*Original Research Article*

Evaluation of Correlation and Path analysis on yield and yield contributing characters in Cowpea [*Vigna unguiculata* (L.) Walp]

.

ABSTRACT

|  |
| --- |
| The current study was conducted during 2019-2020 at the Post Graduate Research Farm, RCSM, College of Agriculture, Kolhapur. Correlation and path coefficient analyses among eleven morphological traits were studied in 30 genotypes and 3 released cowpea varieties. According to the correlation data, the number of pods per plant, number of main branches, number of seeds per pod, leaf width, and pod length all exhibited a highly significant positive link with seed yield per plant. This showed a highly significant positive association of seed yield per plant with number of pods per plant (0.740), followed by number of main branches (0.638), number of seeds per pod (0.376), leaf width (0.363) and pod length (0.281). The characters such as leaf length (0.216), number of days to maturity (0.195) and test weight (0.171) were positively associated but non-significant at the genotypic level. The path analysis revealed that at the genotypic level, the nodes on the main stem (-0.209) and the number of days to 50% blooming (-0.026) were non-significant and negatively correlated. The number of pods per plant, the number of seeds per pod, leaf width, and test weight all showed a significant positive direct effect on seed yield. |

*Keywords: Cowpea, Correlation, Path analysis, Yield characters,*

1. INTRODUCTION

*Vigna unguiculata* L., widely recognized as cowpea, crowder pea, southern pea, black-eyed pea, or lobia, is often referred to as "vegetarian meat" (Ghodake et al., 2023). It is a major leguminous crop grown around the world for its nutritious seeds and fodder. It is resilient to a wide range of environmental circumstances and farmed in a variety of agro-climatic areas. Its protein-rich seeds are not only a staple food source in many countries but also contribute to soil fertility through nitrogen fixation. Maximizing cowpea yield is essential to meet the increasing demand for nutritious food and enhance rural livelihoods. Cowpea yield and yield-contributing features are critical in determining overall productivity and economic relevance. The current study designed to determine the genotypic correlations and breakdown of the direct and indirect effects of yield components on grain yield among 11 quantitative traits of 30 Indigenous genotypes and three released varieties of cowpea in order to identify the most important traits for selection in the future breeding programs.

2. material and methods

The experimental material consisted of 30 indigenous genotypes and 3 released varieties of cowpea from Pulses and Oilseed Crops Research and Training Centre, Pandharpur (Dist. Solapur, Maharashtra). The list of genotypes and varieties presented in Table 1. The present study was carried out during 2019-2020 at Post Graduate Research Farm, RCSM, College of Agriculture, Kolhapur, following Randomized Block Design with three replications. Each genotype was sown in four rows of 5-meter length with spacing of 45 cm between the rows and 10 cm between plants. The 11 morphological traits namely*,* days to 50 percent flowering, days to maturity, leaf length, leaf width, number (no.) of nodes on the main stem, no. of main branches, no. of pods per plant, pod length, no. of seeds per pod, 100 seed weight and seed yield per plant were studied in the present study.

The statistical analysis was performed in accordance with Panse and Sukhatme (1985). The genotypic covariances were estimated according to Singh and Chaudhari (1977). The genotypic correlation coefficient was calculated using the method developed by Johnson et al. (1955). To establish a cause-and-effect link, the first stage was to partition the genotypic correlation coefficient into direct and indirect effects using path analysis, as proposed by Dewey and Lu (1959) and developed by Wright (1921), and the second step was path diagram construction. Path coefficients were derived by solving a set of simultaneous equations of the kind proposed by Dewey and Lu (1959).

