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# Estimation of Genetic Variability for Dual Purpose Traits in $F_2$ Populations of Cowpea [*Vigna unguiculata* (L.)Walp.]

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**A B S T R A C T**

In order compute genetic variability, heritability and genetic advance expressed as per cent of mean, an investigation was carried out with 79 plants of $F_2$ population of MFC-09-12 × PGCP-12 and 90 plants of $F_2$population of MFC-08-14 × PL-3 in cowpea. Considerably high amount of variability was observed for the thirteen quantitative and qualitative characters under study. Environmental influence was minimum for the expression of most of the traits which is evident from narrow difference between phenotypic co-efficient of variation (PCV) and genotypic co-efficient of variation (GCV) estimates. In both the populations, heritability in broad sense was high for most of the traits coupled with high genetic advance as per cent over mean indicated presence of additive gene action for the characters. In both the $F_2$populations, good numbers of superior segregants were isolated for seed and green fodder yield related traits.

## Introduction

Cowpea is an important *kharif* food legume and forms an integral part of traditional cropping systems for the semi-arid regions of the tropics where other food legumes may not perform well. Farmers often grow a short-duration spreading variety for grain and a long- duration spreading variety for fodder, but the grain and fodder yields are poor due to low yield potential of the spreading varieties and also due to early cessation of rains. Since majority of cultivars derive their high productivity from an erect growth habit (Singh and Sharma, 1996). The use of cowpea as a dual-purpose crop, providing both grain and fodder, is attractive in mixed crop/livestock systems where land and feed are becoming increasingly scarce (Tarawali *et al.*, 1997) especially in the dry season. Similarly, the emphasis on the development of dual purpose types in other crops also were reported by Pal and Kumar (2009) in barley and Sah *et al*(2016) in maize.

Etana *et al.*, (2013) stressed upon need to develop dual purpose lines for future animal feed improvement programme. An ideal dual-purpose cowpea cultivar for intercropping/mixed farming would be a type

with semi-determinate growth habit and intermediate maturity (85-95 days) and several such varieties have been developed at IITA that yield 1.5-2.5 t/ha grain and 3-5t/ha fodder and most of them are of erect growth habit. Keeping the above facts in view, attempts were made to identify dual-purpose cowpea genotypes to identify the superior segregants in segregating population ($F_2$) in cowpea.

Selection for a character in the early generation ($F_2$ or $F_3$) would be as effective as when practiced in the later generations assuming high heritability (Allard, 1960) in self-pollinated species. An early and accurate appraisal of segregates has been of vital interest to recover superior segregants in self-pollinated species. Hence, there is a need for early generation testing and evaluation for better recovery of segregants. Therefore, selection of those crosses which are most likely to give the highest proportion of superior segregates (Singh *et al.*, 2003) and an evaluation of the potentialities of the segregates from those crosses ((Allard, 1960; Moalafi *et al.*, 2010) are the two most important steps to be considered. The success of any crop improvement programme depends on the magnitude of genetic variability and the extent to which the desirable trait is heritable (Falconer, 1960). With this background an attempt was made to study the variability for dual purpose traits in $F_2$populations of cowpea.

## Materials and Methods

### Plant material

The released varieties were evaluated for dual purpose traits, five lines (fodder types) and three testers (grain types) were crossed in Line × Tester fashion and 15 $F_1$'sweregenerated. Based on combining ability of fifteen crosses for seed yield and green fodder yield related traits, two crosses viz. MFC-09-12 × PGCP-12 and MFC-08-14 × PL-3 were advanced to $F_2$ generation. These $F_2$ populations along with their parents were evaluated at Indian Grassland and Fodder Research Institute, SRRS, Dharwad during *rabi*/summer 2014-15. All recommended packages of practices were followed to raise a good crop.

### Observations

At first flowering stage, plants were harvested for green fodder yield leaving three nodes from base of the plant. It was followed by application of fertilizer and irrigation for regeneration of the crop. Observations *viz*. number of pods per plant, number of seeds per pod, pod length, seed yield per plant and days to maturity were recorded on regenerated plant while, observations like plant height, days to first flowering, number of primary branches per plant, number of secondary branches per plant, green fodder yield per plant, leaf to stem ratio, dry matter content and crude protein content were recorded prior to harvest.

