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# Path analysis for seed yield in cowpea [*Vigna unguiculata* (L.) Walp.]

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**Abstract**
The experiment was conducted to study on genetic architecture through variability parameters and association analysis for green forage yield and its characters in 46germplasm lines including 2 checks (UPC-5286, UPC-9202); with 2 replication, was carried out during *Rabi* 2017-18 studied for fifteen characters *viz.*, *d*ay to 50% flowering, plant height (cm), leaf length (cm), leaf width (cm), stem girth (cm), number of primary branches, number of secondary branches, number of nodes, inter node length (cm), days to maturity, seed per pod, seed yield per plot (kg), 1000 seed weight (g), crude protein, leaf stem ratio, green forage yield per plant (g), dry matter yield per plant (g). All the characters exhibited existence of variability significantly. This indicated existence of sufficient variability among the genotypes for the mentioned characters and sufficient scope for development of new variety or genotypes.
These results are indicates that seed yield can be improved much better way by selection. Selection for these traits is likely to accumulate more additive genes leading to further improvement of performance of genotypes.

**Keywords:** Path analysis, seed yield, cowpea, *Vigna unguiculata* (L.) Walp.

## Introduction
Cowpea (*Vigna unguiculata* (L.) Walp) 2n=22, member of the family Leguminosae/Fabaceae, a nutritious component of the human diet, as well as for livestock feed, can be used at all stages of growth, therefore, has a tremendous potential to contribute for the mitigation of malnutrition "poor men's meat". Cowpea is only fodder crop which contains high protein content and rich in lysine and tryptophan amino acids as compared to other fodder crops. All the plant parts of cowpea that are used for food are nutritious providing protein, vitamins and minerals. Its grain contains on average 23-25% protein and 50-70% starch. Vir and Singh (2014) [8].
Grain yield, in cowpea is also a complex character. It depends on the expression of various independent characters. Therefore, selection on the basis of one or more characters may not necessarily lead to the improvement in yield. It is, therefore, essential to know the association of various quantitative as well as qualitative characters in order to initiate an effective selection programme aiming at the improvement of yield. Thus, the present study was carried out to assess the variability with the help of genetic parameters like the coefficient of variability and association analysis.

## Materials and Methods
The experimental materials comprised for RBD 46 germplasm lines including 2 checks (UPC-5286, UPC-9202) with 3 replication, Department of Genetics and Plant Breeding, College of Agriculture, Indira Gandhi Krishi Vishwavidalaya, Raipur, Chhattisgarh, India. Observation were recorded on five randomly selected plants in each entry in 2 replication for screening of germplasm line of cowpea for the 21 quantitative characters. According to descriptor, Indian grassland and Fodder Research Institute, Jhansi, India. (Roy *et al.,* 2017) [4]. The replicated data were subjected to variance analysis and test of significance as per the method of Fisher (1935) [2]

## Results and Discussion
### Analysis of variance
Analysis of variance was carried out for seventeen characters. The characters under study *viz*., day to 50% flowering (DFF), plant height (cm), leaf length (cm), leaf width (cm), stem width

(cm), (number of primary branches, number of secondary branches, number of nodes, internode length, day to maturity, pod length (cm), number of locules per pod, day of maturity, 100-seed weight (g), seed yield/ plant (g), seed per pod, seed yield per plot, crude protein, leaf stem ratio, green forage yield per day (q/ha/day), dry matter yield(q/ha), dry matter yield per plant, and green forage yield per plant, exhibited existence of variability significant at 1% and 5% significant level, is presented in Table 1. This indicated existence of sufficient variability among the genotypes for the mentioned characters and sufficient scope for development of genotypes.

