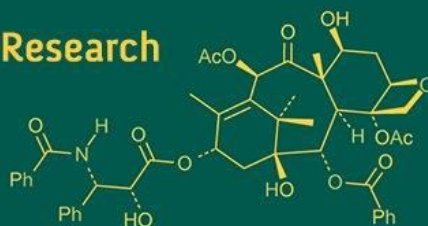


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Yield and its contributing traits: A path analysis approach in pigeon pea

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Abstract

This study investigates the yield and its contributing traits in pigeon pea (*Cajanus cajan* [L.] Millsp.) through path analysis. Thirty-two genotypes were evaluated in randomized block design during the Kharif 2018 season under normal soil and rainfed conditions. The study aimed to understand the direct and indirect effects of yield-related traits on seed yield. The results indicate that the number of secondary branches exhibited the highest positive direct effect on seed yield, followed by pods per plant, days to maturity, 100-seed weight, and number of primary branches. Traits such as plant height showed a negative direct effect on yield. Furthermore, the path coefficient analysis revealed both positive and negative indirect effects of other traits on seed yield. The findings suggest that breeding strategies targeting traits like secondary branches, pods per plant, and 100-seed weight could enhance pigeon pea yield. Varieties such as ICPL 87119, LRG 134, and BDN 2013-1 were identified as superior performers under field conditions in Chitrakoot.

Keywords: Path analysis, pigeon pea, yield, Arhar

Introduction

Pigeon pea (*Cajanus cajan* [L.] Millsp.), also known as red gram or Arhar, is the second most important pulse crop in India after chickpea. It belongs to the family Leguminosae, with a chromosome number of $2n=22$. Pigeon pea is an excellent protein source (20-22%) and is primarily consumed as dry split dhal. In 2017-18, India cultivated pigeon pea on 4.42 million hectares, yielding 4.02 million tons, with Madhya Pradesh contributing significantly (647,000 hectares; 897,000 tons; yield: 1,247 kg/ha). The crop is grown as a sole crop or intercrop with cereals and oilseeds across states like Maharashtra, Karnataka, and Madhya Pradesh.

Apart from food, pigeon pea serves as feed, fuel, fertilizer (fixing nitrogen), and material for baskets and fences. Despite its high potential yield (2,500-3,000 kg/ha), productivity remains stagnant (~700 kg/ha) due to biotic (e.g., wilt, pod borer) and abiotic (e.g., drought, erratic rainfall) stresses, coupled with limited adoption of improved management practices. Pigeon pea has also suffered a loss of genetic variability due to domestication. Breeding efforts focus on developing stress-resistant, high-yielding genotypes and analyzing genetic parameters like GCV, heritability, and genetic advance.

As pulses play a critical role in nutrition and soil health through nitrogen fixation, a holistic approach to develop region-specific varieties and technologies is essential to meet the rising demand, stabilize production, and improve per capita availability.

Materials and Methods

The Experiment was conducted at Agriculture Farm, Nana Ji Deshmukh New Agriculture Campus, Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, Chitrakoot, Satna to evaluate the thirty two genotypes/varieties under normal soil and rain fed condition. The experiment was laid out following Randomized Block Design (RBD) with three replications during Kharif 2018. The experiment was sown on 29th July, 2018 and harvested on 27th, February, 2019. Each treatment was grown in 4m long 6 rows per plot spaced 90 cm apart. The plant to plant distance was maintained 25cm by thinning. Recommended agronomic cultural practices and plant protection measures were adopted to raise a best crop.

Observations were recorded for five randomly selected plants from each replication for 10 characters, including days to 50% flowering, days to maturity, plant height (cm), number of primary branches per plant, number of secondary branches per plant, number of pods per plant, seed yield per plant (g), number of seeds per pod. Appropriate variances and covariances were used for calculate phenotypic and genotypic correlation coefficients (Johnson *et al.*, 1955) ^[4-6].

Results and Discussion

Path coefficient analysis studies

The genotypic and phenotypic correlation coefficient of seed yield with the remaining characters under study were further partitioned into direct and indirect effects using path coefficient analysis and are presented in Table 1 and 2

The path coefficient showed the highest positive direct effect on seed yield kg/ha was exhibited by no. of secondary branches (0.416) followed by pods/plant (0.334), days to maturity (0.210), 100-seed weight (0.196), no. of primary branches per plant (0.090) and days to 50% flowering (0.033). The negative direct effect was recorded with plant height (-0.032) at genotypic level.

At phenotypic level, the highest positive direct effect on seed yield kg/ha was exhibited by no. of secondary branches (0.348) followed by pods/plant (0.335), 100-seed weight (0.129), days to maturity (0.101), days to 50% flowering (0.066) and no. of primary branches per plant (0.039). The negative direct effect was recorded with plant height (-0.032) at phenotypic level., Days to 50% flowering (0.153) *via* days to maturity; no. of secondary branches (0.236) *via* pods/plant; pods/plant (0.295) *via* no. of secondary branches exerted positive indirect effect whereas days to 50% flowering (-0.155) *via* no. of secondary branches exerted substantial negative indirect effects on seed yield kg/ha at genotypic level.

At phenotypic level no. of secondary branches (0.227) *via* pods/plant; pods/plant (0.236) and plant height (0.115) *via* no. of secondary branches showed positive indirect effect while days to 50% flowering (-0.110) *via* no. of secondary branches exerted negative indirect effect on seed yield kg/ha at phenotypic level,

The remaining estimates of the indirect effects in the present analysis were too low to be considered important. The estimate of residual factors at genotypic (0.35183.) and (0.55623) at phenotypic level was found moderate indicating that some of characters affecting seed yield has to be included in the present study.