### Statistical analysis

The mean values were utilized for statistical analysis and the variance due to different sources was estimated. Both phenotypic and genotypic co-efficient of variability for all the characters were estimated using the formulae of Burton and De Vane (1953).Heritability (broad sense) was estimated for all the characters as the ratio of genotypic variance to the total variance as suggested by Hanson *et al.*, (1956). Genetic advance for each character was estimated as per the formula given by Johnson *et al.*, (1955).

## Results and Discussion

### Mean, range and variance

***Morphological traits:*** Wide range of variation was observed among the selected $F_2$ populations for almost all the characters under study when compared with their parents

(Tables 1 and 3). The mean performance of $F_2$ populations of crosses MFC-09-12 × PGCP-12 and MFC-08-14 × PL-3 were lower than both the parents for most of the characters *viz.*, plant height, number of secondary branches per plant, number of pods per plant, number of seeds per pod, seed yield per plant and green fodder yield per plant. The lower mean performance of $F_2$ and $F_3$ populations compared to their parents for plant height, number of primary branches per plant, number of secondary branches per plant, number of pods per plant and seed yield per plant in chickpea recorded by Shivakumar *et al.*, (2013) and in $F_2$ populations of mungbean for seed yield per plant by Dhole and Reddy (2011).

The lower mean performance of $F_2$ populations compared to their parents for most of the characters *viz.*, plant height, number of secondary branches per plant, number of pods per plant, number of seeds per pod, seed yield per plant and green fodder yield per plant in cowpea recorded by Sathish *et al.*, (2017).In addition to this, it was also observed that the value of upper range for most of the characters was double than mean value of $F_2$ populations which clearly indicates greater scope for isolation of more number of segregants for different characters.

***Selection of superior segregants:*** Superior segregants were isolated for green fodder yield per plant, seed yield per plant and days to maturity (Table 5) since these traits directly contributes to the dual purpose nature of cowpea. It was observed that maximum per cent of segregants were obtained for seed yield per plant in both $F_2$ population of crosses MFC-09-12× PGCP-12, MFC-08-14 × PL-3, in comparison to MFC-08-14 and MFC-09-1. Whereas in the cross MFC-08-14 × PL-3, highest per cent of segregants were obtained for days to maturity indicating development of early types from this population. Ten and eight plants from MFC-08-14 × PL-3,MFC-09-12 × PGCP-12, $F_2$populations were identified superior for all these traits (Table 6).

***Genetic parameters***: The $F_2$ population of cross MFC-09-12 × PGCP-12 exhibited highest phenotypic and genotypic co-efficient of variation, heritability in broad sense and genetic advance expressed as per cent mean (GAM) for number of pods per plant, seed yield per plant, green fodder yield per plant, leaf to stem ratio, crude protein content and dry matter content whereas for plant height, number of primary branches per plant, number of secondary branches per plant, number of pods per plant, seed yield per plant, green fodder yield and leaf to stem ratio in $F_2$ population of cross MFC-08-14 × PL-3 (Tables 2 and 4).

The present findings are in accordance with reports of Satish *et al.*, (2017) found high GCV and PCV for plant height, number of secondary branches per plant, number of pods per plant, seed yield per plant, green fodder yield per plant and leaf to stem ratio in $F_2$ populations of dual purpose cowpea. Mary and Gopalan (2006) and Shivakumar *et al.*, (2013) in $F_2$ and $F_2$ derived $F_3$ progenies of cowpea and chickpea, respectively. Salimath *et al.*, (2007) also reported the similar trend in $F_2$ and $F_3$ populations of two crosses of cowpea.

Moderate PCV and GCV was observed for pod length and number of seeds per pod in $F_2$ population of cross MFC-09-12 × PGCP-12 whereas forpod length, number of seeds per pod, dry matter content and crude protein content in $F_2$ population of crossMFC-08-14 × PL-3. Similar results were reported by Satish *et al.*, (2017) in $F_2$ populations of dual purpose cowpea, Salimath *et al.*, (2007) and Mary and Gopalan (2006) in $F_2$ and $F_3$ populations in cowpea, whereas in chickpea by Shivakumar *et al.*, (2013).

