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Research Article

TRAIT SELECTION BY PATH AND PRINCIPAL COMPONENT ANALYSIS FOR YIELD IMPROVEMENT IN MUNGBEAN (*Vigna radiata* (L.) Wilczek)

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Abstract: The present study was formulated to exploit the promising traits for yield improvement in 52 mungbean germplasm using path and principal component analysis (PCA). The genotypes were evaluated during *kharif* 2019 at Agricultural Research Station, Bhavanisagar. Eight yield contributing traits *viz*., plant height, days to first flowering, days to fifty percent flowering, number of pods per plant, pod length, number of seeds per pod, hundred seed weight and grain yield were recorded in this study. Path analysis portrayed that the trait number of pods per plant (1.025) exhibited highest positive direct effect on grain yield succeeded by hundred seed weight (0.498). PCA contributed to a maximum of 70.31 percent of the variability from first three components with Eigen values more than one (PC1-2.52; PC2-1.84; PC3-1.27). The first component furnished 31.49 percent of the total variation and the traits attributing to maximum variation in PC1 included plant height (0.710), number of pods per plant (0.695), single plant yield (0.685), days to first flowering (0.682), days to fifty percent flowering (0.675), and number of seeds per pod (0.182). Highest variation and maximum direct effect on grain yield was displayed by number of pods per plant. Hence selection based on number of pods per plant will be of great value for future mungbean improvement programme.

Keywords: *Mungbean, Path analysis, Principal Component Analysis*

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Introduction

Mungbean (*Vigna radiata*) is a self-pollinated warm season legume crop with the chromosome number 2n=2x=22. It is widely cultivated in tropical, subtropical and temperate zones of Asia with low inputs even under rainfed conditions. Mungbean is a valuable source of carbohydrate (51%), protein (24-26%), minerals (4%) and vitamins (3%) [8, 18]. Mungbean improves the soil fertility by fixing atmospheric nitrogen with its prominent symbiotic association with nitrogen fixing Rhizobium and Bradyrhizobium bacteria [24]. Mungbean occupies around six million hectares in the total cultivable area of the world [18]. In India it is cultivated in around 41 lakh hectares with a production of 19 lakh tonnes in 2017- 2018 [15]. Mostly, mungbean breeding programs aims to improve the yield along with biotic and abiotic stress tolerance as well as for nutritional traits. The success of breeding programs depends on the selection of diverse parental materials with desirable traits. Grain yield is a complex polygenic trait determined by a number of component traits and environmental factors. Hence, the direct selection on the basis of grain yield alone is of no value. Therefore, the selection index for grain yield would be formulated after studying the nature and magnitude of association among the component traits that contributes for grain yield. Path analysis is a regression-based approach which establishes the magnitude and significance of hypothesized causal connections between sets of variables [21]. Furthermore, principal component analysis helps to identify the plant traits that contribute most towards the observed variation. Hence, the present investigation was formulated to identify the traits that contribute the maximum for the yield increment in mungbean.

Materials and Methods

Fifty-two mungbean germplasm were evaluated in Agricultural Research Station, Bhavanisagar during *kharif*, 2019. The genotypes were raised in Randomized Block Design (RBD) with three replications. Each genotype was sown in a row of four-meter length in ridges and furrows with the spacing of 30 cm × 10 cm. All the recommended agronomic practices were made throughout the crop growth period. Observations for quantitative traits were recorded in five randomly selected plants based on standard descriptors for mungbean [7]. The observations included eight quantitative traits *viz*., plant height (cm), days to first flowering, days to fifty percent flowering, number of pods per plant, pod length, number of seeds per pod, hundred seed weight (g) and grain yield (g). The mean data of all the traits were used for path and principal component analysis. Path analysis was formulated using the software TNAUSTAT [12] while PCA was computed using the software MINITAB 17.1 version [16].

