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Correlation and Path Analysis Studies in Mungbean [*Vigna radiata* (L.) Wilczek] under Arid Environment of Western Rajasthan

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ABSTRACT

Background: Mungbean is an important grain legume crop. It contains a high amount of protein, carbohydrates, vitamins and minerals. The productivity of this crop is still low, hence efforts should be made to improve the yield of mungbean by keeping knowledge about association between seed yield and its components. Thus, the present investigation was aimed to determine the correlation and path coefficient analysis for seed yield and its attributing traits in mungbean.

Methods: Seventy-nine diverse genotypes of mungbean were evaluated during *Kharif* 2017-18 for eleven quantitative traits in randomized block design with three replications at the Experimental farm, Department of Genetics and Plant Breeding, College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner, Rajasthan.

Result: Significant genotypic differences were observed for all the traits studied indicating a considerable amount of variation among genotypes for all the characters. The seed yield per plant exhibited highly significant and positive correlation with number of pods per plant, biological yield per plant, harvest index, number of seeds per pod and pod length. The characteristics such as biological yield per plant, harvest index, number of pods per plant, pod length, number of seeds per pod, plant height, 100-seed weight and days to 50 per cent flowering had high positive direct effect on seed yield per plant. Therefore, selection based on the traits *viz*., number of pods per plant, biological yield per plant, harvest index, number of seeds per pod, 100-seed weight and pod length could help in enhancing the seed yield per plant in mungbean.

Key words: Correlation, Mungbean, Path-coefficient analysis, Seed yield.

INTRODUCTION

Mungbean [*Vigna radiata* (L.) Wilczek; 2n=22], belonging to the family Fabaceae and sub-family Papilionaceae, is a self-pollinating diploid grain legume. It is an important multipurpose pulse crop extensively cultivated in arid, semi-arid and sub-tropics. It can be grown in various crop rotation practices because of its short-duration nature, wider adaptability, low water requirement and photo insensitiveness (Singh *et al*., 2015).

Mungbean is an essential dietary component in India. It is the cheapest source of protein and provides nutritional security to vegetarians. It is also consumed in the preparation of other food products like *Papad, Namkeen, Mangori, Dal vada*, *etc*. *Mung Ki Dal Ki Khichadi* made with mungbean *Dal* and rice is easily digestible and therefore always recommended by doctors for sick people (Sharma, 2016).

India is the principal producer of mungbean in the world with an annual production of 3.17 million tonnes from an area of 5.5 million hectares with productivity of 570 kg/ha. The Mungbean alone accounts for 10% of production and 16% of the area for all pulses. In India, it is mainly grown in Rajasthan, Madhya Pradesh, Maharashtra, Karnataka, Uttar Pradesh, Bihar, Tamil Nadu, Gujarat, Haryana, Punjab and Andhra Pradesh (Anonymous, 2022a). Rajasthan occupies the first position in the area and production of mungbean in India. In Rajasthan, it is cultivated on 25.60 lakh hectare area with the production of 9.05 lakh tonne and productivity of 354 kg/ha. Major mungbean growing districts of Rajasthan are Nagaur, Jodhpur, Churu, Pali, Jaipur, Ajmer, Jalor and Tonk (Anonymous, 2022b).

Though India is a leading producer of green gram in the world its productivity is very low as compared to its potential production. Therefore, there is great scope for its improvement by developing high-yielding, disease and pest resistance varieties with improved nutritional value.

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Development of high-yielding cultivars requires knowledge of the existing genetic variation and also the extent of association among yield contributing characters.

Yield is a complex dependent character and is contributed by several components. Correlation coefficient analysis is a statistical technique that measures the degree and association between two or more variables. Estimates of the correlation coefficient are useful in identifying the component traits that can be used for yield improvement of mungbean. Correlation studies simply measure the association of yield and yield attributes and do not give the actual dependence of yield on the correlated characters. Path coefficient analysis provides a thorough understanding of the contribution of various characters by partitioning the correlation coefficient into components of direct and indirect effects (Wright, 1921), which helps the breeder in determining the yield components. To accumulate the optimum contribution of yield-contributing characters, it is essential to know the association of various characters along with path coefficients (Bhutia *et al.,* 2016). Path coefficient analysis is an effective method to determine the direct and indirect causes of association and also permits to examine the specific forces acting to produce a given correlation.

Therefore, in the present study, an effort has been made to generate information on the association of yield with its different component measures through correlation and path analysis so that an appropriate selection strategy can be formulated for evolving suitable genotypes of mungbean for arid zones.