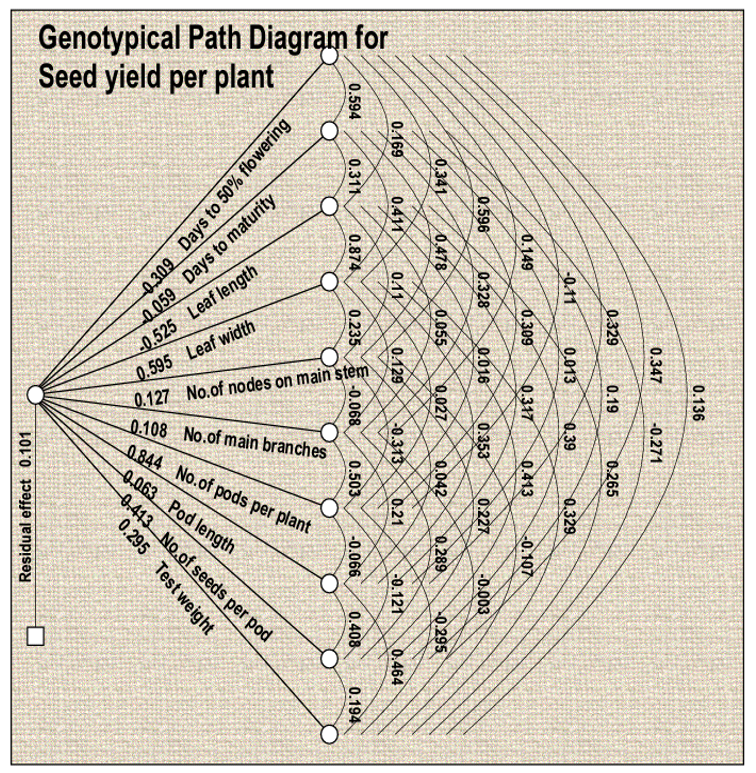
**Table 1. List of Genotypes and Varieties of Cowpea used in the present study**

|  |  |  |  |
| --- | --- | --- | --- |
| **Sr.**  **No.** | **Genotypes/Varieties** | **Pedigree** | **Source(s)** |
| 1 | CP-5 | RC-101 × Ajmer selection | RARI, Durgapura |
| 2 | CP-6 | RC-101 × RC-19 |
| 3 | CP-7 | C 152 × V 16 | UAS, Bangalore |
| 4 | CP-8 | C 152 × V 57817 |
| 5 | CP-13 | Vamban 1 × COCP-7 | PRC, Vamban |
| 6 | CP-15 | COCP-7×Vamban 1 |
| 7 | CP-16 | Selection from bidoli local | SKRU, Bikaner |
| 8 | CP-17 | Answara × Bhagyalaxmi | RARS, Pattambi |
| 9 | CP-18 | Selection from GC-13 | SDAU, Srinagar |
| 10 | CP-19 | TPTC-29 | ARS, Tirupati |
| 11 | CP-20 | DC-15 | UAS, Dharwad |
| 12 | CP-25 | PGCP-1 × PGCP-12 | GBPAU & T, Pantnagar |
| 13 | CP-26 | PL-3 × PL-1 |
| 14 | CP-2-1 | Local Selection | RARI, Durgapura |
| 15 | CP-9-1 | Local Selection |
| 16 | CP-17-1 | Local Selection |
| 17 | PCP-1110 | RC-101 × Phule Vithai-2-3-1 | ARS, Pandharpur |
| 18 | PCP-1115 | RC-101 × Phule Vithai -4-3-3 |
| 19 | PCP-1116 | RC-101 × Phule Vithai -4-5-3 |
| 20 | PCP-1123 | RC-101 × Phule Vithai -7-1-1 |
| 21 | PCP-1124 | RC-101 × Phule Vithai -7-1-5 |
| 22 | PCP-1126 | RC-101 × Phule Vithai -7-7-1 |
| 23 | PCP-1805 | PCP-1123 × SHRCP-01 |
| 24 | PCP-1809 | PCP-1124 × SHRCP-01 |
| 25 | PCP-1810 | PCP-1124 × SHRCP-02 |
| 26 | PCP-1814 | PCP-1124 × SHRCP-03 |
| 27 | PMCP-1002 | Mutant Phule Pandhari |
| 28 | PMCP-1005 | Mutant Phule Pandhari |
| 29 | PMCP-1008 | Mutant Phule Pandhari |
| 30 | PMCP-1021 | Mutant Phule Pandhari |
| 31 | Phule Pandhari | VC8 × V575 |
| 32 | Phule Rukmini | Pusadofasali x VCM 8 |
| 33 | Phule Vithai | VCM 8 x Konkan safed |