Table-1 *Direct and indirect effect of component traits on grain yield*

	PH	DFF	DFPF	PPP	PL	SPP	HSW	Correlation
PH	0.032	-0.111	0.014	0.681	0.009	0.006	-0.214	0.416
DFF	0.017	-0.212	0.024	0.624	0.014	0.013	-0.14	0.339
DFPF	0.017	-0.203	0.025	0.66	0.014	0.011	-0.139	0.384
PPP	0.021	-0.129	0.016	1.025	0.015	-0.008	-0.169	0.771
PL	-0.007	0.065	-0.008	-0.355	-0.044	-0.006	0.300	-0.054
SPP	0.001	-0.014	0.001	-0.041	0.001	0.201	0.096	0.246
HSW	-0.014	0.060	-0.007	-0.348	-0.027	0.039	0.498	0.202

PH: Plant height, DFF: Days to first flowering, DFPF: Days to fifty percent flowering,
PPP: Number of pods per plant, PL: Pod length, SPP: Number of seeds per pod, HSW: Hundred seed weight

Results

Path analysis

Path analysis displayed very high positive direct effect on grain yield exhibited by number of pods per plant (1.025) followed by hundred seed weight (0.498) with high positive direct effect [Table-1]. The trait days to first flowering (-0.212) showed moderate negative direct effect whereas the trait number of seeds per pod (0.201) displayed moderate positive direct effect contributing to grain yield in mungbean. The component traits displayed indirect effect over yield increment in mungbean. The traits plant height (0.681), days to fifty percent flowering (0.660) and days to first flowering (0.624) displayed high positive indirect effect on grain yield via number of pods per plant. Pod length exhibited high negative and positive indirect effect via number of pods per plant (-0.355) and hundred seed weight (0.300) respectively. High negative indirect effect via number of pods per plant was exhibited by hundred seed weight (-0.348). Plant height and days to fifty percent flowering displayed moderate negative indirect effect via hundred seed weight (-0.214) and days to first flowering (-0.203) respectively. Low negative indirect effect on grain yield -0.169, -0.140 and -0.139 was attributed by number of pods per plant, days to first flowering and days to fifty percent flowering via hundred seed weight respectively. The trait number of pods per plant also displayed low negative indirect effect on grain yield via days to first flowering (-0.129). The residual effect (0.3262) observed from the present study was low, which implies that the traits recorded in the study were adequate to explain their pattern of interaction on grain yield.

Principal component analysis

The percentage of variation explained by the first three principal components (PC) and the vector loadings for each agronomic character and PC were eternized [Table-2]; [Fig-1a] and [Fig-1b]. These three components alone furnished a maximum of 70.31 percent of the variability among mungbean genotypes. The Eigen values for PC 1, PC 2 and PC 3 were 2.52, 1.84 and 1.27 respectively. The first principal component PC 1 interpreted for 31.49 percent of the total variation and the PC 1 separates accessions on six traits *viz*., plant height (0.710), number of pods per plant (0.695), single plant yield (0.685), days to first flowering (0.682), days to fifty percent flowering (0.675) and number of seeds per pod (0.182). The second principal component PC 2 accounted for 22.97 percent of the total variation mainly attributed by pod traits and single plant yield. The third principal component PC 3 with the contribution of 15.85 percent to the total variation contributed primarily by pod and seed traits *viz*., hundred seed weight (0.892) and pod length (0.489).

Table-2 *Eigen values, percent of total variation and cumulative variation among eight quantitative traits of 52 mungbean accessions*

Traits	Eigen vectors		
	PC 1	PC 2	PC 3
Plant height	0.710	0.404	0.074
Days to first flowering	0.682	-0.645	0.103
Days to 50 percent flowering	0.675	-0.622	0.160
No. of pods/plant	0.695	0.567	-0.262
Pod length	-0.287	0.412	0.489
No. of seeds/pod	0.182	-0.336	0.177
Hundred seed weight	-0.165	-0.016	0.892
Single plant yield	0.685	0.518	0.302
Eigen value	2.520	1.840	1.270
Proportion of variation	31.49	22.97	15.85
Cumulative proportion	31.49	54.46	70.31

