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Research Article

Correlation and Path Analysis in Pigeonpea [*Cajanus cajan* (L.) Millsp.]

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ABSTRACT

Pigeonpea [Cajanus cajan (L.) Millsp.] is a predominant pulse crop grown and consumed in India that plays an important role in sustainable food and nutritional security. It is very difficult to increase the area under cultivation for improving the production and hence the selections of distinct traits for the genotypes have to be focussed for enhancing the productivity. Fifteen genotypes of Pigeonpea (Cajanus cajan (L.)) have been evaluated to study the correlation and path analysis for seed yielding traits and its contributing characters. Racemes per plant show positive and highly significant correlation with grain yield per plant to emerge as most important associates of seed yield. Studies on path analysis identified the characters viz., racemes per plant, total number of pods and pod bearing length as the most important direct yield contributing traits which merit due consideration at the time of devising selection strategy aimed at developing high yielding varieties in pigeonpea. The information was fetched together after applying various statistical tools in order to make the outcomes of association studies for the various pigeonpea breeding programs.

Keywords: *Correlation, Direct-indirect effects, Pigeonpea, Quantitative traits, Selection.*

INTRODUCTION

Being an often cross pollinated crop, Pigeonpea acts as a potent reservoir of genetic variability. The second most important pulse crop of India after chickpea is bestowed with rich source of proteins (20-21 %) and is an important soil ameliorant crop (Tharageshwari & Hemavathy, 2020). The crop occupies an area of about 4.3 million hectares globally, India leading in this context by occupying 85 percent of the area. In India it occupies an area of about 5.58 m ha with an annual production of 4.29 million tonnes (FAOSTAT, 2020). The WHO recommendation of 80g/day protein could not be fulfilled, since the per-capita availability of protein in the country is about 28 g/ day leading to malnutrition for the growing population **(**Saroj et al., 2013, & Prasad et al., 2013).

Yield is a complex trait governed by multiple genes, which is affected directly or indirectly by various components (BalChinmayee, 2016).

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However the inheritance of quantitative characters is influenced by variation in other characters which may be due to genetic linkage or pleiotropy. Hence, knowledge of association between yield and its components helps in formulating selection programme. Correlation studies would provide estimates of degree of association between grain yield and its components. Whereas path coefficient analysis further elucidates the intrinsic nature of association of component traits by determining direct or indirect contribution of these traits to yield (Baldaniya et al., 2018). Hence, the study was undertaken to analyse correlation and path coefficients which enroute in selecting superior lines, thus leading to crop improvement of pigeonpea.

MATERIALS AND METHODS

Fifteen genotypes (including checks) of Pigeonpea were studied during *kharif*, 2018 at Dept. of Pulses, Tamil Nadu Agricultural University. The experimental trial was laid out in randomized complete block design with five replications under irrigated conditions. Sowing was done in two rows of 4m length with a spacing of 60 x 30cm and recommended package of practices were followed to raise a good crop. Data on the basis of five randomly selected competitive plants were recorded on days to 50 per cent flowering, number of primary branches per plant, plant height (cm), racemes per plant, pod length (cm), number of clusters per plant, number of pods per cluster, pod bearing length (cm), number of pods per plant, hundred seed weight (g) and dry matter weight (g). Correlation coefficient and path coefficient were worked out as per method suggested by Searle (1961) and Dewey and Lu (1959), respectively. Data obtained were subjected to correlation and path coefficient analysis using Statistical Software R package ‘‘corrplot’’ (Taiyun Wei & Viliam Simko, 2017) and GENRES 7.01, respectively. The measurement of the direct and indirect effects was characterized based on the scale given by Lenka and Misra (1973) as negligible (0.00 to 0.09), low (0.10 to 0.19), moderate (0.20 to 0.29), high (0.30 to 0.99) and very high (>1.00).