**Table.1** Mean performance and variance of parents and $F_2$ population of MFC-09-12 × PGCP-12for thirteen characters in cowpea

| Statistical parameters | (Parents) | Plant height (cm) | No. of primary Branches | No. of secondary Branches | Leaf to stem ratio | Days to first flowering | Days to maturity | No. of pods per plant | No. of seeds per pod | Pod length (cm) | Seed yield per plant (g) | Green fodder yield per plant (g) | Dry matter content (%) | Crude protein content (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Mean** | MFC-09-12 | 87.60 | 4.40 | 3.50 | 1.21 | 70.50 | 115.40 | 16.40 | 13.92 | 16.49 | 16.50 | 182.38 | 13.56 | 22.23 |
| | PGCP-12 | 74.77 | 4.03 | 1.20 | 0.91 | 53.00 | 95.00 | 15.80 | 13.43 | 16.28 | 14.56 | 147.00 | 12.24 | 23.84 |
| **Variance** | MFC-09-12 | 112.80 | 1.30 | 1.06 | 0.06 | 4.76 | 14.90 | 11.60 | 2.08 | 0.41 | 18.70 | 294.61 | 2.68 | 1.62 |
| | PGCP-12 | 133.20 | 2.10 | 0.66 | 0.03 | 3.34 | 25.80 | 8.50 | 3.30 | 1.03 | 7.20 | 326.00 | 1.26 | 0.57 |

**Table.2** Estimation of genetic parameters for thirteen quantitative characters in $F_2$ population of MFC-09-12 × PGCP-12

| SI. No. | Characters | Mean | Range | | PV | GV | PCV | GCV | $h^2$ (%) | GA | GAM (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Max | | | | | | | |
| **1** | Plant height (cm) | 54.66 | 24.00 | 120.00 | 322.07 | 82.00 | 32.83 | 16.57 | 25.46 | 9.41 | 17.22 |
| **2** | No. of primary branches per plant | 3.14 | 2.00 | 8.00 | 5.48 | 1.88 | 74.55 | 43.67 | 34.31 | 1.65 | 52.69 |
| **3** | No. of secondary branches per plant | 2.61 | 0.00 | 7.00 | 3.14 | 0.97 | 67.89 | 37.80 | 31.00 | 1.13 | 43.35 |
| **4** | Leaf to stem ratio | 1.37 | 0.67 | 2.26 | 0.58 | 0.41 | 55.63 | 46.45 | 69.73 | 1.10 | 79.91 |
| **5** | Days to first flowering | 70.94 | 65.00 | 97.00 | 38.93 | 30.47 | 8.80 | 7.78 | 78.27 | 10.06 | 14.18 |
| **6** | Days to maturity | 116.16 | 100.00 | 139.00 | 57.89 | 15.32 | 6.55 | 3.37 | 26.46 | 4.15 | 3.57 |
| **7** | No. of pods per plant | 14.42 | 5.00 | 36.00 | 66.43 | 55.16 | 56.51 | 51.50 | 83.04 | 13.94 | 96.67 |
| **8** | No. of seeds per pod | 12.73 | 9.40 | 17.60 | 7.16 | 2.59 | 21.01 | 12.65 | 36.24 | 2.00 | 15.69 |
| **9** | Pod length (cm) | 15.38 | 12.60 | 19.01 | 3.10 | 1.66 | 11.45 | 8.38 | 53.54 | 1.94 | 12.63 |
| **10** | Seed yield per plant (g) | 13.91 | 4.20 | 32.17 | 70.93 | 47.91 | 60.54 | 49.75 | 67.54 | 11.72 | 84.23 |
| **11** | Green fodder yield per plant (g) | 142.38 | 64.00 | 264.00 | 1478.92 | 851.92 | 27.10 | 20.50 | 57.22 | 45.48 | 31.94 |
| **12** | Dry matter content (%) | 13.31 | 9.46 | 21.50 | 30.72 | 28.10 | 41.64 | 39.82 | 91.47 | 10.44 | 78.45 |
| **13** | Crude protein content (%) | 22.46 | 17.14 | 23.30 | 20.70 | 18.24 | 20.26 | 19.02 | 88.12 | 8.26 | 36.77 |