Path coefficient analysis partitioned the observed genotypic correlation coefficient between yield and its components into direct and indirect effects. The genotypic path coefficient (direct and indirect effects *via.*, other characters) has been follows:

In path analysis when seed yield per plant was considered as dependent trait has been presented in Table.2. Maximum positive direct effect was obtained for seed yield per plot (1.083), followed by inter node length (cm) (0.809), days to maturity (0.703), dry matter yield per plant (0.626), no. of secondary branches (0.401), leaf stem ratio (0.361), leaflet width (cm) (0.27) days to 50% flowering (0.269), crude protein (0.13), plant height (cm) (0.077), no. of seeds per pod (0.066) whereas negative direct effect showed by stem girth (cm) (-1.284), green forage yield (-1.059), no. of nodes (-0.061), 1000 seed weight (-0.412).

Days to 50 % flowering showed positive indirect effect on days to maturity (0.679), no. of inter node length (0.314), dry matter yield per plant (0.221), green forage yield (0.182) and negative correlation with seed yield per plant (-0.011). Brahmaiah (2013) and Tyagi *et al.*, (2000) [1, 5] also reported similar results.

Plant height showed positive indirect effect on green forage yield (0.1977) followed by seed yield per plot (0.104), days to maturity (0.098) and negative correlation with seed yield per plant (-0.075). Leaflet length showed positive indirect effect on seed yield per plot (0.496) followed by leaflet width (cm) (0.115), no. of secondary branches (0.081) and negative significant correlation with seed yield per plant (-0.049). Leaflet width (cm) showed positive indirect effect on days to maturity (0.397) followed by inter node length (cm) (0.332), green forage yield (0.270) and no correlation with seed yield per plant.

Stem girth (cm) showed positive indirect effect on inter node length (0.396), followed by dry matter yield per plant (0.317), leaf stem ratio (0.218) and negative correlation with seed yield per plant (-0.09). No. of primary branches showed positive indirect effect on no. of nodes (0.227) followed by no. of secondary branches (0.173), dry matter yield per plant (0.136) and positive correlation with seed yield per plant (0.13).

No. of secondary branches showed positive indirect effect on dry matter yield per plant (0.118) followed by leaf stem ratio (0.112), leaflet width (cm) (0.051) and negative significant correlation with seed yield per plant (-0.223). No. of nodes showed positive indirect effect on days to maturity (0.505) followed by green forage yield (0.422), dry matter yield per plant (0.389) and positive correlation with seed yield per plant (0.14).

Inter node length (cm) showed positive indirect effect on days to maturity (0.310) followed by dry matter yield per plant (0.305), leaflet width (cm) (0.111) and positive significant correlation with seed yield per plant (0.254). Days to maturity showed positive indirect effect on inter node length (cm) (0.357) followed by leaflet width (0.153), seed yield per plant (0.113) and negative correlation with seed yield per plant (0.002).

No. of seeds per plantshowed positive indirect effect on internode length (0.221), followed by dry matter yield per plant (0.099), days to maturity (0.097) and positive correlation with seed yield per plan (0.065).

**Table 1:** Analysis of variancefor Green forage yield and its attributing traits in Cowpea

| Mean Sum of Square | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Source of variation** | **Degree of freedom** | **Day to 50% flowering** | **Plant height (cm)** | **Leaf length (cm)** | **Leaf width (cm)** | **Stem girth (cm)** | **No. of secondary branches** | **No. of secondary branches** | **No. of nodes** | **Internode length (cm)** |
| Replication | 1 | 13.31 | 7.75 | 40.71 | 5.6 | 0.9 | 1.83 | 0.28 | 12.56 | 1.92 |
| Treatment | 45 | 128.18** | 4983.63 ** | 2.02 ** | 1.25 ** | 0.49 ** | 1.49 ** | 0.52 ** | 6.62 ** | 0.63 ** |
| Error | 45 | 33.13 | 507.96 | 0.58 | 0.44 | 0.1 | 0.7 | 0.44 | 2.85 | 0.24 |

| Mean Sum of Square | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Source of variation** | **Degree of freedom** | **Days to maturity** | **No. of seeds per pod** | **seed yield per plot (kg)** | **1000 seed weight** | **Crude protein %** | **leaf stem ratio** | **Green forage yield per plant (g)** | **Dry matter yield per plant (g)** | **Seed yield per plant (g)** |
| Replication | 1 | 71.31 | 1.31 | 0.01 | 131.56 | 32.63 | 0.14 | 17.91 | 2.88 | 0.0083 |
| Treatment | 45 | 402.09 ** | 22.95 ** | 0.66 ** | 1206.55 ** | 14.67 ** | 0.05 ** | 182.01 ** | 19 ** | 18.63** |
| Error | 45 | 27.13 | 0.64 | 0.01 | 37.16 | 5.37 | 0.02 | 23.05 | 2.23 | 0.45 |

