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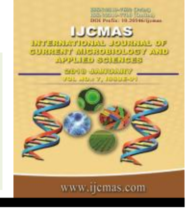

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Correlation and Path Analysis in F_4 Progenies of Green Gram [*Vigna radiata* (L.) R. Wilczek] for Seed Yield and its Attributes

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A B S T R A C T

The present experiment comprised of three parents Meha, GJM-1006 and GJM-1008 their 30 F_4 progenies derived from the crosses Meha x GJM-1006 (17 progenies) and Meha x GJM-1008 (13 progenies). Seed yield per plant was strongly and positively associated with the yield components like days to 50 % flowering, plant height, primary branches per plant, days to maturity, pods per plant, 100 seed weight, seeds per plant and clusters per plant in the two segregating populations except days to 50 % flowering and days to maturity in the cross Meha x GJM-1006. Path analysis involving two segregating populations revealed that seed yield was primarily influenced by plant height and 100 seed weight which had higher positive direct effects on seed yield per plant in Meha x GJM-1008. While, in the cross Meha x GJM-1006, seed yield per plant was primarily influenced by plant height, seeds per pod and primary branches per plant. Hence, for increasing the seed yield, direct selection of genotypes based on traits exhibiting positive correlation and higher positive direct effect will be more fruitful.

Introduction

Though pulses are very popular crop in the developing world, there is a massive gap in productivity between pulse crops inside and outside the developing world. The enhancement of domestic production of pulses is more realistic and appropriate to meet growing requirement of the country and for that technological breakthrough is needed. Green gram, also known as mungbean, is a self-pollinating diploid plant with 2n = 2x = 22 chromosomes. India is the largest producer of mungbean, where it is the third most important pulse crop followed by pigeonpea and chickpea. Seeds are easily digestible and also very good source of minerals (calcium, iron (4-7mg/100g), zinc (3mg/100g), potassium and phosphorus) and vitamins (folate and vitamin K) and dietary fibres. Sprouted seeds of mungbean are nutritionally enhanced as ascorbic acid is synthesized with increment in riboflavin and thiamine.

Information on correlations of component traits with yield and among themselves might help to increase selective efficiency. The correlation between grain yield and component traits may sometimes be misleading due to an over-estimation or under estimation for its association with other characters. Thus, yield components have ultimate influence on yield, both directly and indirectly (Tukey, 1954). Splitting of total correlation into direct and indirect effects, therefore, would provide a more meaningful interpretation of such association. While, reviewing the studies on correlation made in several crop plants, it has been observed that strength and direction of correlation in different character combinations depend on the nature of experimental material and environmental condition in which they have been studied (Falconer, 1960).

The path coefficient analysis was originally developed by Wright (1921) but the technique was first used in plant breeding by Dewey and Lu (1959). It is a technique used to find relative contribution of component characters directly on the main characters and indirectly through other characters to increase the efficiency of selection. Path coefficient, which is a standard partial regression coefficient, specifies the cause and effect relationship and measures the relative importance of each variable (Wright, 1921). Therefore, correlation in combination with path coefficient analysis is an important tool to quantify the direct and indirect influence of one character upon another (Dewey and Lu, 1959). The present study aimed at to evaluate the correlation coefficients and path coefficients in order to formulate selection criteria for evolving high yielding genotypes and to estimate the contribution of yield components on yield and their association in green gram utilizing F_4 progenies.

Materials and Methods

The present study comprised of 3 parents (Meha, GJM-1006 and GJM-1008) and 30 F_4 progenies derived two crosses *viz*., Meha x GJM-1006 (17 progenies) and Meha x GJM-1008 (13 progenies) were laid out in Randomized Block Design with three replications. Each parental / progeny row consisted of 20 plants with 60 cm x 15 cm inter and intra row spacing. The experiment was carried out during summer, 2016 at the College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari. Ten plants from each parent as well as 10 plants from each F_4 progenies were randomly selected for recording following observations such as days to 50% flowering, plant height, primary branches per plant, days to maturity, clusters per plant, pods per plant, seeds per pod, 100 seed weight, seed yield per plant and harvest index.

For correlation coefficient, analysis of covariance for all possible pairs of ten characters was carried out using the procedure of Panse and Sukhatme (1978) for each family. The genotypic correlations were tested using the method suggested by Fisher and Yates (1963). The cause and effect relationship between two variables cannot be known from simple correlation coefficient.