3. results and discussion

The correlation and path analysis for grain yield per plant and its contributing characters in cowpea genotypes are presented in table 2 and 3. The characters such as no. of pods per plant (0.740), no. of main branches (0.638), no. of seeds per pod (0.376), leaf width (0.363) and pod length (0.281) are positively correlated with the no. of seeds per plant. whereas, leaf length (0.216), days to maturity (0.195), and test weight (0.171) were positively correlated but not statistically significant. The no. of nodes on main stem (-0.209) and days to 50% blooming (-0.026) showed a non-statistically significant negative correlation. Previous research found comparable results for the number of pods per plant and the number of main branches per plant (Sharma et al., 2016), the number of seeds per pod (Nigude et al., 2004), leaf width (Bhardwaj et al., 2014), and pod length (Tyagi et al., 2000).

The characters like days to 50% flowering, days to maturity, leaf length, leaf width, no. of nodes on the main stem, pod length, no. of seeds per pod, and test weight were highly significant and positively correlated with each other. In agreement with the earlier studies by Thorat and Gadewar (2013) for days to 50% flowering and days to maturity, no. of seeds per pod and pod length (Paghadar et al. 2019), and for days to 50% flowering, days to maturity, pod length, no. of seeds per pod and test weight (Kalambe et al. 2019). The direct and indirect effect of yield and yield contributing characters at genotypic levels were as indicated fig.1. The genotypic correlation between the days to 50% flowering and seed yield per plant was negative and non-significant (-0.026). Its direct effect on seed yield per plant was negative and high (-0.308).



**Fig. 1. Genotypical path diagram for seed yield per plant in Cowpea**

The genotypic correlation between days to maturity and seed yield per plant (0.195) and leaf length and seed yield per plant (0.216) was non-significant positive. Leaf width and seed yield per plant were positive and highly significant (0.363) and no. of main branches and seed yield per plant was positive and highly significant (0.638), whereas the correlation between no. of nodes on main stem and seed yield per plant was negative and non-significant (-0.209).

The genotypic correlation between no. of pods per plant and seed yield per plant, pod length and seed yield per plant, no. of seeds per pod, and seed yield per plant was positive and highly significant. Its direct effect on seed yield per plant was positive and high, whereas the correlation between test weight and seed yield per plant was positive and non-significant (0.171) while its direct effect on seed yield per plant was positive and high (0.294). Previous studies have also found similar results for different characters such as, for no. of pods per plant, seeds per pod and 100 seed weight (Vineeta K et al. (2003) and no. of main branches (Sharma et al. 2016), pod length (Venkatesan et al. 2003), no. of pods per plant and pod length (Lal et al.2007), no. of pods per plant and days to 50% flowering (Patil et al. 2021), no. of branches per plant (Phogat et al. 2017), no. of pods per plant (Das et al. 2020), no. of pods per plant, no. of seeds per pod, no. of branches and pod length (Chaudhary et al. 2020), no. of branches, pod length and pods per plant (Gupta et al. 2019), no. of seeds and no. of pods per plant in correlation and path analysis (Tirkey et al. 2022), no. of pods per plant (Aliyu et al. 2022), no. of pods per plant, pod length and no. of seeds per pod (Sogalad et al. 2022), no. of seeds per pod (Panchta et al. 2020), 100 seed weight, no. of pods, pod length and no. of branches (Singh et al. 2020). Looking into the future, these analyses hold great promise. Advancements in genomics enable a deeper understanding of the genetic basis of these characters, facilitating targeted breeding for improved yield. Incorporating omics data, and precision agriculture technologies can provide comprehensive insights into complex interactions and optimize yield. Addressing climate resilience, integrating multi-trait selection, and considering nutritional quality in analyses contribute to sustainable agriculture and food security.

