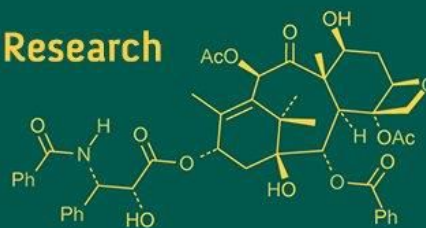


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Neha Verma

M.Sc. Scholar, Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Gera Roopa Lavanya

Professor, Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Shubham Kumar

M.Sc. Scholar, Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Sonu Kumar

M.Sc. Scholar, Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Corresponding Author:

Neha Verma

M.Sc. Scholar, Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Estimation of direct and indirect effects of yield-contributing traits on seed yield in greengram (*Vigna radiata* (L.) Wilczek)

Neha Verma, Gera Roopa Lavanya, Shubham Kumar and Sonu Kumar

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Abstract

The goal of the current study was to determine the correlation coefficients and the direct and indirect effects of several yield-related variables on seed yield among thirty genotypes of Greengram. A randomized block design with three replications was used for the experiment, which was carried out during Kharif 2024. The number of pods per plant, the number of seeds per pod, the number of clusters per plant, the number of primary branches per plant, the Harvest index, and the Seed index all shown a highly significant and positive link with the seed production per plant, according to correlation studies among the features. At the genotypic and phenotypic levels, respectively, positive and significant associations were also found with pod length, plant height, and the number of pods per cluster, indicating that these features are crucial for yield. The number of pods per cluster, number of primary branches per plant, pod length, harvest index, seed index, and number of pods per plant all had a direct positive effect on seed yield per plant in Greengram, according to the path coefficient analysis of various quantitative traits. Days to 50% flowering, days to 50% pod formation, days to maturity, and biological yield had a negative direct effect on seed yield per plant. Therefore, direct selection for these qualities would help separate high-yielding genotypes from highly segregating populations.

Keywords: Correlation, Greengram, genotypes, path analysis and seed yield

Introduction

Greengram (*Vigna radiata* L.) is one of India's major *Zaid* and *Kharif* pulse crops and belong to family *Fabaceae* with a diploid Chromosome number. it can be cultivated as a catch crop in between the *Rabi* and *Kharif* seasons. It is mostly grown in East Asia, Southeast Asia, and the Indian subcontinent, with India as its principal origin. India produces 24% of the world's pulses, making it the world's top producer. It is a significant pulse crop with a high nutritional content. A cheap source of protein and other nutrients, it is also regarded as such. Its short duration makes it a great crop to plant alongside other important crops in an intercropping system. It is a significant traditional pulse crop in India. It is especially significant in India, where the majority of people are vegetarians, as it provides a plentiful supply of high-quality, easily digestible protein. About 334-344 kcal per serving are provided by its seeds, which normally contain 59-65% carbs, 22-28% total protein, 21-25% amino acids, 1.5-2.63% lipids, 1.0-1.5% fat, 3.5-4.5% fiber, and 4-5% ash (Asari *et al.*, 2019) ^[1] Furthermore, Mungbean is well known for having a higher iron and folate content than many other legumes (Vara and Shiva, 2013) ^[2]. Essential amino acids including phenylalanine, isoleucine, leucine, and lysine are present in considerable amounts in it. Pulses, which are grown all over the world and have enormous nutritional and economic value, are produced and consumed most in India. Pulses are utilized as green manure, feed, and soil fertility enhancers in addition to being a significant source of plant-based protein for people. In terms of nutrition, they offer vital minerals like iron, zinc, folate, and magnesium, as well as proteins, carbs, dietary fibers, vitamins, and phytochemicals. Legumes, which rank second only to grasses in agricultural importance, are an essential part of world agriculture, human and cattle nutrition, and environmental sustainability. They are part of the third biggest family of higher plants, which includes over 20,000 species.

According to Das and Barua (2015) ^[3], India accounts for 54% of global production and 65% of the total land used for mungbean farming. According to the

Directorate of Economics & Statistics (2020) ^[4], the crop occupies around 4.34 million hectares and yields 2.12 million tonnes, with an average productivity of 489 kg/ha. Self-pollinating and short-duration, it boosts rural livelihoods and provides 22-24% protein (Degefa *et al.*, 2014) ^[5]. According to Desai *et al.* (2020) ^[6], mature grains possess 347 kcal, 1.2 g fat, 16.3 g fiber, 23.9 g protein, 62.6 g carbohydrates, and 1.2 g fat per 100 g. After chickpeas and pigeon peas, mungbean is the third most significant pulse in India. Over 35.58 lakh hectares were under cultivation in 2024-2025, yielding 3.10 million tons. Rajasthan led the region in both area and yield, followed by Maharashtra and Karnataka (Directorate of Economics & Statistics, 2024) ^[7].