MATERIALS AND METHODS

The present investigation was carried out at the Experimental farm, Department of Genetics and Plant Breeding, College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner during *Kharif*, 2017-18. The experimental material consisting of 79 genotypes procured from NBPGR, Regional Station, Jodhpur; Rajasthan Agricultural Research Institute, Durgapura, Jaipur; Agricultural Research Station, Sriganganagar and Agricultural Research Station, Mandor,

Table 1: List of mungbean genotypes used for present investigation.

Name of germplasm	Year of collection	Source of procurement
Germplasm procured from NBPGR, Regional Station, Jodhpur		
IC-39269	1993	Jodhpur, Rajasthan
IC-39275	1993	Kherapa, Jodhpur, Rajasthan
IC-39279	1993	*
IC-39288	1993	Nimbojhai, Nagour, Rajasthan
IC-39293	1993	Kadampura, Nagour, Rajasthan
IC-39298	1993	Bambor,Jodhpur, Rajasthan
IC-39300	1993	Jaswasar, Bikaner, Rajasthan
IC-39328	1993	Lalela, Barmer, Rajasthan
IC-39333	1993	Dhawa, Barmer, Rajasthan
IC-39352	1993	Manduwa, Barmer, Rajasthan
IC-39368	1993	Lunawas, Jodhpur, Rajasthan
IC-39375	1993	Nibali, Barmer, Rajasthan
IC-39383	1993	Godan, Jalore, Rajasthan
IC-39395	1993	Aburoad, Sirohi, Rajasthan
IC-39399	1993	Jaspura, Palanpur, Gujarat
IC-39409	1993	Kapara, Banaskantha, Gujarat
IC-39420	1993	Nearsami, Patan, Gujarat
IC-39427	1993	Harij, Patan, Gujarat
IC-39451	1988	Lakhtarar, Surendranagar, Gujarat
IC-39454	1988	Surendranagar, Gujarat
IC-39465	1988	Kalyana, Patan, Gujarat
IC-39483	1988	Kalapur, Surendranagar, Gujarat
IC-39492	1988	Dudhai, Mahesana, Gujarat
IC-39495	1988	Chandrani, Kachchh, Gujarat
IC-39500	1988	Kishangarh, Gujarat
IC-39515	1988	Kauth, Gujarat
IC-39580	1992	Bachau, Kutch, Gujarat
IC-39582	1992	Chilora, Kheda, Gujarat
IC-39591	1992	Sevelia, Kheda, Gujarat

Table 1: Continue...

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IC-39604	1992	Bholi, Rajasmand, Rajasthan
IC-39608	1992	Nevra, Jodhpur, Rajasthan
IC-39610	1992	Osian, Jodhpur, Rajasthan
IC-52073	1992	*
IC-52076	1992	*
IC-52078	1992	*
IC-52081	1992	*
IC-52082	1992	*
IC-52087	1992	*
IC-55069	1992	*
IC-102792	1986	Banar, Jodhpur, Rajasthan
IC-102821	1986	Gidani, Jaipur, Rajasthan
IC-102857	1986	Khasur, Dholpur, Rajasthan
IC-102963	1986	Avikanagar, Tonk, Rajasthan
IC-103014	1986	Alampur, Kheda, Gujarat
IC-103059	1986	Krakas, Amreli, Gujarat
IC-103204	1987	Gangawar, Chittorgarh, Raj.
IC-103207	1987	Dhinva, Chittorgarh, Rajasthan
IC-103244	1986	Bhrwasa, Didwana, Nagaur, Raj.
IC-103245	1987	Odda, Banswara, Rajasthan
IC-103785	1989	Khemlo, Vishsana, Rajasthan
IC-103821	1989	Nagdhan, Santrampur, Gujarat
IC-103973	1989	Barvalbhipor, Bhavnagar, Gujarat
IC-324012	-	*
IC-338868	1990	Sanari, Barmer, Rajasthan
Varieties procured from Agriculture University, Jodhpur		
Sweta		CSAVAT, Kanpur
IPM-02-3		ICAR-IIPR, Kanpur
IPM-02-14		ICAR-IIPR, Kanpur
Samrat (PDM-139)		ICAR-IIPR, Kanpur
GM-4		AAU, Pulse Res. Station, Vadodara
MH 2-15		CCSHAU, Hisar
MH-421		CCSHAU, Hisar
IPM-205-7		ICAR-IIPR, Kanpur
IPM 99-125 (Meha)		ICAR-IIPR, Kanpur
IPM-409-4		ICAR-IIPR, Kanpur
GAM-5		AAU, Pulse Res. Station, Vadodara
COGG-912		TNAU, Coimbatore
Varieties procured from RARI, Durgapura, Jaipur		
RMG-62		SKRAU-ARS, Durgapura, Jaipur
RMG-268		SKRAU-ARS, Durgapura, Jaipur
RMG-344		SKRAU-ARS, Durgapura, Jaipur
RMG-492		SKRAU-ARS, Durgapura, Jaipur
Keshwanand Mung-1 (RMG-975)		SKNAU-RARI, Durgapura, Jaipur
Keshwanand Mung-2 (MSJ-118)		SKNAU-RARI, Durgapura, Jaipur
Varieties procured from ARS, Sriganganagar		
Ganga-1		SKRAU-ARS, Sriganganagar
Ganga-8		SKRAU-ARS, Sriganganagar
MUM-2		CCS Meerut University, Meerut
SML-668		PAU, Ludhiana
SML-832		PAU, Ludhiana
ML-683		PAU, Ludhiana
ML-818		PAU, Ludhiana