**SUMMARY**

Cowpea is a nutritious seed and fodder crop widely grown in different agro-climatic zones due to its tolerance to environmental challenges. During the 2019-2020, thirty cowpea genotypes and three cultivated varieties were examined at the Post Graduate Research Farm, RCSM, College of Agriculture, Kolhapur, Maharashtra, to study the correlation and path analysis on yield and yield-contributing features. The characters such as the no. of pods per plant, no. of main branches per plant, the no. of seeds per pod, the width of the leaf, and the length of the pod all revealed a positive and highly significant correlation with the no. of seeds produced per plant. The characters such as the no. of pods per plant, the number of seeds per pod, leaf width, and test weight had a highly favourable direct impact on the no. of seeds produced per plant. Thus, a program to improve yield will benefit from direct selection for all these traits. Finally, this evaluation study provides a robust framework for unravelling the factors influencing productivity and acts as a guiding light for breeders and agronomists, supporting the development of high-yielding and resilient cowpea varieties to meet future agricultural difficulties and feed expanding populations.

4. Conclusion

The characters number of pods per plant, followed by the number of main branches per plant, number of seeds per pod, leaf width, and pod length showed a positive and highly significant correlation with seed yield per plant. The characters number of pods per plant, number of seeds per pod, leaf width, and test weight had high positive direct effect on seed yield per plant. Thus, direct selection for these traits will be beneficial in the yield improvement programme.

Ethical approval

This article does not contain any studies with human participants or animals performed by any of the authors.

REFERENCES

Aliyu O M, Tiamiyu A O, Usman M and Abdulkareem Y F. 2022. Variance components, correlation and path analyses in cowpea [Vigna unguiculata (L.) Walp]. Journal of Crop Science and Biotechnology 25:173–182. https://doi.org/10.1007/s12892-021-00121-5

Bhardwaj R, Singh D P, Upasana R, Tiwana U.S and Bajaj R K. 2014. Association studies in cowpea (Vigna unguiculata L.). Journal of food legumes 27(1): 74-76.

Chaudhary A R, Solanki S D, Rahevar P M and Patel D A. 2020. Genetic Variability, Correlation and Path Coefficient Analysis for Yield and Its Attributing Traits in Cowpea [Vigna unguiculata (L.) Walp] Accessions. International Journal of Current Microbiology and Applied Sciences 9(2):1281-1293. doi: https://doi.org/10.20546/ijcmas.2020.902.151

Das S, Karak C and Roy S. 2020. Genetic variability, correlation and path analysis studies in cowpea [Vigna unguiculata (L.) Walp.]. International Journal of Economic Plants 7(3):123-128.

Dewey D R and Lu K. 1959. A correlation and path‐coefficient analysis of components of crested wheatgrass seed production 1. Agronomy journal 51(9):515-518.https://doi.org/10.2134/agronj1959.00021962005100090002x

Ghodake B. D., More K., & Gund S. 2023. Assessment of genetic diversity in cowpea (Vigna unguiculata L.) genotypes by using RAPD markers. Pharma Innovation, 12(2):605-608. DOI: https://doi.org/10.22271/tpi.2023.v12.i2h.18484

Gupta R K, Pramila, Banshidhar and Kumar U. 2019. Study on correlation and path analysis in cowpea[Vigna unguiculata (L.) Walp] International Journal of Chemical Studies 7(6):1264-1268.

Johnson H W, Robinson H F and Comstock R E. 1955. Genotypic and phenotypic correlations in soybean and their implications in selection. Agronomy Journal 47(10): 477 – 483.http://dx.doi.org/10.2134/agronj1955.00021962004700100008x

Kalambe A S, Wankhade M P, Deshmukh J D, Chavan B R and Shinde A V. 2019. Correlation studies in cowpea (Vigna unguiculata L.). Journal of Pharmacognosy and Phytochemistry 8(3):321-323.

Nigude A D, Dumbre A D, Lad D B and Bangar N D. 2004. Genetic variability and correlation studies in cowpea [Vigna unguiculata (L.) Walp]. Journal of Maharashtra Agricultural University 29(1):30-34.

Paghadar P J, Vachhani J H, Gajera K P and Chovatiya S J. 2019. Evaluation of correlation and path analysis in vegetable cowpea [Vigna unguiculata (L.) Walp.]. International Journal of Chemical Studies 7(4): 628-630.

Panchta R, Arya S, Singh D P, Satpal, Preeti and Kumar R. 2020. Genetic Variability and Association Studies in Cowpea [Vigna unguiculata (L.) Walp] For Seed Yield and Related Traits. Forage Research 46(3):232-235.