RESULTS AND DISCUSSION

In plant breeding, correlation coefficient analysis measures the mutual relationship between various plant characters and determines the component characters on which selection can be based for genetic improvement in yield. The correlation between single plant yield and other traits were presented in the Table 1 and Figure 1[R (corrplot) heatmap]. Seed yield was found to be significantly and positively correlated with racemes per plant (0.51) and plant height (0.331). As racemes per plant is a primary yield contributing trait, increase in racemes per plant increases the yield, hence selection for this trait will improve the yield. The results are in harmony with Tharageshwari and Hemavathy (2020), Devi et al. (2020), Lakshmi Narayanan et al. (2018), Kesha Ram et al. (2016), Chandana et al. (2014), Saroj et al. (2013). Days to 50 per cent flowering is negatively correlated with number of primary branches per plant (-0.243). The trait number of primary branches per plant exhibited significant and positive correlation with racemes per plant (0.301), plant height (0.346) and pod bearing length (0.349). The same results were corroborated by Tharageshwari and Hemavathy (2020), Vanisree and Sreedhar (2014), Prasad et al. (2013), Sodavadiya et al. (2009), Mahajan et al. (2007) and Linge et al. (2010). Racemes per plant showed highly significant positive correlation with clusters per plant (0.509), hence an increase in racemes per plant increases the clusters per plant and will result in increased yield. Pod length showed positive correlation with plant height (0.287). The plant height exhibited negative correlation with clusters per plant (-0.276) and total number of pods (-0.280) whereas positively correlated with pod bearing length (0.729) and hundred seed weight (0.288). Similar findings were reported by Pandey et al. (2015). The trait pods per cluster showed significant positive correlation with total number of pods (0.262), whereas negatively correlated with pod bearing length (-0.234). The trait racemes per plant and clusters per plant showed highly significant positive

correlation with total number of pods (0.503, 0.809). Total number of pods exhibited significant positive correlation with dry matter weight (0.299). This study was in accordance with Tharageshwari and Hemavathy (2020), Pandey et al. (2015), Vanisree and Sreedhar (2014). Correlation ranges from -1 to +1. The values closer to zero means there is no linear trend between the two variables. The close to 1, the correlation is the more positively correlated they are; that is as one increases so does the other and the closer to one, stronger the relationship. In this case (Figure 1), Yellow circles (closer to one) indicates that there exists a significant positive correlation between PH and PBL (0.73), CPP and TNP (0.81). Green shaded circles depicts positive correlation. The correlation closer to -1 is similar, but instead of both increasing, one variable decreases as the other increases. Here, Days to 50 per cent flowering (Blue shaded circles) is negatively correlated with number of primary branches per plant (-0.24). The diagonals shows perfect correlation (DFF, NPB, RPP, PL, PH, CPP, PPC, TNP, PBL, HSW, DMW, SPY). The size of the circle varies from very minute dots (0.01) to larger circles (0.83) depending on the values. Based on the correlation studies racemes per plant and plant height **s**howed highly positive association with single plant yield. Hence these traits could be included while designing the selection index in yield enhancing breeding programme.

If less number of variables are considered in a selection program, correlation analysis alone serve the purpose. But when the number of variables are increased, there arises a complex situation. To overcome this complexity, path analysis (Wright, 1921) was done to partition the correlation into direct and indirect effects, so that the effect of each trait is established and hence their number is reduced in selection programs. It measures the direct and indirect contribution of various independent characters on a dependent character. The results of path analysis were presented in Table 2. Residual effect was found to be 0.26, which indicated that around 74% of the total variation were explained by the traits taken for study. Hence, selection on these studied characters might be useful in genetic improvement for yield. The characters viz., racemes per plant (1.457) and total number of pods (1.049) showed very high and positive direct effect on seed yield per plant and it was positive and high in case of pod bearing length (0.637). The relationship of number of pods with yield was also studied by Francis (2003), Baskaran and Muthiah (2007), Rao et al. (2013), Kesha ram et al. (2016), Tharageshwari and Hemavathy (2020), Devi et al. (2020) and they reported high positive direct effect of number of pods per plant. The trait plant height (0.680) showed positive high indirect effect through pod bearing length towards single plant yield. The traits clusters per plant (0.832), number of primary branches per plant (0.591) and total number of pods (0.832) exhibited positive high indirect effect through racemes per plant towards single plant yield. The pod bearing length (-0.534) showed negative high indirect effect by plant height towards yield.