*Source was not mentioned by NBPGR, Regional Station, Jodhpur.

Jodhpur is given in Table 1. The germplasm of mungbean was evaluated in randomized block design with three replications accommodating 3 meters long two rows per replication at 30 cm spacing under sprinkler irrigated situation. All recommended agronomic practices were adopted to raise a healthy crop. Observations recorded for 11 characters *viz*., days to 50 per cent flowering, days to maturity, plant height, number of branches per plant, number of pods per plant, number of seeds per pod, pod length, 100-seed weight, biological yield per plant, seed yield per plant and harvest index. The data on days to 50 per cent flowering and days to maturity were recorded on plot basis, while five randomly selected plants from each of the entries were selected for recording the remaining observations.

Analysis of variance was calculated by the method suggested by Panse and Sukhatme (1985). Phenotypic and genotypic correlation coefficients were worked out as per the procedure outlined by Burton and Devane (1953) and Johnson *et al*. (1955). Direct and indirect effects of component traits on grain yield were worked out using the correlation coefficient of various traits as suggested by Wright (1921) and elaborated by Dewey and Lu (1959).

RESULTS AND DISCUSSION

The analysis of variance (Table 2) revealed significant differences among seventy-nine diverse genotypes for all eleven characters studied indicating the presence of significant variability in the materials thereby justifying the selection of the experimental materials. The phenotypic and genotypic correlation among the yield and yield components in mungbean are presented in Table 3. A significant correlation of characters suggested that there is much scope for direct and indirect selection for further improvement. In general, the estimates of genotypic correlation coefficient were higher than their corresponding phenotypic ones thereby suggesting inherent association among the characters studied. In the present investigation, seed yield per plant had significant and positive correlation with number of pods per plant, biological yield per plant, harvest index, number of seeds per pod and pod length at phenotypic level. Therefore, selection for seed yield per plant may be done by taking biological yield per plant, number of pods per plant, harvest index, number of seeds per pod and pod length into account. These characteristics may be emphasized for the mungbean breeding programme. Significantly positive correlation in seed yield per plant with number of seeds per pod and number of pods per plant have earlier been reported by Bisht *et al.* (2014) and Bhutia *et al.* (2016); Choudhary *et al.* (2016) for biological yield per plant. Significantly positive correlation in seed yield per plant with harvest index was earlier reported by Gadakh *et al.* (2013); Katiyar *et al.* (2015); Jadhav *et al*. (2019) and Gaur *et al.* (2021).

The phenotypic correlation coefficient of days to 50 per cent flowering, days to maturity, plant height and number of branches per plant with seed yield per plant was found

Table 2: Analysis of variance for different characters of mungbean.

Source of variation	D.F.	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of branches per plant	No. of pods per plant	No. of seeds per pod	Pod length (cm)	100-seed weight (g)	Biological yield per plant (g)	Harvest index (%)	Seed yield per plant (g)
Replications	2	0.34	4.81	27.06	0.362**	0.76	0.46	0.48	0.001	2.04	0.98	0.63
Genotypes	78	250.90**	159.74**	1057.98**	0.635**	572.79**	2.84**	2.91**	0.580**	1252.01**	316.13**	162.12**
Error	156	0.18	1.79	12.36	0.006	1.99	0.20	0.16	0.003	6.87	3.07	0.37

*Significant at P = 0.05.
**Significant at P = 0.01.