Therefore, path analysis suggested by Wright (1921) and Dewey and Lu (1959) was adopted for each family separately in order to partition the genotypic correlation between variables with seed yield into direct and indirect effects of those variables on yield. Genotypic correlation coefficients of ten variables with yield were used to estimate the path coefficients for the direct effect of various independent characters on dependent character seed yield per plant. The technique given by Goulden (1959) was followed for inversion of the 'B' matrix using partitioning method of matrix inversion. The indirect effects for a particular character through other characters were obtained by multiplication of direct path and particular correlation coefficient between those two characters, respectively.

Results and Discussion

Correlation and path co-efficient analysis of F_4 progenies obtained from two crosses of green gram revealed strong and positive association of various yield component traits like days to 50 % flowering, plant height, primary branches per plant, days to maturity, pods per plant, 100 seed weight, seeds per plant and clusters per plant in the two segregating populations except days to 50 % flowering and days to maturity in the cross Meha x GJM-1006. While, harvest index depicted positive and non-significant association with seed yield in F_4 populations of Meha x GJM-1006 as well as Meha x GJM-1008 (Table 1). An observation of the data of cross Meha x GJM-1006 revealed that days to 50% flowering showed positive and significant correlation with plant height (0.52), primary branches (0.76), clusters per plant (0.44) and days to maturity (1.00). This finding is in accordance with Kumar *et al.*, (2005), Biradar *et al.*, (2007), Makeen *et al.*, (2007), Singh *et al.*, (2009[a]), Rahim *et al.*, (2010), Khajudparn and Tantasawat (2011), Reddy *et al.*, (2011), Srivastava and Singh (2012), Gadakh *et al.*, (2013), Prasanna *et al.*, (2013), Titumeer *et al.*, (2014), Khaimichho *et al.*, (2014), Patel *et al.*, (2014), Singh and Kumar (2014), Pathak *et al.*, (2014), Rathor *et al.*, (2015), Hemavathy *et al.*, (2015). Plant height was positively and significantly associated with primary branches per plant (0.33), days to maturity (0.62), clusters per plant (0.69), pods per plant (0.76), seeds per pod (0.38), 100 seed weight (0.40) and seed yield per plant (0.77). The trait primary branches per plant were positively and significantly associated with clusters per pod (1.00), pods per plant (0.96) and seed yield per plant (0.41). Similar results were obtained by Biradar *et al.*, (2007), Singh *et al.*, (2009[b]), Kumar *et al.*, (2010b), Khajudparn and Tantasawat (2011), Narasimhulu *et al.*, (2013), Kumar *et al.*, (2013), Prasanna *et al.*, (2013), Titumeer *et al.*, (2014), Pathak *et al.*, (2014), Javed *et al.*, (2014) and Patel *et al.*, (2014).

The genotypic correlation of days to maturity was positive and non- significant for pods per plant (0.10) and seed yield per plant (0.19). Clusters per plant were positively and significantly associated with pods per plant (0.89) and seed yield per plant (0.69). The similar results were also observed by Sadiq *et al.*, (2005), Biradar *et al.*, (2007), Srivastava *et al.*, (2008), Singh *et al.*,(2009[b]), Tabasum *et al.*, (2010), Khajudparn and Tantasawat (2011), Gadakh *et al.*, (2013), Narasimhulu *et al.*, (2013), Prasanna *et al.*, (2013), Patel *et al.*, (2014), Ahmad *et al.*,(2014), Pathak *et al.*,(2014), Singh and Kumar (2014), Rathor *et al.*, (2015), Hemavathy *et al.*, (2015) and Keerthinandan *et al.*, (2016). Positive and significant correlation of pods per plant was observed with seed yield per plant (0.92), 100 seed weight (0.48) and seeds per pod (0.41). The genotypic correlation of seeds per pod with 100 seed weight (1.00), seed yield per plant (0.78) and harvest index (0.34) was positive and significant. The similar results were also observed by Biradar *et al.*, (2007), Kumar *et al.*, (2010a), Rahim *et al.*,(2010), Kumar *et al.*, (2010b), Khajudparn and Tantasawat (2011), Reddy *et al.*, (2011), Gadakh *et al.*, (2013), Narasimhulu *et al.*, (2013), Kumar *et al.*, (2013), Patel *et al.*, (2014), Pathak *et al.*, (2014), Titumeer *et al.*, (2014), Rathor *et al.*, (2015), Hemavathy *et al.*, (2015) and Das and Barua (2015). Hundred seed weight showed positive and significant association with harvest index (1.00) and seed yield per plant (0.98). A general observation of the cross Meha x GJM-1008 revealed that days to 50% flowering exhibited positive and significant correlation with days to maturity (0.69), plant height (0.87), primary branches per plant (1.00), seeds per pod (0.48), clusters per plant (1.00), pods per plant (0.56), 100 seed weight (0.83) and seed yield per plant (0.64).