The traits racemes per plant (0.599), pods per cluster (0.988), pod bearing length (0.346) and dry matter weight (0.403) exhibited positive high indirect effect via total number of pods towards single plant yield. Pod length (0.486), plant height (0.499) and pod bearing length (0.369) showed positive high indirect effect through clusters per plant towards single plant yield. The traits plant height (0.251) and pod bearing length (0.283) showed positive moderate indirect effect through racemes per plant towards single plant yield. Days to 50 per cent flowering (0.235), pods per cluster (0.295) exhibited positive indirect effect whereas racemes per plant (-0.235), plant height (-0.268) and pod bearing length (-0.282) exhibited negative indirect effect via number of primary branches per plant through single plant yield. Number of primary branches per plant (-0.23) showed negative indirect effect via plant height through single plant yield, whereas pods per cluster (0.209) showed positive indirect effect. The remaining all traits showed low to

negligible indirect effect of independent traits over the dependent trait. Similar path coefficient analysis was done by Devi et al. 2020. It was inferred that the traits viz**.,** racemes per plant, total no. of pods, pod bearing length directly contribute to single plant yield. Therefore, they can be considered in a breeding programme for improvement of single plant yield.

Table 1: Correlation coefficient between twelve quantitative characters in Pigeonpea germplasm

	DFF	NPB	RPP	PL	PH	CPP	PPC	TNP	PBL	HSW	DMW	SPY
DFF	1.000	-0.243*	0.053	0.007	-0.021	-0.052	-0.097	-0.105	-0.113	0.016	0.019	0.006
NPB		1.000	0.301**	0.127	0.346**	-0.044	-0.134	-0.020	0.349**	-0.069	-0.054	0.131
RPP			1.000	-0.060	0.169	0.509**	-0.131	0.503****	0.108	0.107	0.073	0.510**
PL				1.000	0.287*	-0.192	-0.196	-0.097	0.118	-0.070	-0.145	0.099
PH					1.000	-0.276*	-0.122	-0.280*	0.729**	0.288*	-0.217	0.331**
CPP						1.000	0.011	0.809****	-0.072	-0.035	0.203	0.202
PPC							1.000	0.262*	-0.234*	-0.035	0.180	-0.068
TNP								1.000	-0.205	-0.082	0.299**	0.185
PBL									1.000	0.209	-0.199	0.208
HSW										1.000	-0.096	0.152
DMW											1.000	-0.083
SPY												1.000

*. Correlation is significant at the 0.05 level (2-tailed). **. Correlation is significant at the 0.01 level (2-tailed)

DFF	Days to 50 per cent flowering
NPB	Number of primary branches per plant
RPP	Racemes per plant
PL	Pod length(cm)
PH	Plant height (cm)
CPP	Number of clusters per plant
PPC	Number of pods per cluster
TNP	Total number of pods per plant
PBL	Pod bearing length(cm)
HSW	Hundred seed weight (g)
DMW	Dry matter weight(g)
SPY	Single plant yield (g)

Table 2: Direct (Diagonal) and indirect effects of twelve characters on single plant yield in Pigeonpea germplasm

	DFF	NPB	RPP	PL	PH	CPP	PPC	TNP	PBL	HSW	DMW	SPY
DFF	**-0.150**	0.235	0.187	-0.034	0.021	0.032	-0.006	-0.017	-0.090	0.002	-0.020	0.006
NPB	0.061	**-0.580**	0.591	-0.020	-0.231	0.062	-0.011	-0.020	0.310	0.029	0.041	0.131
RPP	-0.019	-0.235	**1.457**	0.000	-0.086	-0.927	-0.014	0.599	0.124	-0.022	-0.024	0.510**
PL	-0.021	-0.048	0.002	**-0.243**	-0.186	0.486	-0.009	-0.134	0.119	0.018	0.055	0.099
PH	0.006	-0.268	0.251	-0.090	**-0.500**	0.499	-0.009	-0.363	0.680	-0.071	0.068	0.331**
CPP	0.003	0.022	0.832	0.073	0.154	**-1.624**	0.006	0.988	-0.145	0.011	-0.072	0.202
PPC	0.042	0.295	-0.975	0.108	0.209	-0.440	**0.021**	0.546	-0.175	0.015	-0.190	-0.068
TNP	0.002	0.011	0.832	0.031	0.173	-1.529	0.011	**1.049**	-0.210	0.021	-0.099	0.185
PBL	0.021	-0.282	0.283	-0.046	-0.534	0.369	-0.006	-0.346	**0.637**	-0.073	0.078	0.208
HSW	0.001	0.074	0.138	0.019	-0.155	0.080	-0.001	-0.097	0.204	**-0.230**	0.027	0.152
DMW	-0.012	0.093	0.135	0.052	0.131	-0.454	0.016	0.403	-0.191	0.024	**-0.259**	-0.083
										Residual effect		**0.26**