**Significant at 1 % probability level, *Significant at 5 % probability level

**Table 2:** Path coefficient analysis matrix of direct and indirect effects when Seed yield per plant is taken as dependent character

| S. No. | Character | DFF | PH | LL | LW | ST | NPB | NSB | NN | IL | DM | SP | SY | SW | CP | GFY | LSR | DMY | Correlation with SYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | DFF | 0.269 | 0.008 | -0.002 | 0.119 | -0.984 | -0.033 | 0.006 | -0.539 | 0.314 | 0.679 | 0.002 | 0.148 | -0.041 | -0.021 | 0.198 | 0.182 | 0.221 | -0.011 |
| 2 | PH | -0.028 | 0.077 | -0.057 | 0.048 | -0.439 | -0.058 | 0.022 | 0.017 | 0.039 | 0.099 | -0.013 | 0.105 | -0.102 | -0.036 | 0.173 | 0.050 | 0.030 | -0.075 |
| 3 | LL | -0.002 | 0.014 | -0.306 | 0.115 | -0.398 | 0.040 | 0.081 | -0.136 | 0.061 | 0.098 | 0.008 | 0.496 | -0.183 | -0.030 | 0.002 | 0.039 | 0.052 | -0.049 |
| 4 | LW | -0.119 | 0.014 | -0.130 | 0.270 | -1.160 | 0.012 | 0.076 | -0.419 | 0.333 | 0.397 | -0.003 | 0.170 | -0.032 | -0.010 | 0.270 | 0.127 | 0.204 | 0.000 |

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | ST | -0.206 | 0.026 | -0.095 | 0.244 | -1.284 | -0.001 | 0.115 | -0.539 | 0.396 | 0.424 | 0.005 | 0.186 | -0.077 | -0.010 | 0.191 | 0.218 | 0.317 | -0.090 |
| 6 | NPB | 0.062 | -0.031 | -0.085 | 0.022 | 0.013 | 0.145 | 0.173 | 0.227 | -0.076 | -0.109 | 0.000 | -0.023 | 0.038 | 0.012 | -0.404 | 0.032 | 0.136 | 0.130 |
| 7 | NSB | -0.004 | 0.004 | -0.062 | 0.051 | -0.370 | 0.063 | 0.401 | -0.087 | 0.032 | -0.071 | -0.003 | 0.038 | -0.002 | -0.041 | -0.401 | 0.112 | 0.119 | -0.223* |
| 8 | NN | -0.219 | -0.002 | -0.063 | 0.171 | -1.047 | -0.050 | 0.053 | -0.661 | 0.368 | 0.505 | 0.023 | 0.072 | -0.063 | -0.004 | 0.422 | 0.244 | 0.390 | 0.140 |
| 9 | IL | -0.104 | 0.004 | -0.023 | 0.111 | -0.628 | -0.014 | 0.016 | -0.301 | 0.809 | 0.310 | 0.018 | -0.135 | 0.029 | -0.005 | -0.244 | 0.106 | 0.305 | 0.254* |
| 10 | DM | -0.260 | 0.011 | -0.043 | 0.153 | -0.775 | -0.023 | -0.040 | -0.475 | 0.357 | 0.703 | 0.009 | 0.114 | -0.031 | -0.019 | 0.110 | 0.104 | 0.103 | -0.002 |
| 11 | SP | -0.009 | -0.015 | -0.035 | -0.011 | -0.102 | 0.000 | -0.017 | -0.232 | 0.221 | 0.097 | 0.066 | -0.166 | 0.056 | -0.011 | 0.072 | 0.051 | 0.099 | 0.065 |
| 12 | SY | -0.037 | 0.007 | -0.140 | 0.042 | -0.221 | -0.003 | 0.014 | -0.044 | -0.101 | 0.074 | -0.010 | 1.083 | -0.349 | -0.036 | -0.268 | -0.007 | -0.085 | -0.082 |
| 13 | SW | -0.027 | 0.019 | -0.136 | 0.021 | -0.241 | -0.013 | 0.002 | -0.101 | -0.056 | 0.054 | -0.009 | 0.918 | -0.412 | -0.038 | -0.092 | -0.002 | -0.047 | -0.160 |
| 14 | CP | 0.043 | -0.021 | 0.071 | -0.021 | 0.103 | 0.013 | -0.125 | 0.020 | -0.029 | -0.104 | -0.005 | -0.295 | 0.120 | 0.130 | 0.095 | -0.053 | -0.063 | -0.121 |
| 15 | GFY | 0.050 | -0.013 | 0.001 | -0.069 | 0.232 | 0.055 | 0.152 | 0.263 | 0.187 | -0.073 | -0.004 | 0.274 | -0.036 | -0.012 | -1.059 | -0.002 | 0.013 | -0.041 |
| 16 | LSR | -0.136 | 0.011 | -0.033 | 0.095 | -0.776 | 0.013 | 0.124 | -0.447 | 0.238 | 0.202 | 0.009 | -0.022 | 0.002 | -0.019 | 0.006 | 0.361 | 0.557 | 0.184 |
| 17 | DMY | -0.095 | 0.004 | -0.025 | 0.088 | -0.651 | 0.031 | 0.076 | -0.411 | 0.395 | 0.116 | 0.010 | -0.148 | 0.031 | -0.013 | -0.022 | 0.321 | 0.626 | 0.333** |