Table.1 Genotypic correlation coefficients of seed yield per plant with other characters in F_4 population of the cross Meha x GJM-1006 and Meha x GJM-1008 in mung bean

Characters		DFF	PH	PB	DM	CP	PP	SP	100 SW	HI	SY
DFF	Meha x GJM-1006	1.00	0.52**	0.76**	1.00**	0.44**	0.24^{NS}	-0.20^{NS}	-0.50**	-0.77**	0.14^{NS}
	Meha x GJM-1008	1.00	0.87**	1.00**	0.69**	1.00**	0.56**	0.48**	0.83**	-0.39*	0.64**
PH			1.00	0.33*	0.62**	0.69**	0.76**	0.38**	0.40**	-0.07^{NS}	0.77**
			1.00	0.86**	0.91**	0.86**	0.87**	0.69**	0.53**	-0.06^{NS}	0.85**
PB				1.00	0.02^{NS}	1.00*	0.96**	-0.04^{NS}	-0.16^{NS}	-0.53**	0.41**
				1.00	0.63**	1.00**	0.61**	0.22^{NS}	0.75**	-0.41**	0.70**
DM					1.00	-0.04^{NS}	0.10^{NS}	-0.03^{NS}	-0.21^{NS}	-0.33*	0.19^{NS}
					1.00	0.76**	0.56**	0.24^{NS}	-0.04^{NS}	-0.39*	0.39*
CP						1.00	0.89**	-0.01^{NS}	0.14^{NS}	-0.08^{NS}	0.69**
						1.00	0.71**	0.41**	0.63**	-0.51**	0.61**
PP							1.00	0.41**	0.48**	0.11^{NS}	0.92**
							1.00	0.84**	0.31*	0.13^{NS}	0.91**
SP								1.00	1.00**	0.34*	0.78**
								1.00	0.50**	0.73**	1.00**
100 SW									1.00	1.00**	0.98**
									1.00	-0.16^{NS}	0.74**
HI										1.00	0.19^{NS}
										1.00	0.28^{NS}

DFF - Days to 50% flowering	**PH - Plant height (cm)**	**DM - Days to maturity**
PB - Primary Branches per plant	CP - Clusters per plant	PP - Pods per plant
SP - Seeds per pod	100 SW- 100-seed weight (g)	SY - Seed yield per plant (g)
HI - Harvest index (%)		

** - Significant at 1.0 per cent level of probability, * - Significant at 5.0 per cent level of probability, NS- Non-Significant.

Table.2 Path coefficient analysis of component characters towards seed yield per plant in F_4 population of the cross Meha x GJM-1006 and Meha x GJM-1008 in mung bean

