traits in yard long bean, the highest phenotypic coefficient of variance and genotypic coefficient of variance was reported for pod weight in the study, which was in concurrence with Savithri *et al*. (2018); Afrose *et al*. (2023).

The PCV and GCV values for yield per plant were very high (40.57 and 29.26, respectively), coupled with moderate heritability (52.00 %) and high genetic gain (43.46). High estimates of PCV (41.11), GCV (23.75) and genetic advance (28.26), along with moderate heritability (33.40 %), were exhibited for yield per plot. The results for PCV and GCV showed that the PCV values were higher than GCV values which may be due to higher influence of environment factors in the expression of the character or due to more interaction of genotypes with the environment. The results are in accordance with Khanpara *et al.* (2016); Thangam *et al.* (2020); Aishwarya and Deepanshu (2023); Barik *et al* (2023).

For days to harvest, the PCV and GCV values were low (6.90 and 6.24, respectively), with high heritability (81.70 %) and moderate genetic advance (11.62). These findings were in agreement with Pathak *et al.* (2017) and Saidaiah *et al*. (2021). Low estimates of PCV (3.31), GCV (2.06) and genetic gain (2.63) were

observed for crop duration, along with moderate heritability (38.60 %). The estimates of PCV were high (21.79), GCV moderate (18.71) and heritability and genetic advance were high (73.80 % and 33.11, respectively) for protein content. Moderate PCV and GCV values (14.12 and 13.77, respectively), along with high heritability (95.10 %) and high genetic gain, were displayed for keeping quality. For protein content, Pathak *et al*. (2017); Ahmed *et al.* (2021); Barik *et al*. (2023) also made similar observations. The results of crop duration, protein content and keeping quality were in conformity with Merin (2022).

In the study, High PCV was recorded for the number of primary branches per plant, terminal leaf width, lateral leaf width, pod length, pod weight, pods per plant, yield per plant, yield per plot and protein content. High GCV was observed for primary branches per plant, lateral leaf width, pod length, pod weight, pods per plant, yield per plant and yield per plot. Both high PCV and GCV were recorded for the number of primary branches per plant, lateral leaf width, pod length, pod weight, pods per plant, yield per plant and yield per plot. Moderate PCV and GCV were reported for vine length, number of seeds per pod, 100 seed weight and keeping quality. The results indicate ample variability among genotypes for these characters and, hence, improvement of these traits through breeding methods.

High estimates of heritability were documented for vine length, terminal leaf width, lateral leaf width, days to flowering, pod length, pod weight, number of seeds per pod, 100 seed weight, days to harvest, protein content and keeping quality, whereas moderate values for number of primary branches per plant, terminal length, lateral leaf length, pods per plant, yield per plant and yield per plot. Low heritability was observed for pod girth. Genetic advance values were higher for vine length, number of primary branches per plant, terminal leaf width, lateral leaf width, pod length, pod weight, number of seeds per pod, 100 seed weight, pods per plant, yield per plant, yield per plot, protein content and keeping quality, while value was moderate for terminal length, lateral leaf length, days to flowering and days to harvest. Low estimates of genetic advance were recorded for pod girth and crop duration. When traits have a strong genetic advance and high heritability, this indicates additive gene action. Hence these traits can be improved by earlier phenotypic selection. For characters such as days to flowering and days to harvest, though high heritability is recorded, genetic advance is moderate, which suggests the presence of non-additive gene action and the scope of improvement through suitable hybridization programmes. Low heritability in conjunction with genetic gain was observed for pod girth alone, which indicates dominance or epistatic effect and for crop improvement, selection may not be possible. The results were in concurrence with the results of Asoontha and Abraham (2017); Sudhamani *et al*. (2022); Merin (2022); Vinay *et al.* (2022); Wadghane *et al*. (2022); Zaki *et al*. (2022); Barik *et al.* (2023); Kavyashree *et al*. (2023).

## CONCLUSIONS

High PCV, GCV, heritability and genetic advance were observed for lateral leaf width, pod length and pod weight. The magnitude of PCV and GCV were highest for pod weight, while heritability estimates were highest for pod length and genetic advance for pods per plant. High estimates of heritability combined with genetic advance for traits, such as protein content, keeping quality, number of seeds per pod, 100 seed weight, vine length, terminal leaf width, lateral leaf width, pod length, pod weight, and pods per plant imply the importance of additive gene action in improving these traits. For characters such as days to flowering and days to harvest, though high heritability is recorded, genetic advance is moderate, which suggests the presence of non-additive gene action and the scope of improvement through suitable hybridization programmes.

## FUTURE SCOPE

High heritability, along with high genetic advance was registered among the genotypes for ten quantitative traits, which indicated the scope of improving these characteristics by selection. This will facilitate the development of promising yard long bean varieties in the future.

**Author contributions.** The first author confirms sole responsibility for the following: study conception and layout of the experiment, conduct of the experiment, statistical analysis and interpretation of results, and manuscript preparation. The second author served as a scientific advisor, critically reviewed the entire research work, and corrected the final manuscript.

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**Conflict of Interest.** None.

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