**Table.3** Mean performance and variance of parents and $F_2$ population of MFC-08-14 × PL-3for thirteen characters in cowpea

| Statistical parameters | (Parents) | Plant height (cm) | No. of primary branches | No. of secondary branches | Leaf to stem ratio | Days to first flowering | Days to maturity | No. of pods per plant | No. of seeds per pod | Pod length (cm) | Seed yield per plant (g) | Green fodder yield per plant (g) | Dry matter content (%) | Crude protein content (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Mean** | MFC-08-14 | 86.37 | 4.80 | 3.80 | 1.17 | 63.20 | 100.45 | 17.55 | 15.14 | 15.40 | 16.40 | 173.60 | 13.41 | 20.45 |
| | PL-3 | 74.23 | 2.70 | 2.40 | 1.06 | 54.20 | 90.70 | 15.20 | 14.32 | 15.54 | 14.23 | 142.00 | 12.87 | 23.42 |
| **Variance** | MFC-08-14 | 154.70 | 0.46 | 0.66 | 0.13 | 5.42 | 20.70 | 11.30 | 0.15 | 11.88 | 8.46 | 428.08 | 0.49 | 0.47 |
| | PL-3 | 183.70 | 0.30 | 0.83 | 0.16 | 3.63 | 13.47 | 7.70 | 0.11 | 2.90 | 3.60 | 374.20 | 1.06 | 0.92 |

**Table.4** Estimation of genetic parameters for thirteen quantitative characters in $F_2$ population of MFC-08-14 × PL-3

| SI.No. | Characters | Mean | Range | | PV | GV | PCV | GCV | $h^2$ (%) | GA | GAM (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Max | | | | | | | |
| **1** | Plant height (cm) | 60.19 | 22.00 | 123.00 | 1250.22 | 881.85 | 58.75 | 49.34 | 70.54 | 51.38 | 85.36 |
| **2** | No. of primary branches per plant | 3.38 | 2.00 | 8.00 | 2.14 | 1.40 | 43.25 | 34.95 | 65.28 | 1.97 | 58.17 |
| **3** | No. of secondary branches per plant | 2.91 | 0.00 | 9.00 | 3.40 | 2.06 | 63.36 | 49.32 | 60.59 | 2.30 | 79.09 |
| **4** | Leaf to stem ratio | 1.42 | 0.81 | 1.95 | 0.59 | 0.49 | 54.03 | 49.54 | 84.08 | 1.33 | 93.57 |
| **5** | Days to first flowering | 82.34 | 60.00 | 94.00 | 46.04 | 34.54 | 8.24 | 7.14 | 75.02 | 10.49 | 12.74 |
| **6** | Days to maturity | 119.49 | 99.00 | 135.00 | 51.50 | 19.20 | 6.01 | 3.67 | 37.28 | 5.51 | 4.61 |
| **7** | No. of pods per plant | 14.08 | 8.00 | 36.00 | 50.62 | 26.45 | 50.54 | 36.53 | 52.25 | 7.66 | 54.40 |
| **8** | No. of seeds per pod | 12.84 | 8.80 | 16.40 | 2.67 | 2.46 | 12.73 | 12.21 | 91.99 | 3.10 | 24.12 |
| **9** | Pod length (cm) | 15.28 | 11.54 | 18.52 | 3.06 | 2.72 | 11.45 | 10.79 | 88.88 | 3.20 | 20.96 |
| **10** | Seed yield per plant (g) | 13.18 | 8.20 | 33.50 | 56.80 | 44.33 | 57.16 | 50.50 | 78.05 | 12.12 | 91.91 |
| **11** | Green fodder yield per plant (g) | 152.42 | 76.00 | 284.00 | 1294.92 | 857.92 | 23.61 | 19.22 | 66.25 | 49.11 | 32.22 |
| **12** | Dry matter content (%) | 13.80 | 8.56 | 17.41 | 4.38 | 2.97 | 15.17 | 12.48 | 67.68 | 2.92 | 21.15 |
| **13** | Crude protein content (%) | 21.25 | 18.50 | 23.43 | 18.60 | 17.27 | 20.30 | 19.56 | 92.85 | 8.25 | 38.82 |