Table 3: Phenotypic (P) and genotypic (G) correlation coefficient between different characters of mungbean.

Characters		Days to 50% flowering	Days to maturity	Plant height	No. of branches per plant	Number of pods per plant	Number of seeds per pod	Pod length	100-seed weight	Biological yield per plant	Harvest index	Seeds yield per plant
Days to 50% flowering	P	1.000	0.9357**	0.7247**	0.4251**	-0.8074**	-0.4632**	-0.4334**	-0.2862**	-0.4702**	-0.8272**	-0.7697**
	G	1.000	0.9528	0.7378	0.4322	-0.8128	-0.5144	-0.4685	-0.2895	-0.4751	-0.8400	-0.7734
Days to maturity	P		1.000	0.6442**	0.3949**	-0.7222**	-0.4194**	-0.3932**	-0.2895**	-0.4062**	-0.7654**	-0.6936**
	G		1.000	0.6579	0.4095	-0.7379	-0.4716	-0.4280	-0.2955	-0.4145	-0.7896	-0.7070
Plant height	P			1.000	0.4536**	-0.6095**	-0.3381**	-0.3411**	-0.3193**	-0.3827**	-0.6778**	-0.6122**
	G			1.000	0.4694	-0.6198	-0.3701	-0.3838	-0.3278	-0.3928	-0.6963	-0.6239
No. of branches/plant	P				1.000	-0.2803**	-0.1860**	-0.3116**	-0.2854**	-0.1283*	-0.4372**	-0.3364**
	G				1.000	-0.2843	-0.2154	-0.3447	-0.2913	-0.1298	-0.4487	-0.3407
Number of pods per plant	P					1.000	0.4065**	0.3262**	0.1226	0.7165**	0.7844**	0.9191**
	G					1.000	0.4509	0.3509	0.1226	0.7276	0.7995	0.9271
Number of seeds per pod	P						1.000	0.3639**	0.1932**	0.1717**	0.4899**	0.4066**
	G						1.000	0.4356	0.2115	0.1976	0.5434	0.4498
Pod length	P							1.000	0.4080**	0.0954	0.4516**	0.3424**
	G							1.000	0.4390	0.1045	0.4908	0.3684
100-seed weight	P								1.000	0.1075	0.2632**	0.2307**
	G								1.000	0.1077	0.2696	0.2329
Biological yield/plant	P									1.000	0.3015**	0.8446**
	G									1.000	0.3188	0.8527
Harvest index	P										1.000	0.736**
	G										1.000	0.7367
Seeds yield per plant	P											1.000
	G											1.000

Table 4: Phenotypic (P) and genotypic (G) path coefficient of various characters on seed yield of mungbean.