DFF	Days to 50 per cent flowering
NPB	Number of primary branches per plant
RPP	Racemes per plant

PL	Pod length(cm)
PH	Plant height (cm)
CPP	Number of clusters per plant
PPC	Number of pods per cluster
TNP	Total number of pods per plant
PBL	Pod bearing length(cm)
HSW	Hundred seed weight (g)
DMW	Dry matter weight(g)
SPY	Single plant yield (g)

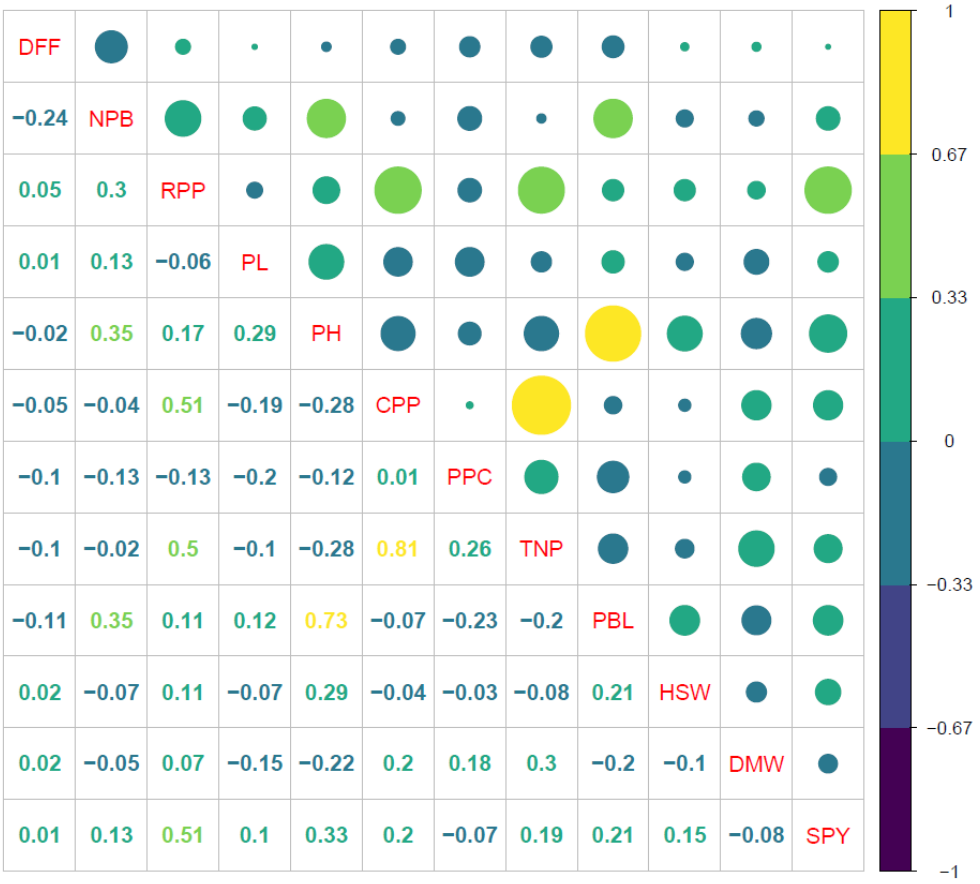

Figure 1: Heatmap for Correlation coefficients in Pigeonpea germplasm

CONCLUSION

The major yield contributing trait, racemes per plant have a direct and positive correlation with grain yield per plant, making them the most essential companions of seed yield. In path analysis studies, the traits viz**.,** racemes per plant, total no. of pods, pod bearing length directly contribute to single plant yield. Moreover, racemes per plant, total number of pods, and pod bearing length were found as the most important direct yield contributing features and they should be taken into account when looking into the selection strategies of pigeonpea. Therefore, they can be considered in a breeding programme for improvement of single plant yield. Hence these traits could be included while designing the selection index in yield enhancing breeding programme.

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Conflict of Interest

The author(s) declares no conflict of interest.

Author Contributions

SPR and MSA were involved in data collection, analysis, interpretation and writing first draft of the manuscript. ATH : involved in revision and final compilation of the manuscript.

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