Characters	Cross	DFF	PH	PB	DM	CP	PP	SP	100 SW	HI	SY
DFF	Meha x GJM-1006	**0.13**	0.07	0.10	0.15	0.02	0.03	-0.03	-0.07	-0.10	0.14^{NS}
	Meha x GJM-1008	**0.38**	0.34	0.42	0.27	0.39	0.22	0.19	0.32	-0.15	0.64**
PH		0.29	**0.57**	0.19	0.35	0.40	0.43	0.22	0.23	-0.04	0.77**
		0.58	**0.66**	0.56	0.60	0.57	0.58	0.46	0.35	-0.04	0.85**
PB		0.22	0.10	**0.30**	0.01	0.28	0.29	-0.01	-0.05	0.16	0.41**
		-0.41	-0.33	**-0.38**	-0.24	-0.45	-0.23	-0.09	-0.29	0.16	0.70**
DM		-0.21	-0.12	0.00	**-0.19**	-0.01	-0.02	0.01	0.04	0.06	0.19^{NS}
		-0.22	-0.30	-0.20	**-0.32**	-0.25	-0.18	-0.08	0.01	0.13	0.39*
CP		0.05	0.20	0.26	0.01	**0.28**	0.25	0.00	0.04	-0.02	0.69**
		-0.33	-0.28	-0.38	-0.24	**-0.32**	-0.23	-0.13	-0.20	0.17	0.61**
PP		-0.08	-0.25	-0.32	-0.03	-0.30	**-0.33**	-0.14	-0.16	-0.04	0.92**
		0.42	0.65	0.45	0.42	0.53	**0.74**	0.62	0.23	0.10	0.91**
SP		-0.08	0.14	-0.02	-0.01	0.00	0.16	**0.38**	0.61	0.13	0.78**
		-0.06	-0.09	-0.03	-0.03	-0.05	-0.11	**-0.13**	-0.06	-0.09	1.00**
100 SW		-0.10	0.08	-0.03	-0.04	0.03	0.10	0.33	**0.20**	0.25	0.98**
		0.32	0.21	0.29	-0.02	0.25	0.12	0.20	**0.39**	-0.07	0.74**
HI		-0.09	-0.01	-0.06	-0.04	-0.01	0.01	0.04	0.14	**0.12**	0.19^{NS}
		-0.03	-0.01	-0.03	-0.03	-0.04	0.01	0.06	-0.01	**0.08**	0.28^{NS}

DFF - Days to 50% flowering	**PH - Plant height (cm)**	**DM - Days to maturity**
PB - Primary Branches per plant	CP - Clusters per plant	PP - Pods per plant
SP - Seeds per pod	100 SW- 100-seed weight (g)	SY - Seed yield per plant (g)
HI - Harvest index (%)		

** - Significant at 1.0 per cent level of probability, * - Significant at 5.0 per cent level of probability, NS- Non-Significant.

The association of plant height was positive and significant with primary branches per plant (0.86), days to maturity (0.91), clusters per plant (0.86), pods per plant (0.87), seeds per pod (0.69), 100 seed weight (0.53) and seed yield per plant (0.85). These results are also in agreement with the findings of Parameswarappa (2005), Biradar *et al.,* (2007), Makeen *et al.,* (2007), Srivastava *et al.,* (2008), Kumar *et al.,* (2010a), Reddy *et al.,* (2011), Khajudparn and Tantasawat (2011), Prasanna *et al.,* (2013), Gadakh *et al.,* (2013), Kumar *et al.,* (2013), Alom *et al.,* (2011), Titumeer *et al.,* (2014), Ahmad *et al.,* (2014), Singh and Kumar (2014), Pathak *et al.,* (2014), Rathor *et al.,* (2015), Hemavathy *et al.,* (2015) and Keerthinandan *et al.,* (2016). Primary branches per plant were positively and significantly associated with days to maturity (0.63), pods per plant (0.61), clusters per plant (1.00), 100 seed weight (0.75) and seed yield per plant (0.70).