Characters		Days to 50% flowering	Days to maturity	Plant height	No. of branches per plant	Number of pods per plant	Number of seeds per pod	Pod length	100-seed weight	Biological yield per plant	Harvest index	Seeds yield per plant
Days to 50% flowering	P	0.0047	0.0044	0.0034	0.0020	-0.0038	-0.0022	-0.0020	-0.0013	-0.0022	-0.0039	-0.7697**
	G	0.0257	0.0245	0.0190	0.0111	-0.0209	-0.0132	-0.0120	-0.0074	-0.0122	-0.0216	-0.7734
Days to maturity	P	-0.0139	-0.0148	-0.0095	-0.0059	0.0107	0.0062	0.0058	0.0043	0.0060	0.0113	-0.6936**
	G	-0.0326	-0.0342	-0.0225	-0.0140	0.0252	0.0161	0.0146	0.0101	0.0142	0.0270	-0.7070
Plant height	P	0.0202	0.0179	0.0279	0.0126	-0.0170	-0.0094	-0.0095	-0.0089	-0.0107	-0.0189	-0.6122**
	G	0.0176	0.0157	0.0239	0.0112	-0.0148	-0.0088	-0.0092	-0.0078	-0.0094	-0.0166	-0.6239
No. of branches per plant	P	-0.0128	-0.0119	-0.0137	-0.0302	0.0085	0.0056	0.0094	0.0086	0.0039	0.0132	-0.3364**
	G	-0.0139	-0.0132	-0.0151	-0.0322	0.0092	0.0069	0.0111	0.0094	0.0042	0.0144	-0.3407
Number of pods per plant	P	-0.1115	-0.0997	-0.0842	-0.0387	0.1381	0.0561	0.0450	0.0169	0.0989	0.1083	0.9191**
	G	-0.1228	-0.1114	-0.0936	-0.0429	0.1510	0.0681	0.0530	0.0185	0.1099	0.1208	0.9271
Number of seeds per pod	P	-0.0148	-0.0134	-0.0108	-0.0060	0.0130	0.0320	0.0116	0.0062	0.0055	0.0157	0.4066**
	G	-0.0181	-0.0166	-0.0130	-0.0076	0.0159	0.0352	0.0153	0.0074	0.0070	0.0191	0.4498
Pod length	P	-0.0150	-0.0136	-0.0118	-0.0108	-0.0113	0.0126	0.0347	0.0141	0.0033	0.0157	0.3424**
	G	-0.0188	-0.0172	-0.0154	-0.0138	0.0141	0.0175	0.0401	0.0176	0.0042	0.0197	0.3684
100-seed weight	P	-0.0055	-0.0055	-0.0061	-0.0055	0.0023	0.0037	0.0078	0.0191	0.0021	0.0050	0.2307**
	G	-0.0053	-0.0054	-0.0060	-0.0054	0.0023	0.0039	0.0081	0.0184	0.0020	0.0050	0.2329
Biological yield per plant	P	-0.2902	-0.2507	-0.2362	-0.0792	0.4422	0.1060	0.0589	0.0664	0.6172	0.1861	0.8446**
	G	-0.2917	-0.2545	-0.2412	-0.0797	0.4467	0.1213	0.0642	0.0661	0.6139	0.1957	0.8527
Harvest index	P	-0.3309	-0.3061	-0.2711	-0.1749	0.3173	0.1959	0.1806	0.1053	0.1206	0.4000	0.7325**
	G	-0.3136	-0.2947	-0.2529	-0.1675	0.2984	0.2028	0.1832	0.1006	0.1190	0.3733	0.7367

significantly negative which suggests its use in breeding programme for earliness and dwarfness. Significantly negatively correlation in seed yield per plant and for 50 per cent flowering, plant height and number of branches per plant was earlier reported by Khanpara *et al.* (2012) and Bisht *et al.* (2014). Significantly negatively correlation in seed yield per plant and days to maturity was earlier reported by Khanpara *et al.* (2012).

Path coefficient analysis was carried out by taking seed yield as a dependent variable to partition the correlation coefficient into direct and indirect effects to determine the contribution of different characters toward the seed yield. The result of present investigation on path coefficient analysis is presented in Table 4 revealed that direct and positive effect on seed yield per plant was observed for characters like biological yield per plant, harvest index, number of pods per plant, pod length, number of seeds per pod, plant height, 100 seed weight, days to 50 per cent flowering, respectively. Therefore, selection based on these component traits would results improvement in seed yield of mungbean.

Direct positive effect on seed yield through biological yield and harvest index was earlier reported by Gadakh *et al.* (2013) and Choudhary *et al.* (2016); for number of pods per plant, number of seeds per pod, pod length, plant height and 100-seed weight was earlier reported by Bhutia *et al.* (2016), Choudhary *et al.* (2016) and Dhunde *et al*. (2021) in mungbean.

Days to maturity and number of branches per plant had negative direct effect on seed yield per plant; similar findings were reported by Kumar *et al.* (2004) and Choudhary *et al*. (2016) in mungbean.

The low value of residual effect at phenotypic (0.1723) and genotypic (0.1620) levels indicates that the characters studied in the present investigation had major contribution towards seed yield and therefore, other remaining characters have little contribution towards seed yield in mungbean.

Hence, the present study reveals that number of pods per plant, biological yield per plant, harvest index, number of seeds per pod, 100-seed weight and pod length are important agronomic traits as they have directly contributed towards seed yield; plant height and days to 50 per cent flowering also had direct effect on seed yield. Therefore, selection based on these component traits would results improvement in seed yield of mungbean.

CONCLUSION

In the light of above findings, it may be concluded that improvement in the characters like number of pods per plant, biological yield per plant, harvest index, number of seeds per pod, 100-seed weight, plant height, pod length, days to maturity and number of branches per plant will help in improving the seed yield in mungbean directly. Therefore, these characters should be considered for yield improvement in the mungbean breeding programme.

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Conflict of interest

All authors declare that they have no conflicts of interest.

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