Residual = 0.54724

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | DFF = Day to 50% flowering | 5 | ST= Stem girth (cm) | 9 | IL = Internode length (cm) | 14 | CP = Crude protein % |
| 2 | PH = Plant height (cm) | 6 | NPB = Number of primary branches | 10 | DM = Days to maturity | 15 | LSR = Leaf stem ratio |
| 3 | LL = Leaf length (cm) | 7 | NSB = Number of secondary branches | 11 | SP = Seed per pod | 16 | GFY = Green forage yield per plant (g) |
| 4 | LW = Leaf width (cm) | 8 | NN = Number of nodes | 12 | SY = Seed yield per plot (kg) | 17 | DMY= Dry matter yield per plant (g) |
| | | | | 13 | SW = 1000 Seed weight (g) | 18 | SYP= Seed yield per plant (g) |

Seed yield per plot showed positive indirect effect on days to maturity (0.074) followed by leaflet width (0.042), no. of secondary branches (0.014) and negative correlation with seed yield per plant (-0.082). 1000 seed weight showed positive indirect effect on stem seed yield per plot (0.917) followed by days to maturity (0.054), leaflet width (0.021) and negative correlation with seed yield per plant (-0.016).Crude protein showed positive indirect effect on no. of primary branches (0.013) followed stem girth (0.103), leaflet length (0.071) and negative significant correlation with seed yield per plant (-0.121).

Green forage yield showed positive indirect effect on seed yield per plot (0.274) followed by no. of nodes (0.263), stem girth (0.231) and negative correlation with seed yield per plant (-0.021). Leaf stem ratio showed positive indirect effect on dry matter yield per day (0.557) followed by internode length (0.237), days to maturity (0.202) and positive correlation with seed yield per plant (0.184).Dry matter yield showed positive indirect effect on internode length (0.395), followed by dry matter yield per plant (0.321), days to maturity (0.116) and positive significant correlation with seed yield per day (0.333).

These finding are in conformity to the finding of previous workers Venkatesan *et al.* (2003a), Meena *et al*. (2014) and Verma (2016) [6, 3, 7].

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