Evaluating genetic variability, heritability, and genetic advance remains fundamental to identifying superior genotypes in self-pollinated crops like mungbean, where natural variability is often limited by floral structure and specific microclimatic requirements. Parameters such as genotypic and phenotypic coefficients of variation, heritability, and genetic advance provide insights into trait architecture and guide effective selection (Johnson *et al.*, 1955) ^[8]. Combining correlation with path coefficient analysis offers a systematic approach to untangle direct and indirect trait effects, thereby supporting more precise selection strategies (Rahman *et al.*, 1982; Dewey & Lu, 1959) ^[9-10].

Correlation coefficient is the degree and amplitude of link between important plant features can be evaluated with correlation coefficient analysis, which also provides crucial selection criteria and helps create models based on yield and its contributing elements in field trials. However, the precise nature of these relationships is frequently not made clear by it. The robust statistical method known as path coefficient analysis, on the other hand, is intended to separate correlations and measure the direct and indirect effects of many variables on seed production.

Materials and Methods

A experiment was conducted at the Crop Research Fields, Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, U.P., in Kharif 2024, a randomized block design with three replications was used to investigate correlation and path analysis for yield and its attributing traits in greengram. The crop covered a gross area of 167.6 m² with a net seeded area of 96 m², with rows spaced 30 cm apart and plants spaced 10 cm apart. The essential plant protection measures were implemented to guard against pests and diseases, and recommended agronomic techniques were adhered to to guarantee healthy crop growth.

Experimental Material

The experimental material for the present study was procured from the Department of Genetics and Plant Breeding, SHUATS, Prayagraj, and comprised 30 diverse Greengram lines, the details of which are presented in Table 1. For each replication, the following fourteen characters were observed on five randomly chosen individual plants of each genotype *viz.*, Days till 50% of the flowers bloom, 50% of the pods develop, Days till maturity Biological yield (g), seed index (g), harvest index (%), number of seeds per pod, number of major branches per plant, number of clusters per

plant, number of pods per cluster, number of pods per plant, and plant height (cm).

Table 1: Genotypes of Greengram used in the present investigation

S. No.	Genotypes	S. No.	Genotypes
1.	IPM-302-2	16.	PUSA M-1872
2.	SWETA(KM-2241)	17.	VGG 17-002
3.	GM-7	18.	BASANTI
4.	ML-668	19.	MN818
5.	IPM-205-7	20.	SHIRKHA
6.	JLM 707-5	21.	IPM-99-125
7.	PDM-139	22.	VIRAT
8.	IPM-2K-14-9	23.	KM-2
9.	MH-421	24.	MH-142
10.	GM-6	25.	KM-1
11.	GM-4	26.	IPM 2-15
12.	SML-832	27.	COG-912
13.	PM 1511	28.	IPM-02-3
14.	GAM-4	29.	RMG-344
15.	IPM 2-14	30.	PUSA-1771

2. Results and Discussion

2.1 Genetic Variability

For every trait listed in Table 2, the genotypic and phenotypic coefficient of variation were calculated. Plant height had a genotypic coefficient of variation (GCV) of 3.86%, while the number of pods per cluster had a GCV of 17.54%. Plant height had a phenotypic coefficient of variation (PCV) of 8.83%, whereas the number of pods per cluster had a PCV of 19.10%. The range of broad-sense heritability estimates was 19.09% to 84.34%. Pod length (84.04%), biological yield (82.71%), number of pods per cluster (84.34%), seed index (75.90%), harvest index (72.83%), number of major branches per plant (74.15%), and number of seeds per pod (69.79%) all showed high heredity (>60%). these results show that selection can successfully enhance these qualities, which are mostly governed by additive gene effects. Clusters per plant (59.38%), number of pods per plant (59.07%), days to 50% flowering (54.68%), and days to 50% pod development (54.17%) all showed moderate heritability (30-60%). Plant height showed the lowest heritability (19.09%).