**Table.5** Superior segregants in $F_2$ population for economically important characters over checks considered for dual purpose in cowpea

| Population | No. of plants | Green fodder yield per plant (g) | Seed yield per plant (g) | Days to maturity | No. of plants common for three characters |
|---|---|---|---|---|---|
| **$F_2$ (MFC-08-14 × PL-3)** | 90 | 25 (27.77)[a] | 33 (36.66)[a] | 32 (35.55)[a] | 10(11.11) |
| | | 19 (21.11)[b] | 26 (28.88)[b] | 27 (30.00)[b] | |
| **$F_2$ (MFC-09-12 × PGCP-12)** | 79 | 11 (13.92)[a] | 28 (35.44)[a] | 41 (51.89)[a] | 8(10.12) |
| | | 9 (11.39)[b] | 23 (29.11)[b] | 39(49.36)[b] | |
| **MFC-08-14 (check I)** | - | 173.6.2 | 16.4 | 109.4 | - |
| **MFC-09-1 (Check II)** | - | 186.2 | 17.47 | 106.8 | - |

* Values in parenthesis are percentage fig
a - superior segregants scored over check I
b - superiorsegregants scored over check II

**Table.6** Superior segregants identified for economically important traits in $F_2$ populations

| Cross MFC-08-14 x PL-3<br>Plant No | Green fodder yield per plant (g) | Seed yield per plant (g) | Days to maturity | Crude protein content (%) |
|---|---|---|---|---|
| 13 | 170 | 28 | 117 | 19.28 |
| 89 | 166 | 24 | 105 | 22.64 |
| 108 | 191 | 18 | 117 | 19.57 |
| 141 | 248 | 27 | 116 | 22.82 |
| 196 | 216 | 28 | 118 | 18.86 |
| 222 | 188 | 18 | 117 | 22.27 |
| 232 | 256 | 26 | 106 | 20.45 |
| 284 | 224 | 20 | 114 | 23.18 |
| 304 | 197 | 24 | 116 | 21.23 |
| 337 | 263 | 22 | 115 | 22.8 |
| MFC-08-14 (check I) | 173.6.2 | 18.4 | 109.4 | 20.45 |
| MFC-09-1 (check II) | 186.2 | 19.47 | 106.8 | 20.63 |

| Cross MFC-09-12 x PGCP-12<br>Plant No | Green fodder yield per plant (g) | Seed yield per plant (g) | Days to maturity | Crude protein content (%) |
|---|---|---|---|---|
| 41 | 184 | 22 | 110 | 20.47 |
| 69 | 157 | 18 | 114 | 21.66 |
| 94 | 194 | 18 | 110 | 19.01 |
| 120 | 158 | 25 | 117 | 18.45 |
| 145 | 171 | 16 | 126 | 22.41 |
| 160 | 187 | 16 | 104 | 21.32 |
| 263 | 220 | 28 | 107 | 20.27 |
| 290 | 181 | 30 | 109 | 23.12 |
| MFC-08-14 (check I) | 173.6.2 | 18.4 | 109.4 | 20.45 |
| MFC-09-1 (check II) | 186.2 | 19.47 | 106.8 | 20.63 |

Lower values of PCV and GCV was recorded for days to first flowering and days to maturity in both the $F_2$ populations of crosses (MFC-09-12 × PGCP-12 and MFC-08-14 × PL-3) which was in accordance with Satish *et al.,* (2017) in $F_2$ populations of dual purpose cowpea, Salimath *et al.,* (2007) in $F_3$ population and Mary and Gopalan (2006) in $F_3$ and $F_4$ population

## Conclusion

The variability found in the $F_2$ populations of the evaluated crosses (MFC-09-12 × PGCP-12 and MFC-08-14 × PL-3) would provide greater scope for the recovery of superior segregants for dual purpose in cowpea in further generations. The promising segregants identified from such population may be useful in the future plant breeding programmes.

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