Original Research Article

Assessment of Correlation and Path analysis for seed yield and its component characters in Greengram [*Vigna radiata* L. (Wilczek)]

ABSTRACT

The present study titled- Assessment of Correlation and Path analysis for seed yield and its component characters in Greengram [*Vigna radiata* L. (Wilczek)] was carried out during *Kharif* season 2021 at Crop Research Center (C.R.C), Sardar Vallabhbhai Patel University, Meerut. In the present study, twelve yield and yield related parameters have been studied in 25 diverse genotypes of greengram. The mean sum of squares for genotypes were highly significant for all the traits. In this experiment for majority of cases the genotypic correlation coefficient values was higher than the phenotypic values indicating that the phenotypic expression of correlation was influenced by environment. Seed yield/plant had a highly significant and positive correlation both at genotypic and phenotypic level with number of pods/plant, number of seeds/pod, biological yield and harvest index. Days to 50% flowering, days to maturity, plant height, number of branches/plant, number of pods/cluster and 1000 seed weight exhibited a non-significant correlation with seed yield. In this investigation seed yield per plant was dependent variable and rest of the characters were independent variables. Genotypic and phenotypic path coefficient analysis of seed yield/plant and its component attributes showed that highest positive direct effect towards seed yield/plant was observed by biological yield, harvest index, number of seeds/pod, number of pods/plant, days to 50% flowering, pod length, days to maturity and plant height. Seed yield/ plant could be improved by selection based on these traits.

Keywords: Greengram, Correlation, Path analysis

1. INTRODUCTION

Mungbean [*Vigna radiata* (L.) Wilczek] also known as greengram or moong is one of the most important edible food legumes of Asia. It is a short duration crop globally cultivated throughout the Asian countries like China, India, Indonesia, Bangladesh and Myanmar. In India mungbean is grown mainly in arid and semi-arid conditions during kharif or summer season and contribute nearly 15 percent to total pulse production [1]. The genus *Vigna* has been of immense importance to Asia as six different pulse-yielding crops belong to this genus. Of them, mungbean is the most widely spread species. Moreover, genus *Vigna* comprises of more than 10 domesticated crop species and 100 wild species [2].

India is the largest producer, consumer and importer of pulses in the world. The main leguminous crops grown in the country under a variety of agroclimatic conditions are pigeon pea, chickpeas, greengram, blackgram, peas and lentils. India has made remarkable progress in boosting pulses production during the last fifteen years. During 2005-2006, total pulses production in India was 13.38 million tons, and increased to 25.58 million metric tons during 2020-21. This shows an impressive growth of 91% or a compound annual growth rate (CAGR) of 4.42% [3]. During 2022-2023, the mungbean production in India was 3.37 million tons over an area of 5.5 million hectare with an average grain yield of 570 kg/ha. More than

80 per cent of mungbean production comes from ten major states viz., Rajasthan, Maharashtra, Madhya Pradesh, Karnataka, Bihar, Andhra Pradesh, Odisha, Tamil Nadu, Gujarat and Telangana [4]. Mungbean is a short-day, self pollinated, warm- season crop grown mainly in the semi-arid to sub humid tropics and tropics with 600 to 1000 mm of annual rainfall. It requires 22 to 35^0 C mean temperature during crop production and elevations not exceeding 1800 to 2000 m above mean sea level. For a high yield, a warm climate and deep, well drained loam or sandy loam soils are desired. Mungbeans are upright or semi-upright annual plants, with branches and the upper branch is slightly twinned, usually growing to a height of 40 to 120 cm. The arrangement of the leaves is trifoliate, with large, ovoid, intact or seldom-divided membranous lobules, with hairs on both sides. Clusters of 12–15 flowers are situated at the top of the plant, and eventually these flowers will develop into small cylindrical pods. The pod is 10-15 cm long and wide, cylindrical, straight or slightly curved, with small seeds, spherical or oblong, and the colour is often green, but it can be yellowish brown and mottled.