At 5% selection intensity, the genetic advance (GA) ranged from 0.76 (per plant seed yield) to 9.01 (biological yield). Between 3.47% and 33.18% was the range of the genetic progress as a percentage of mean (GAM). Pod length (31.54%), number of pods per cluster (33.18%), biological yield (29.43%), seed index (22.63%), harvest index (21.9%), and major branches per plant (19.52%) all showed high GAM (>20%). Clusters per plant (13.54%), number of pods per plant (15.09%), number of seeds per pod (17.89%), days to 50% flowering (11.42%), and days to 50% pod formation (10.60%) all showed moderate GAM (10-20%). Plant height (3.47%) and seed yield per plant (8.85%) both showed low GAM (<10%). Comparable outcomes were reported by Karthik *et al.* (2022), Shakeer *et al.* (2022) and Mishra *et al.* (2023) ^[11, 12, 13].

4.2 Correlation Analysis

The genotypic and phenotypic correlation coefficients were computed among all characteristics presented in Tables 3 and 4. The number of pods per plant (0.695**), the number of seeds per pod (0.394**), the number of clusters per plant (0.321**), the number of primary branches per plant (0.450**), the harvest index (0.439**), and the seed index

(0.422**) all exhibited a highly significant and positive association with the seed yield per plant. Pod length (0.1923), plant height (0.1865), and number of pods per cluster (0.240*) also showed positive and significant associations.

The most important traits for increasing yield were confirmed by genotypic correlation coefficient analysis, which showed a positive and significant correlation between seed yield per plant and the number of primary branches (0.446**), clusters per plant (0.325**), pods per cluster (0.692**), pods per plant (0.234*), pod length (0.1951), number of seeds per pod (0.394**), seed index (0.417**), and harvest index (0.421**). Days to 50% blooming (-0.314**), days to first pod setting (-0.219*), and days to maturity (-0.223*) all showed significant negative relationships, which once more favored early-maturing genotypes. Saikumar *et al.* previously reported a similar finding in 2022. Muthuswamy *et al.* (2019) and Kumar *et al.* (2018) [14, 15, 16].

4.3 Path Analysis

We are often concerned with boosting yield because the outcome of a breeding program depends on a number of morpho-physiological features. Other factors also affect

these features' impact on yield because they are often linked. Separating the direct effects of a component character on yield from indirect effects through other features is made easier with the help of path coefficient analysis. The genotypic and phenotypic correlation coefficients of seed yield with its contributing factors were separated into direct and indirect impacts using route coefficient analysis. The findings are displayed in Figs. 2, 3, and Tables 5 and 6.

Both directly and indirectly, through connections with other variables, each component affected the yield. The number of pods per cluster (0.5365) had the greatest direct positive impact on seed yield per plant, according to the phenotypic path coefficient results. This was followed by the number of primary branches per plant (0.2074), pod length (0.0240), harvest index (0.1089), seed index (0.0105), and number of pods per plant (0.0154). The number of pods per cluster (0.5372) had the greatest direct positive impact on seed yield per plant, according to the genotypic path coefficient results. This was followed by the number of primary branches (0.1896), harvest index (0.0576), seed index (0.0206), pod length (0.0283), and number of pods per plant (0.0151). Ghimire *et al.* (2018), Parihar *et al.* (2018), and Saikumar *et al.* (2022) all showed similar results [14, 17, 18].

Table 2: Genetic parameters for 14 quantitative traits of 30 Greengram genotypes

S. No.	Parameters	GCV	PCV	h^2 (Broad Sense)	Genetic advance 5%	Genetic Advance as % of mean 5%
1	Days to 50% flowering	7.49	10.13	54.68	4.45	11.42
2	Days to 50% pod formation	6.99	9.50	54.17	5.22	10.60
3	Days to maturity	3.15	4.71	44.56	3.04	4.33
4	Plant Height	3.86	8.83	19.09	2.37	3.47
5	Number of primary branches per plant	11.01	12.78	74.15	1.56	19.52
6	Number of clusters per plant	8.53	11.07	59.38	1.00	13.54
7	Number of pods per cluster	17.54	19.10	84.34	1.48	33.18
8	Number of pods per plant	9.53	12.40	59.07	2.09	15.09
9	Pod length	16.70	18.22	84.04	2.55	31.54
10	Number of seeds per pod	10.40	12.44	69.79	1.54	17.89
11	Biological yield	15.71	17.28	82.71	9.01	29.43
12	Seed index	12.61	14.48	75.90	0.86	22.63
13	Harvest index	12.51	14.66	72.83	0.84	21.99
14	Seed yield per plant	7.24	12.19	35.26	0.76	8.85