Panse V G and Sukhatme P V. 1985. Statistical method for Agricultural worker. ICAR, New Delhi 4: 145-150.

Patil S, Pethe U B, Mahadik S G, Dalvi V V and Joshi M M. 2021. Correlation and path analysis study in F3 generation of cowpea [Vigna unguiculata (L.) Walp] genotypes. Journal of Pharmacognosy and Phytochemistry 10(1):203-207.

Phogat D S, Panchita R, Kumari P, Niwas R and Arya S. 2017. Variability, Correlation and Path Analysis Studies in Fodder Cowpea [Vigna unguiculata (L.) Walp]. Trends in Biosciences 10(3):1130-1132.

Sharma P, Sharma M and Vyas M. 2016. Correlation coefficient and path analysis between seed yield and its components traits in cowpea [Vigna unguiculata (L.) Walp.]. International Journal of Current Research 8(8): 35783-35786.

Singh O V, Shekhawat N, Singh K and Gowthami R. 2020. Assessment of genetic variability and inter-character association in the germplasm of cowpea[Vigna unguiculata (L.) Walp] in hot arid climate. Legume Research-An International Journal 43(3):332-336.

Singh R K and Choudhary B D. 1977. Biometrical Methods in Quantitative Genetic Analysis. Kalyani Publishers New Delhi39-68.

Sogalad M S, Deshpande S K and Kavyashree N M. 2022. Genetic variability, correlation and path analysis studies in grain cowpea [Vigna unguiculata (L.) Walp sub sp. unguiculata]. The Pharma Innovation Journal 11(12):3749-3754.

Thorat A and Gadewar R D. 2013. Variability and Correlation studies in cowpea (Vigna unguiculata). International Journal for Environmental Rehabilation and Conservation 4(1): 44-49.

Tirkey M, Lal G M and Anand S P. 2022. Estimation of Correlation and Path Analysis for Quantitative Traits in Cowpea [Vigna unguiculata (L.) Walp]. International Journal of Plant and Soil Science 34(22):1194-1200. https://doi.org/10.9734/ijpss/2022/v34i2231486

Tyagi P C, Kumar N and Agarwal M C. 2000. Genetic variability and association of component characters for seed yield in cowpea. Legume Research 23(2):92-96.

Venkatesan M, Prakash M and Ganesan J. 2003. Correlation and path analysis in cowpea [Vigna unguiculata (L.) Walp.]. Legume Research 26(2): 105-108.

Vineeta K, Arora R N and Singh J V. 2003. Variability and path analysis in grain cowpea. Advances in arid legumes research 59-62.

Wright S J. 1921. Correlation and causation. Journal of Agricultural Research. 20: 557-585.

**Table 2. Genotypic correlation of 11 characters in 30 Genotypes and 3 Varieties of Cowpea**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Observations** | **Days to 50% flowering** | **Days to maturity** | **Leaf length (cm)** | **Leaf width (cm)** | **No. of nodes on main stem** | **No. of main branches** | **No. of pods per plant** | **Pod length (cm)** | **No. of seeds per pod** | **Test weight (gm)** | **Seed yield per plant (gm)** |
| **Days to 50% flowering** | **1.000** | 0.594\*\* | 0.169 | 0.340\*\* | 0.595\*\* | 0.149 | -0.109 | 0.328\*\* | 0.347\*\* | 0.136 | -0.026 |
| **Days to maturity** | 0.594\*\* | **1.000** | 0.311\*\* | 0.411\*\* | 0.477\*\* | 0.328\*\* | 0.308\*\* | 0.012 | 0.19 | -0.271\*\* | 0.195 |
| **Leaf length (cm)** | 0.169 | 0.311\*\* | **1.000** | 0.873\*\* | 0.109 | 0.055 | 0.016 | 0.317\*\* | 0.389\*\* | 0.265\* | 0.216 |
| **Leaf width (cm)** | 0.340\*\* | 0.411\*\* | 0.873\*\* | **1.000** | 0.234\* | 0.129 | 0.027 | 0.352\*\* | 0.413\*\* | 0.328\*\* | 0.363\*\* |
| **No. of nodes on main stem** | 0.595\*\* | 0.477\*\* | 0.109 | 0.234\* | **1.000** | -0.067 | -0.313\*\* | 0.042 | 0.227\* | -0.107 | -0.209 |
| **No. of main branches** | 0.149 | 0.328\*\* | 0.055 | 0.129 | -0.067 | **1.000** | 0.502\*\* | 0.21 | 0.288\*\* | -0.003 | 0.638\*\* |
| **No. of pods per plant** | -0.109 | 0.308\*\* | 0.016 | 0.027 | -0.313\*\* | 0.502\*\* | **1.000** | -0.066 | -0.121 | -0.294\*\* | 0.740\*\* |
| **Pod length (cm)** | 0.328\*\* | 0.012 | 0.317\*\* | 0.352\*\* | 0.042 | 0.21 | -0.066 | **1.000** | 0.408\*\* | 0.463\*\* | 0.281\*\* |
| **No. of seeds per pod** | 0.347\*\* | 0.19 | 0.389\*\* | 0.413\*\* | 0.227\* | 0.288\*\* | -0.121 | 0.408\*\* | **1.000** | 0.194 | 0.376\*\* |
| **Test weight (gm)** | 0.136 | -0.271\*\* | 0.265\* | 0.328\*\* | -0.107 | -0.003 | -0.294\*\* | 0.463\*\* | 0.194 | **1.000** | 0.171 |
| **Seed yield per plant (gm)** | -0.026 | 0.195 | 0.216 | 0.363\*\* | -0.209 | 0.638\*\* | 0.740\*\* | 0.281\*\* | 0.376\*\* | 0.171 | **1.000** |