Nutritionally, Greengram is considered as an excellent source of protein (Engel *et al.* 1978). The seeds of mungbean constitute protein (24-28%), oil (1.0-1.5%), ash (4.5–5.5%), fiber (3.5-4.5%) and carbohydrates (62–65%) on dry weight basis. The protein in the mungbeans contains a better quantity of essential amino acids, including leucine, phenylalanine, valine, isoleucine, tryptophan, methionine, arginine and lysine [5]. Mungbean is also considered as quality pulse which provides nutritional balance in cereal-based diet of the people in South Asia and Southeast Asian countries. This valuable crop constitutes an important place in vegetarian diets because of its high and easily digestible protein. It improves soil fertility and texture due to fixing of atmospheric nitrogen via root rhizobial symbiosis [6]. Besides its primary use as dal, other preparations such as weaning foods, snacks, noodles and biscuits are also prepared from it. Low input requirement, short crop duration along with high global demand makes mungbean an ideal rotation crop in rice based cropping system. The crop is popular because of its suitability for multiple cropping systems. Due to its short life cycle of 60-75 days, it fits well into the intensive cropping systems, inter cropping, rotation and mixture. Hence, cultivation of mungbean generates triple benefit including additional income with nutrient-rich food and increased soil fertility. Moreover, intercropping of mungbean increases the yield of the subsequent cereals and reduces the requirement of nitrogen fertilizers and pest incidence[7] [8]. In India and some South Asian countries, it contributes significant dietary protein supply to predominantly cereal rich diets. Recently domestic consumption of mungbean has increased because of the rising popularity of Indian ethnic foods and perceived health benefits due to high levels of certain minerals and vitamins [9]. Sprouted mungbean seeds are eaten raw or cooked all over the world. Though greengram is considered as an important pulse crop in India, production and productivity levels are very low to meet the nutrient demand of people and the reason behind this low production and productivity are sowing on marginal and sub-marginal land under the rainfed situation, lack of high yielding genotypes, low seed replacement ratio of improved high yielding varieties, imbalanced use of plant nutrients.

The correlation provides information about inter relationship among yield and its components. Progress in crop improvement depends upon the nature and magnitude of inter relationship between heritable and inheritable variance in the expression of the traits. The seed yield in greengram like in other crops has a very complex existence because its expression depends upon several other plant traits which have a positive and negative correlation with yield and among themselves. The observed correlation between yield and its component characters is the net result of the direct and indirect effects of the component character through other yield attributes. The total correlation coefficient between yield and its component characters may sometimes be misleading, as it may be an over or under estimate of its association with other characters [10]. In these cases, direct selection on the basis of correlated response may not be fruitful. For critical evaluation, the correlation coefficient need to be split into direct and indirect effects using path coefficient analysis since, many characters affect a given trait. Thus, the correlation and path coefficients in combination can give a better insight into cause and effect relationship between different pairs of characters.

2. MATERIAL AND METHODS

During the Kharif season of 2021, a field trial was conducted at the Center for Crop Research (C.R.C) at Sardar Vallabhbhai Patel University of Agriculture & Technology in Meerut. Geographically, Meerut, which stands for the North Western Plain Zone, is located at 29.010 latitude north and 77.450 longitude, with an elevation of 217 meters above sea level. This environment is characterized by hot, humid summers and cold, dry winters. The sandy loam soil in the experimental field had a consistent texture, adequate drainage and a slightly alkaline (pH 7.68) reaction. The investigation's experimental material included 25 genotypes (Table 1) that were gathered from all across India and assessed using a Randomized Block Design (RBD) with three replications in the plot of 2 rows of 4 meter length. 30 cm separated the rows, and appropriate thinning kept the plant-to-plant gap at 20 cm. All suggested practices were adhered to maintain a high-quality crop stand. To document observations on days to 50% flowering, days to maturity, plant height, number of branches per plant, number of pods per plant, number of pods per cluster, pod length, number of seeds per pod, biological yield per plant, test weight and harvest index, five vigorous plants were chosen at random from each replication and tagged. Replication-wise mean values of 25 genotypes for 12 characters were employed in this experiment's statistical and biometrical analysis for the parameters, including analysis of variance using the provided methodologies - Analysis of variance as per the methods given by Panse and Sukhatme [11], Correlation analysis between characters as per method given by Robinsons *et al.* [12] and Path analysis for the various independent traits on dependent variable by the methods suggested by the Dewey and Lu [13].