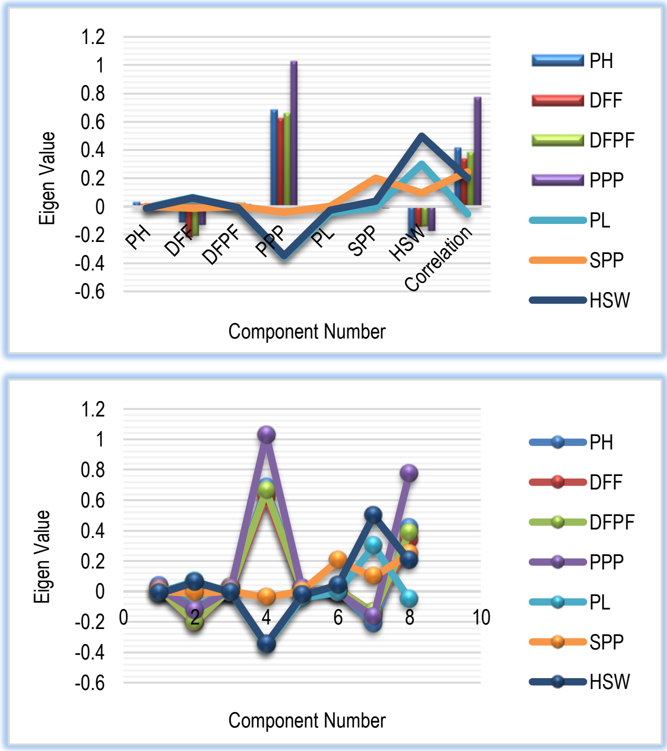

Fig-1 (a) Scree plot (b) Relationship among quantitative traits as revealed by two dimensional plots of the PCA

Discussion

The present study focused on analyzing the desirable traits over yield enhancement in mungbean. Path coefficient analysis pictures the direct and indirect effect of independent variables over the dependent variable grain yield. Path analysis displayed very high positive direct effect from number of pods per plant over grain yield of mungbean. High positive direct effect exhibited by number of pods per plant was reported earlier by [2,4,11,13,23] and [17]. Hundred seed weight exhibited high positive direct effect towards grain yield. The results corroborated with the findings given by [10,11,13] and [17]. Hence, the direct selection based on number of pods per plant and hundred seed weight would improve the grain yield of mungbean. The moderate negative direct effect showed by days to first flowering and positive effect by number of seeds per pod was akin to the findings of [23] and [17] respectively. High positive indirect effect via number of pods per plant was displayed by the following traits *viz*., plant height, days to fifty percent flowering and days to first flowering. Similar findings for plant height was reported by [22] and [10] whereas similar findings for flowering was reported by [1,5] and [6]. Pod length exhibited high negative and positive indirect effect via number of pods per plant [5,17,22] and hundred seed weight [13] respectively. Hundred seed weight also exhibited high negative indirect effect via number of pods per plant as reported by [22] and [17]. Moderate negative indirect effect via hundred seed weight and days to first flowering was exhibited by plant height and days to fifty percent flowering respectively. Such a parallel finding for plant height was reported by [10] and for days to fifty percent flowering by [23]. The trait number of pods per plant displayed low negative indirect effect via hundred seed weight [10,17] and days to first flowering [23].

High indirect effect via number of pods per plant was exhibited by the following traits *viz*., plant height, days to fifty percent flowering, days to first flowering, pod length and hundred seed weight. The traits *viz*., pod length, plant height, number of pods per plant, days to first flowering, days to fifty percent flowering portrayed low to high indirect effect via hundred seed weight. These findings represented that indirect selection for grain yield in mungbean can be accomplished through number of pods per plant and hundred seed weight. Principal Component Analysis is an Eigen vector based multivariate analysis used to determine genetic variability based on the quantitative traits studied. It reduces the dimension of a large data set by transforming a number of possibly correlated variables into a smaller number of uncorrelated variables known as principal components. Principal component analysis displayed more than 70 percent of variability from first three components of PCA. The present result is corroborated with [20], [14] and [9]. The traits that featured maximum to the first principal component PC 1 were plant height, number of pods per plant, single plant yield, days to first flowering, days to fifty percent flowering and number of seeds per pod. Similar results have also been furnished by [3] for number of pods per plant and [19] for plant height and number of seeds per pod. Similar results for single plant yield were reported by [9] and [19]. The component PC 2 revealed the higher values for pod characters and single plant yield. Hundred seed weight and pod length contributed maximum for the principal component PC 3 that was similar to the reports of [14].

Conclusion

The trait number of pods per plant displayed maximum direct effect on path analysis and also contributed for high variation in the first component of PCA. Hence the selection based on number of pods per plant would be highly prominent for yield increment in mungbean in the future breeding programmes.

Application of research: The selection strategy in mungbean improvement programme can be formulated based on understanding the correlation and variation exhibited by the quantitative traits of mungbean.

Research Category: Plant Breeding and Genetics

Abbreviations: PCA-Principal Component Analysis
PC-Principal Component, RBD-Randomized Block Design

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Study area / Sample Collection: Agricultural Research Station, Bhavanisagar

Cultivar / Variety / Breed name: Mungbean (*Vigna radiata* (L.) Wilczek)

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