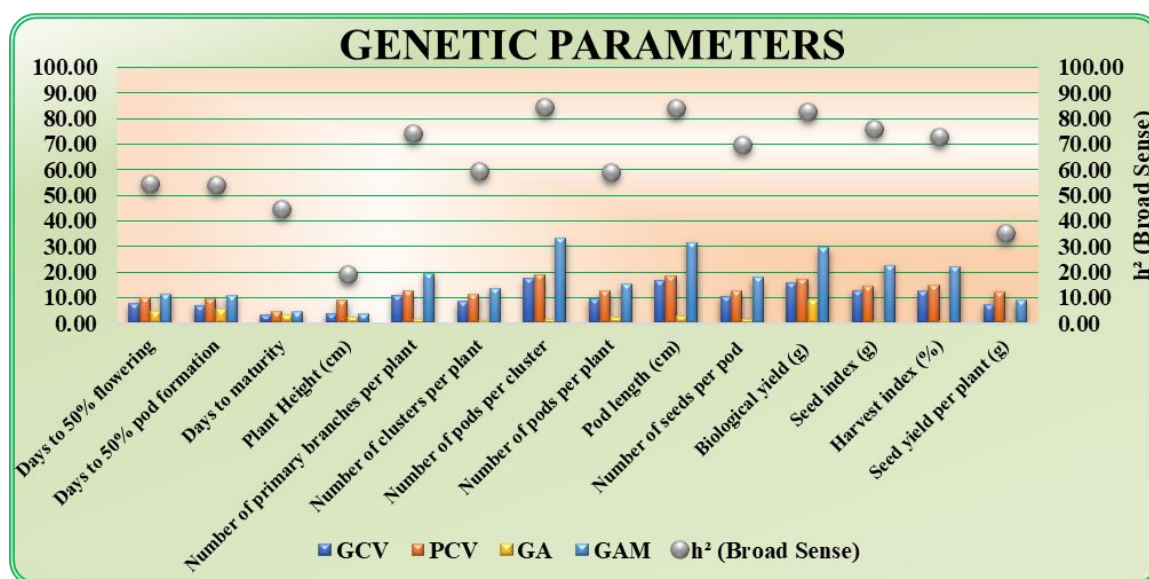


Fig 1: Graph showing GCV, PCV, genetic advance, and heritability for 14 quantitative traits in greengram genotypes.

Table 3: Estimation of phenotypic correlation coefficients between seed yield and 14 yield-attributing quantitative traits in 30 greengram genotypes.

Phenotypic Correlation Matrix													
	Days to 50% pod formation	Days to maturity	Plant height	No of primary branches per plant	Number of Clusters per Plant	Number of pods per cluster	Number of Pods per Plant	Pod Length	Number of Seeds per Pod	Biological Yield	Seed Index	Harvest Index	Seed Yield per plant
Days to 50% flowering	0.540**	0.438**	-0.001	-0.112	-0.051	-0.305**	0.093	0.128	-0.402**	0.379**	-0.279**	-0.244*	-0.320**
Days to 50% pod formation		0.242*	-0.026	-0.089	0.106	-0.251*	0.050	0.220*	-0.215*	0.323**	-0.103	-0.093	-0.216*
Days to maturity			-0.154	-0.491**	-0.327**	-0.325**	0.038	-0.1	-0.518**	0.147	-0.290**	-0.299**	-0.213*
Plant Height				0.332**	0.251*	0.333**	0.068	0.129	0.256*	0.085	0.151	0.142	0.186
Number of primary branches per plant					0.406**	0.519**	0.218*	0.277**	0.496**	0.123	0.373**	0.389**	0.450**
Number of clusters per plant						0.433**	0.353**	0.360**	0.288**	0.070	0.449**	0.454**	0.321**
Number of pods per cluster							0.282**	0.287**	0.489**	-0.160	0.471**	0.473**	0.695**
Number of pods per plant								0.347**	0.158	0.226*	0.425**	0.411**	0.240*
Pod length									0.366**	0.526**	0.291**	0.210*	0.192
Number of seeds per pod										0.030	0.377**	0.450**	0.394**
Biological yield											-0.0684	-0.071	-0.147
Seed index												0.827**	0.422**
Harvest index													0.439**

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

Table 4: Estimation of genotypic correlation coefficients between seed yield and 14 yield-contributing quantitative traits in 30 greengram genotypes.