Table 1: Detail of the Mungbean genotypes used in investigation

Genotype	Source	Genotype	Source
1.Pusa-16	IARI, New Delhi	14.Asha Mung	IIPR, Kanpur
2.Pusa Vaishali	IARI, New Delhi	15.MH-521	IIPR, Kanpur
3.IPM-02-19	IIPR, Kanpur	16.Pusa 9531	IARI, New Delhi
4.OMG-1045	IIPR, Kanpur	17.PDM-191	PAU, Ludhiana
5.Pusa-371	IARI, New Delhi	18.ML-141	PAU, Ludhiana
6.Hum-12	IIPR, Kanpur	19. MH-21	IIPR, Kanpur
7.VBG-04-008	IIPR, Kanpur	20.IPM-05-2-8	IARI, New Delhi
8. Kaporgaon	GBPUAT, Pantnagar	21.Pusa -0891	IARI, New Delhi
9.WGG-37	GBPUAT, Pantnagar	22.SMM-15-72	PAU, Ludhiana
10.Indore Mung	GBPUAT, Pantnagar	23.PDM-262	PAU, Ludhiana
11.Pant Mung-7	GBPUAT, Pantnagar	24.Pusa Vishal	IARI, New Delhi
12.Pusa-0871	IARI, New Delhi	25.WNM -16	IIPR, Kanpur
13.Tarun-18	PAU, Ludhiana		

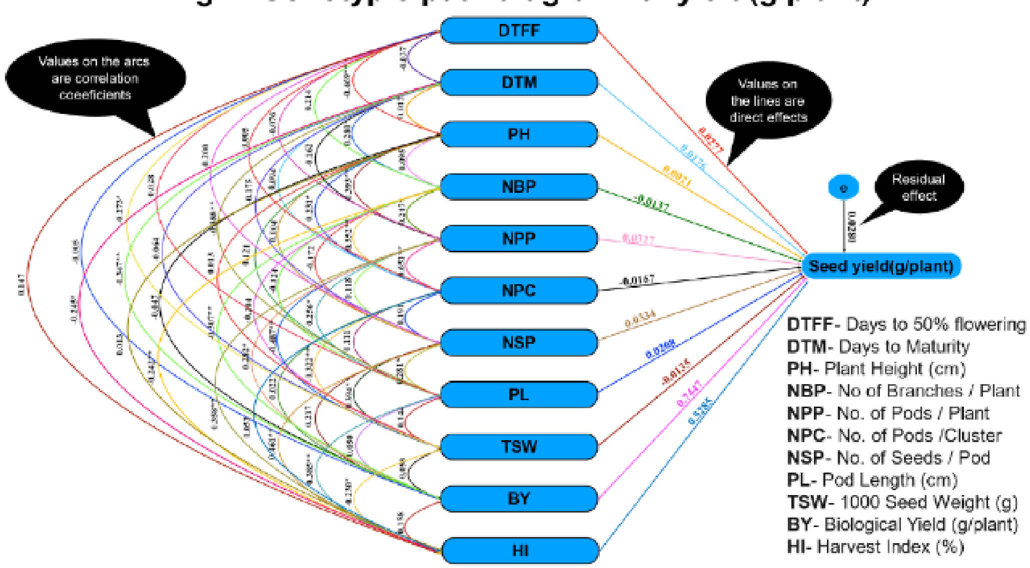
3. RESULTS AND DISCUSSION

The statistical analysis revealed a significant differences for all twelve characters under examination and among the twenty-five genotypes of mungbean, there were very significant variances.

Most of the time throughout this experiment, the genotypic correlation coefficient values were greater than the phenotypic values (Table 2), suggesting that the environment had an influence on the correlation's phenotypic expression. However, in other instances, the genotypic coefficient was merely slightly greater than the phenotypic correlation, implying that these characteristics were inherently related. The analysis showed that the number of pods/plant, number of seeds/pod, biological yield and harvest index were all positively correlated with seed yield/plant at both the genotypic and phenotypic levels. These outcomes concur with the conclusions of Zida *et al.* [14], Khaimichho *et al.* [15], Lal *et al.* [16], Tiwari *et al.* [17], Thanga *et al*. [18], Kate *et al.* [19], Sandhiya *et al.* [20], Sarfaraz *et al.* [21] and Dhunde *et al.* [22].

Plant height, number of branches/plant, number of pods/cluster, days to 50% flowering, days to maturity and 1000 seed weight all showed non-significant correlations with seed yield. These findings are in accordance to the findings of Bhareti *et al.*[23], Khanpara *et al.*[24], Nand and Anuradha [25] and Kumar *et al.*[26]. The characters, namely, number of pods/plant, number of seeds/pod, biological yield and harvest index, were therefore found to be positively correlated with seed yield/plant and among themselves on the basis of correlation coefficient studies. This suggests the usefulness of these characters in selection programs aimed at enhancing population yield potential.