Path coefficient is a tool for partitioning the observed correlation coefficient into direct and indirect effects of yield components on the grain yield to provide clearer picture of character associations for formulating efficient

selection strategy. The concept of path-coefficient analysis was developed by Sewall Wright (1921) ^[12] and technique was first used for plant selection by Dewey and Lu (1959) ^[2]. Path analysis differs from simple correlations in that it points out the causes and their relative importance, whereas, the later measures simply the mutual association ignoring the causation, path-analysis has emerged as a powerful and widely used technique for understanding the direct and indirect contribution of different characters to economic yield in crop plants so that the relative importance of various yield contributing characters can be assessed.

The path coefficient showed the highest positive direct effect on seed yield kg/ha was exhibited by no. of secondary branches followed by pods/plant, days to maturity, 100-seed weight, no. of primary branches per plant and days to 50% flowering. The negative direct effect was recorded with plant height at genotypic level.

At phenotypic level, the highest positive direct effect on seed yield kg/ha was exhibited by no. of secondary branches followed by pods/plant, 100-seed weight, days to maturity, days to 50% flowering and no. of primary branches per plant. The negative direct effect was recorded with plant height at phenotypic level.

Days to 50% flowering *via* days to maturity; no. of secondary branches *via* pods/plant; pods/plant *via* no. of secondary branches exerted positive indirect effect whereas days to 50% flowering *via* no. of secondary branches exerted substantial negative indirect effects on seed yield kg/ha at genotypic level.

At phenotypic level no. of secondary branches *via* pods/plant; pods/plant and plant height *via* no. of secondary branches showed positive indirect effect while days to 50% flowering *via* no. of secondary branches exerted negative indirect effect on seed yield kg/ha at phenotypic level. The similar result was reported by Ravika and Solanki. (2017) ^[11] for number of primary branches exhibited the highest genotypic magnitude on seed yield/plant, followed by days to 50% flowering and plant height and Ranjani, *et al.*, (2018) ^[13] for number of pods per plant, plant height, days to maturity, number of branches per plant and days to 50% per cent flowering.

The remaining estimates of the indirect effects in the present analysis were too low to be considered important. The estimate of residual factors at genotypic (0.35183.) and (0.55623) at phenotypic level was found moderate indicating that some of characters affecting seed yield has to be included in the present study. On the basis of above per se varieties- ICPL 87119, LRG 134 and BDN 2013-1 are found suitable and best performer in terms of yield and yield contributing characters in field condition and location of Chitrakoot.

Table 1: Direct and indirect effects for different characters on seed yield (kg/ha) at genotypic level in Pigeon pea.

S. No.	Traits	Days to 50% Flowering	No. of primary branches	No. of secondary branches	No. of pods/plant	Plant height (cm)	Days to maturity	100-seed weight (g)
1	Days to 50% Flowering	0.033	-0.013	-0.155	-0.042	0.008	0.153	0.000
2	No. of primary branches	-0.005	0.090	0.109	0.066	-0.004	-0.004	0.014
3	No. of secondary branches	-0.012	0.024	0.416	0.236	-0.012	-0.012	0.045
4	No. of pods/plant	-0.004	0.018	0.295	0.334	-0.005	0.007	0.057
5	Plant height (cm)	-0.008	0.011	0.152	0.048	-0.032	-0.004	-0.002
6	Days to maturity	0.024	-0.002	-0.025	0.011	0.001	0.210	-0.028
7	100-seed weight (g)	0.000	0.007	0.096	0.097	0.000	-0.030	0.196
Residual = 0.35183			Direct Effect On Main Diagonal(Bold Figure)					

Table 2: Direct and indirect effects for different characters on seed yield (Kg/ha) at phenotypic level in Pigeon pea.

S. No.	Characters	Days to 50% Flowering	No. of primary branches	No. of secondary branches	No. of pods/plant	Plant height (cm)	Days to maturity	100-seed weight (g)
1	Days to 50% Flowering	0.066	-0.001	-0.110	-0.039	0.005	0.058	-0.006
2	No. of primary branches	-0.001	0.039	0.075	0.052	-0.004	-0.005	0.009
3	No. of secondary branches	-0.021	0.008	0.348	0.227	-0.010	-0.003	0.024
4	No. of pods/plant	-0.008	0.006	0.236	0.335	-0.004	0.002	0.028
5	Plant height (cm)	-0.011	0.005	0.115	0.046	-0.032	-0.001	0.000
6	Days to maturity	0.038	-0.002	-0.010	0.007	0.000	0.101	-0.020
7	100-seed weight (g)	-0.003	0.003	0.066	0.073	0.000	-0.016	0.129
Residual = 0.55623		Direct Effect on Main Diagonal (Bold Figure)						

Conclusion

Path coefficient analysis revealed that the number of secondary branches had the highest positive direct effect on seed yield per hectare, followed by the number of pods per plant, days to maturity, 100-seed weight, number of primary branches per plant, and days to 50% flowering at both genotypic and phenotypic levels. In contrast, plant height exhibited a negative direct effect at both levels. Positive indirect effects were observed for days to 50% flowering via days to maturity and secondary branches via pods per plant, while days to 50% flowering via secondary branches showed negative indirect effects. These findings emphasize the importance of traits such as secondary branches, pods per plant, and 100-seed weight in yield improvement strategies. Additionally, the moderate residual factors suggest that further research is needed to include other characters influencing seed yield. Based on the results, varieties ICPL 87119, LRG 134, and BDN 2013-1 were identified as the best performers under field conditions in Chitrakoot.

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