The genotypic correlation of days to maturity was positive and significant with pods per plant (0.56), clusters per plant (0.76) and seed yield per plant (0.39). These results are also observed by Kumar *et al.,* (2010a), Reddy *et al.,* (2011), Srivastava and Singh (2012), Jyothsna and Anuradha (2013), Prasanna *et al.,* (2013), Ahmad *et al.,* (2014) and Hemavathy *et al.,* (2015). Similar results of negative and significant correlation were obtained by Prakash *et al.,* (2006), Makeen *et al.,* (2007), Singh *et al.,* (2009[a]), Kumar *et al.,* (2010a), Rahim *et al.,* (2010), Khajudparn and Tantasawat (2011), Srivastava and Singh (2012), Jyothsna and Anuradha (2013), Khaimichho *et al.,* (2014), Alom *et al.,* (2014), Singh and Kumar (2014), Ahmad *et al.,* (2014), Pathak *et al.,* (2014), Hemavathy *et al.,* (2015) and Rekha *et al.,* (2015). Clusters per plant were positively and significantly associated with pods per plant (0.71), seeds per pod (0.41), 100 seed weight (0.63) and seed yield per plant (0.61). Pods per plant were positive and significant with seeds per pod (0.84), 100 seed weight (0.31) and seed yield per plant (0.91). These findings are similar with Kumar *et al.,*(2005), Parameswarappa (2005), Sadiq *et al.,* (2005), Rahim *et al.,* (2010), Tabasum *et al.,* (2010), Khajudparn and Tantasawat (2011), Reddy *et al.,* (2011), Srivastava and Singh (2012), Gadakh *et al.,* (2013), Prasanna *et al.,* (2013), Javed *et al.,* (2014), Patel *et al.,* (2014), Khaimichho *et al.,* (2014), Titumeer *et al.,* (2014), Ahmad *et al.,* (2014), Das and Barua (2015), Hemavathy *et al.,* (2015), and Raselmiah *et al.,* (2016). The genotypic correlation of 100 seed weight was positive and significant with seed yield per plant (0.74). This result is also observed by Biradar *et al.,* (2007), Reddy *et al.,* (2011), Srivastava and Singh (2012), Gadakh *et al.,* (2013), Kumar *et al.,* (2013), Javed *et al.,* (2014), Patel *et al.,* (2014), Khaimichho *et al.,* (2014)**,** Pathak *et al.,* (2014), Rathor *et al.,* (2015), Das and Barua (2015), Hemavathy *et al.,* (2015), Sohel *et al.,* (2016), Keerthinandan *et al.,* (2016) and Raselmiah *et al.,* (2016). Seeds per pod showed positive and significant association with 100 seed weight (0.50), harvest index (0.73) and seed yield per plant (1.00). Harvest index showed positive and non-significant association with seed yield per plant (0.28).

Path analysis involving two segregating populations revealed that seed yield was primarily influenced by plant height and 100 seed weight which had higher positive direct effects on seed yield per plant in Meha x GJM-1008 (Table 2). The results are in accordance with Kumar *et al.,* (2010b), Tabasum *et al.,* (2010), Prasanna *et al.,* (2013), Gadakh *et al.,* (2013), Rathor *et al.,* (2015), Sohel *et al.,* (2016) and Raselmiah *et al.,* (2016). While, in the cross Meha x GJM-1006, seed yield per plant was primarily influenced by plant height, seeds per pod and primary branches per plant which had positive direct effect on seed yield per plant. The results are in accordance with Parameswarappa (2005), Sadiq *et al.*, (2005), Prakash (2006), Biradar *et al.*, (2007), Makeen *et al.*, (2007), Pandey *et al.*, (2007), Vyas (2010), Srivastava and Singh (2012), Gadakh *et al.*, (2013), Prasanna *et al.*, (2013), Kumar *et al.,* (2013), Alom *et al.,* (2014) and Das and Baru (2015). Plant height exhibited maximum positive direct effect and significant correlation with seed yield per plant in desirable direction. Hence, it would be rewarding to lay emphasis on plant height, while developing selection strategies in green gram. Other traits like days to 50% flowering, 100 seed weight and harvest index had positive direct effects on yield in both the crosses. Primary branches per plant, clusters per plant and seeds per pod also exhibited positive direct effect in the cross Meha x GJM-1006, while they showed negative direct effect in Meha x GJM-1008. Days to maturity depicted negative direct effect in two crosses *viz*., Meha x GJM-1006 and Meha x GJM-1008. Clusters per plant had negative direct effect in the cross Meha x GJM-1008 and positive direct effect in the cross Meha x GJM-1006.

Quality and quantity seldom go together and all the efforts of plant breeders are aimed at bringing these together. Hence, the knowledge of inter-relationships present among various characters is necessary when selection for simultaneous improvement of these traits is applied. Grafius (1959) reported that there may not be genes for yield as such, but operate only through its components. So correlation analysis provides the information on nature and magnitude of the association of different components characters with seed yield, which is regarded as highly complex trait in which the breeder is ultimately interested. Looking to the present results, there is a need to study the comparative performance of the progenies by carrying out inter-mating within and between populations and some sort of biparental mating involving the populations *viz.*, Meha x GJM-1006 and Meha x GJM-1008. Simultaneous selection may be applied for yield associated attributes like days to 50% flowering, plant height, 100 seed weight and harvest index as revealed by correlation and path co-efficient analysis.

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