Fig 1: Genotypic path diagram for yield(g/plant)



The coefficient studies revealed that the characters-number of pods/plant, number of seeds/pod, harvest index and biological yield had a positive association with seed yield/plant and with each other. It follows that these characteristics can be beneficial in selection schemes meant to increase the potential for population yield. According to this, the primary determinants affecting seed yield per plant are biological yield, harvest index, number of seeds/pod, number of pods/plant, days to 50% flowering, pod length, days to maturity and plant height. Selection based on these features may increase plant/seed output. The remaining characters had either negative or negligible direct effects on grain yield per plant, but these attributes had substantial direct effects on seed yield/plant. These outcomes concur with the conclusions of Bhutia *et al.* [27], Sreethy *et al.* [28] and Mohammed *et al.* [29].

Contribution of characters via other traits on seed yield/plant was also examined (Table 3). Path diagram displaying Seed yield/plant as a dependent variable and other traits as independent variable has been demonstrated in Figure 1 and 2. High indirect positive contribution of days to 50% flowering via number of branches/plant; Days to maturity via number of branches/plant; Plant height via number of pods/plant; Number of branches/plant via biological yield; Number of pods/plant via number of pods/cluster; Number of pod/cluster via 1000 seed weight; Number of seeds/pod via harvest index; Pod length via harvest index; 1000 seed weight via number of pods/plant; Biological yield via number of pods/plant; Harvest index via number of seeds/pod which is consistent with the results of Eswarn *et al.*[30], Anand *et al.*[31], Ramakrishnan *et al.*[32] and Mohan *et al.*[33]. Seed yield/plant can also be improved by traits that influence it via other traits. The contribution of residual effects that influenced seed yield/plant was very low at both genotypic and phenotypic levels, demonstrating that the attributes included in the current study were adequate to explain the variability in the dependent character i.e., Seed yield/plant.

Fig 2: Phenotypic path diagram for yield(g/plant)

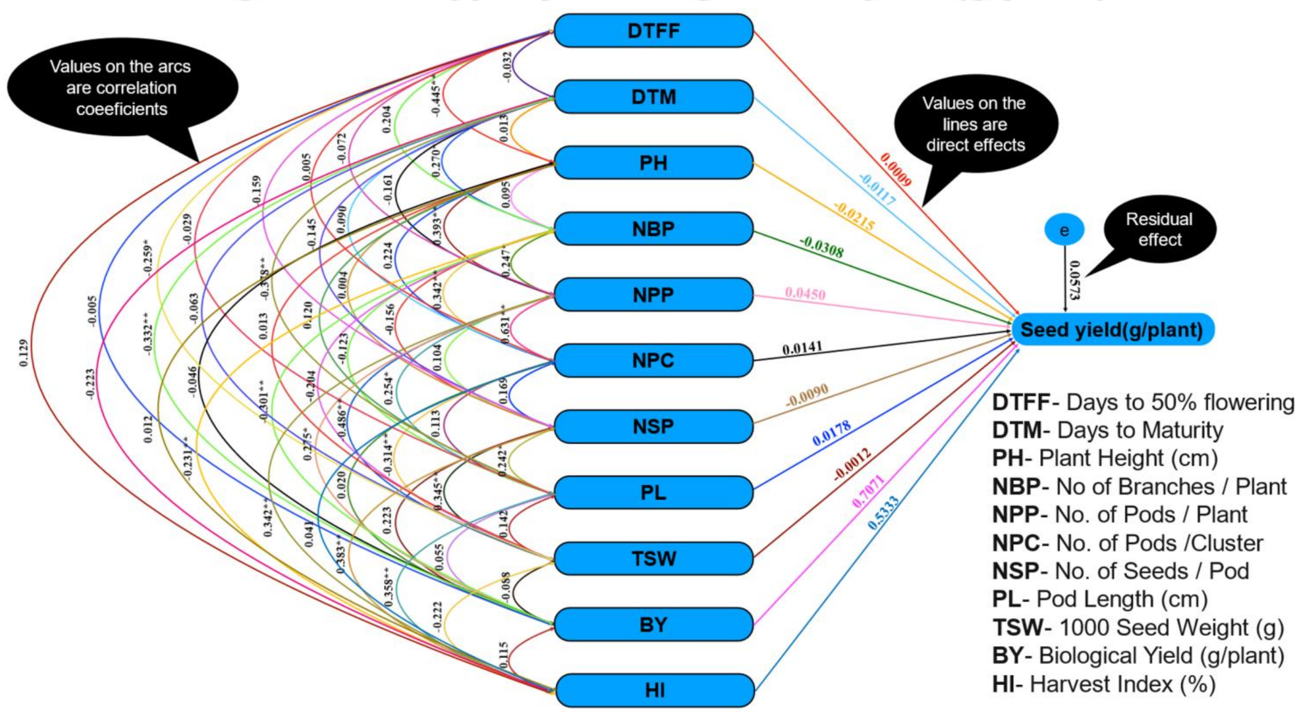


Table 2: Correlation coefficients for genotypic (G) and phenotypic (P) levels among different attributes in Mungbean