Genotypic Correlation Matrix													
	Days to 50% pod formation	Days to maturity	Plant height	No of primary branches per plant	Number of Clusters per Plant	Number of pods per cluster	Number of Pods per Plant	Pod Length	Number of Seeds per Pod	Biological Yield	Seed Index	Harvest Index	Seed Yield per plant
Days to 50% flowering	0.534**	0.426**	-0.001	-0.115	-0.047	-0.304**	0.087	0.129	-0.396**	0.373**	-0.278**	-0.248*	-0.314**
Days to 50% pod formation		0.245*	-0.025	-0.086	0.103	-0.251*	0.053	0.218*	-0.217*	0.325**	-0.103	-0.086	-0.219*
Days to maturity			-0.144	-0.483**	-0.331**	-0.321**	0.042	-0.105	-0.513**	0.153	-0.281**	-0.273**	-0.223*
Plant Height				0.330**	0.248*	0.333**	0.067	0.126	0.257*	0.086	0.153	0.146	0.181
Number of primary branches per plant					0.402**	0.517**	0.221*	0.276**	0.491**	0.126	0.372**	0.388**	0.446**
Number of clusters per plant						0.433**	0.347**	0.361**	0.289**	0.065	0.447**	0.441**	0.325**
Number of pods per cluster							0.280**	0.286**	0.489**	-0.160	0.471**	0.469**	0.692**
Number of pods per plant								0.345**	0.152	0.230*	0.422**	0.411**	0.234*
Pod length									0.365**	0.522**	0.289**	0.202	0.195
Number of seeds per pod										0.026	0.377**	0.442**	0.394**
Biological yield											-0.067	-0.063	-0.151
Seed index												0.823**	0.417**
Harvest index													0.421**

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

Table 5: Estimation of phenotypic path coefficients between seed yield and 14 yield-contributing quantitative traits in 30 greengram genotypes

Phenotypic Correlation Matrix														
	Days to 50% flowering	Days to 50% pod formation	Days to maturity	Plant height	No of primary branches per plant	Number of Clusters per Plant	Number of pods per cluster	Number of Pods per Plant	Pod Length	Number of Seeds per Pod	Biological Yield	Seed Index	Harvest Index	Seed Yield per plant
Days to 50% flowering	-0.1671	-0.0902	-0.0732	0.0002	0.0188	0.0086	0.051	-0.0156	-0.0215	0.0672	-0.0634	0.0467	0.0408	-0.320**
Days to 50% pod formation	0.003	0.0056	0.0014	-0.0001	-0.0005	0.0006	-0.0014	0.0003	0.0012	-0.0012	0.0018	-0.0006	-0.0005	-0.216*
Days to maturity	0.0762	0.0422	0.1739	-0.0268	-0.0855	-0.0569	-0.0565	0.0067	-0.0174	-0.0901	0.0257	-0.0505	-0.0521	-0.213*
Plant Height	0.0001	0.0014	0.008	-0.052	-0.0173	-0.013	-0.0173	-0.0036	-0.0067	-0.0133	-0.0045	-0.0078	-0.0074	0.1865
Number of primary branches per plant	-0.0233	-0.0185	-0.1019	0.0688	0.2074	0.0842	0.1076	0.0452	0.0574	0.1029	0.0256	0.0774	0.0806	0.450**
Number of clusters per plant	-0.0004	0.0009	-0.0027	0.002	0.0033	0.0081	0.0035	0.0029	0.0029	0.0023	0.0006	0.0036	0.0037	0.321**
Number of pods per cluster	-0.1637	-0.1344	-0.1744	0.1789	0.2783	0.2324	0.5365	0.1515	0.1538	0.2626	-0.0859	0.2528	0.2538	0.695**
Number of pods per plant	0.0014	0.0008	0.0006	0.0011	0.0034	0.0054	0.0044	0.0154	0.0053	0.0024	0.0035	0.0066	0.0063	0.240*
Pod length	0.0031	0.0053	-0.0024	0.0031	0.0066	0.0086	0.0069	0.0083	0.024	0.0088	0.0126	0.007	0.005	0.1923
Number of seeds per pod	-0.0036	-0.0019	-0.0047	0.0023	0.0045	0.0026	0.0044	0.0014	0.0033	0.009	0.0003	0.0034	0.0041	0.394**
Biological yield	-0.0215	-0.0183	-0.0084	-0.0049	-0.007	-0.004	0.0091	-0.0129	-0.0299	-0.0018	-0.0568	0.0039	0.0041	-0.1476
Seed index	0.0029	0.0011	0.003	-0.0016	-0.0039	-0.0047	-0.0049	-0.0044	-0.0031	-0.0039	0.0007	-0.0105	-0.0087	0.422**
Harvest index	-0.0266	-0.0102	-0.0326	0.0155	0.0423	0.0494	0.0515	0.0447	0.0229	0.0491	-0.0078	0.0901	0.1089	0.439**