**\* and \*\* significant at 5% and 1%, respectively**

**Table 3. Direct (diagonal) and Indirect (above and below diagonal) path effects of different characters towards seed yield at genotypic level in Cowpea**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Observations** | **Days to 50% flowering** | **Days to maturity** | **Leaf length (cm)** | **Leaf width (cm)** | **No. of nodes on main stem** | **No. of main branches** | **No. of pods per plant** | **Pod length (cm)** | **No. of seeds per pod** | **Test weight (gm)** | **Seed yield per plant (gm)** |
| **Days to 50% flowering** | **-0.308** | -0.034 | -0.088 | 0.202 | 0.075 | 0.016 | -0.092 | 0.020 | 0.143 | 0.040 | -0.026 |
| **Days to maturity** | -0.183 | **-0.058** | -0.163 | 0.244 | 0.060 | 0.035 | 0.260 | 0.001 | 0.078 | -0.079 | 0.195 |
| **Leaf length (cm)** | -0.052 | -0.018 | **-0.525** | 0.520 | 0.014 | 0.006 | 0.013 | 0.019 | 0.160 | 0.078 | 0.216 |
| **Leaf width (cm)** | -0.105 | -0.024 | -0.458 | **0.595** | 0.029 | 0.014 | 0.022 | 0.022 | 0.170 | 0.096 | 0.363\*\* |
| **No. of nodes on main stem** | -0.183 | -0.028 | -0.057 | 0.139 | **0.127** | -0.007 | -0.264 | 0.002 | 0.093 | -0.031 | -0.209 |
| **No. of main branches** | -0.046 | -0.019 | -0.029 | 0.077 | -0.008 | **0.108** | 0.424 | 0.013 | 0.119 | -0.001 | 0.638\*\* |
| **No. of pods per plant** | 0.033 | -0.018 | -0.008 | 0.016 | -0.039 | 0.054 | **0.843** | -0.004 | -0.050 | -0.086 | 0.740\*\* |
| **Pod length (cm)** | -0.101 | -0.001 | -0.166 | 0.209 | 0.005 | 0.022 | -0.055 | **0.062** | 0.168 | 0.136 | 0.281\*\* |
| **No. of seeds per pod** | -0.107 | -0.011 | -0.204 | 0.246 | 0.029 | 0.031 | -0.102 | 0.025 | **0.412** | 0.057 | 0.376\*\* |
| **Test weight (gm)** | -0.042 | 0.015 | -0.139 | 0.195 | -0.013 | -0.001 | -0.248 | 0.029 | 0.080 | **0.294** | 0.171 |

**(R=0.1009). \*, \*\* significant at 5% and 1%, respectively**