Characters		Days to 50% flowering	Days to Maturity	Plant Height (cm)	No of Branches / Plant	No. of Pods / Plant	No. of Pods /Cluster	No. of Seeds / Pod	Pod Length (cm)	1000 Seed Weight (g)	Biological Yield (g/plant)	Harvest Index (%)	Seed yield (g/plant)
Days to 50% flowering	G	1.00	-0.037	-0.469**	0.214	-0.076	0.005	-0.200	-0.028	-0.273*	-0.005	0.147	0.091
	P	1.00	-0.032	-0.445**	0.204	-0.072	0.005	-0.159	-0.029	-0.259*	0.005	0.129	0.075
Days to Maturity	G		1.00	0.012	0.280*	-0.162	0.094	-0.175	-0.388**	-0.064	-0.347**	-0.245*	-0.395**
	P		1.00	0.013	0.270*	-0.161	0.090	-0.145	-0.378**	-0.063	-0.332**	-0.223	-0.386**
Plant Height (cm)	G			1.00	0.095	0.393**	0.231*	0.004	0.121	0.013	-0.047	0.013	-0.029
	P			1.00	0.095	0.393**	0.224	0.004	0.120	0.013	-0.046	0.012	-0.028
No of Branches / Plant	G				1.00	0.247*	0.352**	-0.172	-0.124	-0.204	-0.307**	-0.242*	-0.363**
	P				1.00	0.247*	0.342**	-0.156	-0.123	-0.204	-0.301**	-0.231*	-0.356**
No. of Pods / Plant	G					1.00	0.651**	0.118	0.256*	-0.487**	0.282*	0.358**	0.429**
	P					1.00	0.631**	0.104	0.254*	-0.486**	0.275*	0.342**	0.421**
No. of Pods /Cluster	G						1.00	0.191	0.111	-0.322**	0.022	0.053	0.059
	P						1.00	0.169	0.113	-0.314**	0.020	0.041	0.063
No. of Seeds / Pod	G							1.00	0.281*	0.394**	0.217	0.461**	0.434**
	P							1.00	0.242*	0.345**	0.223	0.383**	0.370**
Pod Length(cm)	G								1.00	0.144	0.050	0.385**	0.270*
	P								1.00	0.142	0.055	0.358**	0.264*
1000 Seed Weight(g)	G									1.00	-0.093	-0.230*	-0.204
	P									1.00	-0.088	-0.222	-0.202
Biological Yield (g/plant)	G										1.00	0.158	0.845**
	P										1.00	0.115	0.795**
Harvest Index (%)	G											1.00	0.687**
	P											1.00	0.644**
Seed yield (g/plant)	G												1.00
	P												1.00

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

Table 3: Path coefficient analysis showing the direct and indirect effect of ten characters on the Seed yield (g/plant) at genotypic (G) and phenotypic (P) levels in Mungbean