Table 6: Estimation of genotypic path coefficients between seed yield and 14 yield-contributing quantitative traits in 30 greengram genotypes.

Genotypic Correlation Matrix														
	Days to 50% flowering	Days to 50% pod formation	Days to maturity	Plant height	No of primary branches per plant	Number of Clusters per Plant	Number of pods per cluster	Number of Pods per Plant	Pod Length	Number of Seeds per Pod	Biological Yield	Seed Index	Harvest Index	Seed Yield per plant
Days to 50% flowering	-0.1359	-0.0726	-0.058	0.0002	0.0157	0.0065	0.0413	-0.0119	-0.0176	0.0539	-0.0507	0.0378	0.0336	-0.314**
Days to 50% pod formation	-0.004	-0.0074	-0.0018	0.0002	0.0006	-0.0008	0.0019	-0.0004	-0.0016	0.0016	-0.0024	0.0008	0.0006	-0.219*
Days to maturity	0.0615	0.0354	0.1443	-0.0208	-0.0696	-0.0477	-0.0463	0.0061	-0.0152	-0.074	0.0221	-0.0406	-0.0394	-0.223*
Plant Height	0.0001	0.0016	0.0088	-0.0612	-0.0202	-0.0152	-0.0204	-0.0041	-0.0077	-0.0157	-0.0053	-0.0094	-0.009	0.1813
Number of primary branches per plant	-0.0219	-0.0165	-0.0915	0.0626	0.1896	0.0763	0.0981	0.0419	0.0524	0.0931	0.0239	0.0705	0.0735	0.446**
Number of clusters per plant	-0.001	0.0022	-0.007	0.0053	0.0085	0.0212	0.0092	0.0073	0.0077	0.0061	0.0014	0.0095	0.0093	0.325**
Number of pods per cluster	-0.1631	-0.1346	-0.1724	0.179	0.2779	0.2324	0.5372	0.1506	0.1537	0.2627	-0.0861	0.2531	0.2518	0.692**
Number of pods per plant	0.0013	0.0008	0.0006	0.001	0.0033	0.0053	0.0042	0.0151	0.0052	0.0023	0.0035	0.0064	0.0062	0.234*
Pod length	0.0037	0.0062	-0.003	0.0036	0.0078	0.0102	0.0081	0.0097	0.0283	0.0103	0.0148	0.0082	0.0057	0.1951
Number	-0.0089	-0.0048	-0.0115	0.0057	0.011	0.0065	0.0109	0.0034	0.0081	0.0223	0.0006	0.0084	0.0099	0.394**

of seeds per pod														
Biological yield	-0.0255	-0.0223	-0.0105	-0.0059	-0.0086	-0.0045	0.011	-0.0157	-0.0357	-0.0018	-0.0684	0.0046	0.0043	-0.1517
Seed index	-0.0057	-0.0021	-0.0058	0.0032	0.0077	0.0092	0.0097	0.0087	0.006	0.0078	-0.0014	0.0206	0.0169	0.417**
Harvest index	-0.0143	-0.005	-0.0157	0.0085	0.0223	0.0254	0.027	0.0237	0.0117	0.0254	-0.0037	0.0474	0.0576	0.421**
Seed yield per plant	-0.314**	-0.219*	-0.223*	0.1813	0.446**	0.325**	0.692**	0.234*	0.1951	0.394**	-0.1517	0.417**	0.421**	

5. Conclusion

Genotypes perform better on average under yield traits, genotypes that for the various sowing conditions should be evaluated. Before being released, they must go through varietal testing if they do better than the typical check. In hybridization programs, these genotypes can also be employed as parents to create superior, high-yielding genotypes. In order to determine the component traits that selection might be relied on to improve genetic yield, this approach quantifies the correlations between different plant characters. Positive genetic correlations between desired features are advantageous to plant breeders because they enable the simultaneous enhancement of both traits. Direct impacts and indirect effects via other qualities are separated by partitioning the correlation. While features with strong indirect effects can be selected indirectly through linked qualities, traits with high direct effects can be targeted directly to increase yield.