Characters		Days to 50% flowering	Days to Maturity	Plant Height (cm)	No of Branches / Plant	No. of Pods / Plant	No. of Pods /Cluster	No. of Seeds / Pod	Pod Length (cm)	1000 Seed Weight (g)	Biological Yield (g/plant)	Harvest Index (%)
Days to 50% flowering	G	**0.0277**	-0.0007	-0.0010	-0.0029	-0.0025	-0.0001	-0.0067	-0.0006	0.0037	-0.0034	0.0776
	P	**0.0009**	0.0004	0.0096	-0.0063	-0.0032	0.0001	0.0014	-0.0005	0.0003	0.0032	0.0690
Days to Maturity	G	-0.0010	**0.0176**	0.0000	-0.0038	-0.0053	-0.0016	-0.0058	-0.0081	0.0009	-0.2582	-0.1297
	P	0.0000	**-0.0117**	-0.0003	-0.0083	-0.0072	0.0013	0.0013	-0.0067	0.0001	-0.2349	-0.1192
Plant Height (cm)	G	-0.0130	0.0002	**0.0021**	-0.0013	0.0129	-0.0039	0.0001	0.0025	-0.0002	-0.0352	0.0068
	P	-0.0004	-0.0002	**-0.0215**	-0.0029	0.0177	0.0032	0.0000	0.0021	0.0000	-0.0326	0.0063
No of Branches / Plant	G	0.0059	0.0049	0.0002	**-0.0137**	0.0081	-0.0059	-0.0057	-0.0026	0.0028	-0.2289	-0.1278
	P	0.0002	-0.0032	-0.0021	**-0.0308**	0.0111	0.0048	0.0014	-0.0022	0.0002	-0.2128	-0.1230
No. of Pods / Plant	G	-0.0021	-0.0029	0.0008	-0.0034	**0.0327**	-0.0109	0.0039	0.0053	0.0066	0.2100	0.1891
	P	-0.0001	0.0019	-0.0085	-0.0076	**0.0450**	0.0089	-0.0009	0.0045	0.0006	0.1945	0.1825
No. of Pods /Cluster	G	0.0001	0.0017	0.0005	-0.0048	0.0213	**-0.0167**	0.0064	0.0023	0.0044	0.0160	0.0280
	P	0.0000	-0.0011	-0.0048	-0.0106	0.0284	**0.0141**	-0.0015	0.0020	0.0004	0.0141	0.0218
No. of Seeds / Pod	G	-0.0055	-0.0031	0.0000	0.0024	0.0039	-0.0032	**0.0334**	0.0058	-0.0053	0.1617	0.2436
	P	-0.0001	0.0017	-0.0001	0.0048	0.0047	0.0024	**-0.0090**	0.0043	-0.0004	0.1577	0.2041
Pod Length(cm)	G	-0.0008	-0.0068	0.0003	0.0017	0.0084	-0.0019	0.0094	**0.0208**	-0.0019	0.0375	0.2034
	P	0.0000	0.0044	-0.0026	0.0038	0.0114	0.0016	-0.0022	**0.0178**	-0.0002	0.0388	0.1907
1000 Seed Weight(g)	G	-0.0076	-0.0011	0.0000	0.0028	-0.0159	0.0054	0.0131	0.0030	**-0.0135**	-0.0690	-0.1215
	P	-0.0002	0.0007	-0.0003	0.0063	-0.0219	-0.0044	-0.0031	0.0025	**-0.0012**	-0.0619	-0.1185
Biological Yield (g/plant)	G	-0.0001	-0.0061	-0.0001	0.0042	0.0092	-0.0004	0.0072	0.0011	0.0013	**0.7447**	0.0837
	P	0.0000	0.0039	0.0010	0.0093	0.0124	0.0003	-0.0020	0.0010	0.0001	**0.7071**	0.0616
Harvest Index (%)	G	0.0041	-0.0043	0.0000	0.0033	0.0117	-0.0009	0.0154	0.0080	0.0031	0.1179	**0.5285**
	P	0.0001	0.0026	-0.0003	0.0071	0.0154	0.0006	-0.0035	0.0064	0.0003	0.0817	**0.5333**

Residual values (G) = 0.0280, Residual values (P) = 0.0573 *, ** significant at 5% 1% level, respectively Bold values indicate direct effects

4. CONCLUSION

The genotypic correlation coefficient values were typically greater than the phenotypic values in the majority of cases, according to correlation studies. It follows that the environment had an influence on the phenotypic expression of correlation. This implied that environmental factors were partially masking substantial inherent correlations at the phenotypic level. However, in other instances, the genotypic coefficient was merely slightly greater than the phenotypic correlation, inferring that these characteristics were inherently related. The current study found a highly significant and positive correlation between the number of pods/plant, number of seeds/pod, biological yield and harvest index and seed yield/plant at both the genotypic and phenotypic levels. This suggests that these characteristics were the main contributors to seed yield. The highest positive direct effect towards seed yield/plant was observed by biological yield, harvest index, number of seeds/pod, number of pods/plant, days to 50% flowering, pod length, days to maturity and plant height, according to a genotypic and phenotypic path coefficient analysis of seed yield/plant and its component attributes. According to this, the primary elements influencing seed yield per plant are biological yield, harvest index, number of seeds/pod, number of pods/plant, days to 50% flowering, pod length, days to maturity and plant height. Selection based on these features may lead to an increase in seed yield/plant. The remaining characters had either negative or negligible direct effects on seed yield/plant, but these qualities had substantial direct effects on seed yield/plant. Plant height, branch count, pod count, pod length, harvest index, biological yield and seed yield/plant are among the traits that can be used to directly select mungbean genotypes for use in a variety of crop improvement breeding techniques in the future.

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