References

- Asari T, Patel BN, Patel R, Patil GB, Solanki C. Genetic variability, correlation and path coefficient analysis of yield and yield contributing characters in mung bean [*Vigna radiata* (L.) Wilczek]. Academic Journals. 2014;7(4):383-387.
- Vara PBV, Shiva PG. Genetic variability, trait association and path analysis of yield and yield components in *Vigna radiata* L. Int J Bio-Res Stress Manag. 2013;4(2):251-254.
- Das RT, Barua PK. Association studies for yield and its components in green gram. Int J Agric Environ Biotechnol. 2015;8(3):561.
- Directorate of Economics and Statistics. Department of Agriculture and Cooperation, New Delhi. Government of India. 2020.
- Degefa I, Petros Y, Andargie M. Genetic variability, heritability and genetic advance in mung bean (*Vigna radiata* (L.) Wilczek) accessions. Plant Sci. 2014;1(2):94-98.
- Desai VK, Parmar LD, Chaudhary AR, Chaudhary NB. Genetic variability, correlation, path coefficient and stability analysis for yield and its attributing traits in summer green gram [*Vigna radiata* (L.) Wilczek] accessions. Int J Curr Microbiol Appl Sci. 2020;9(6):2942-2955.
- Directorate of Economics and Statistics. Department of Agriculture and Cooperation, New Delhi. Government of India. 2024.
- Johnson HW, Robinson HF, Comstock RE. Estimate of genetic and environmental variability in soybean. Agron J. 1955;47:314-318.
- Rahman A, Mahmud I, Rajguru AM. Path coefficient analysis in mungbean. Bangladesh J Agric Res. 1982;7(2):21-26.
- Dewey DR, Lu KA. A correlation and path-coefficient analysis of components of crested wheatgrass seed production. Agron J. 1959;51(9):515-518.
- Karthik U, Lal GM, Bara BM, Yajavathi C, Gangadhar L. Direct and indirect effects of yield contributing characters on seed yield in black gram (*Vigna mungo* (L.) Hepper). Int J Environ Clim Change. 2022;12(11):2016-2027.
- Shakeer S, Pameela S, Sharma B, Lavanya GR, Lal GM, Saikumar SS. Direct and indirect effects of yield contributing characters on seed yield in greengram (*Vigna radiata* (L.) Wilczek). Int J Environ Clim Change. 2020;12(11):3300-3310.
- Mishra A, Shweta TR, Tiwari AP. Studies on character association and path coefficient analysis for yield and yield related traits in greengram [*Vigna radiata* (L.) Wilczek]. Asian J Microbiol Biotechnol Environ Sci. 2023;25(4):717-721.
- Saikumar SS, Lal GM, Lavanya GR, Sharma B, Pameela S, Shakeer S. Direct and indirect effects of yield contributing characters on seed yield in greengram (*Vigna radiata* (L.) Wilczek). Int J Environ Clim Change. 2022;12(11):3300-3310.
- Kumar A, Sharma NK, Kumar R, Sanadya SK, Sahoo S. Correlation and path analysis for seed yield and component traits in mungbean under arid environment. Int J Chem Stud. 2018;6(4):1679-1681.
- Muthuswamy A, Jamunarani M, Ramakrishnan P. Genetic variability, character association and path analysis studies in mungbean [*Vigna radiata* (L.) Wilczek]. Int J Curr Microbiol Appl Sci. 2019;8(4):1136-1146.
- Ghimire SS, Khanal A, Kohar GR, Acharya B, Basnet A, Kandel P, Subedi B, Shrestha J, Dhakal K. Variability and path coefficient analysis for yield attributing traits of mungbean [*Vigna radiata* (L.) Wilczek]. Azarian J Agric. 2018;5(1):7-11.
- Parihar R, Agrawal AP, Sharma DJ, Madhuri G. Character association and path analysis studies on seed yield and its yield attributing traits in mungbean (*Vigna radiata* (L.) Wilczek). J Plant Prod. 2018;7(1):2148-2150.