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Correlation, path and cluster analysis in hyacinth bean (*Lablab purpureus* L. Sweet)

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Seventy three Hyacinth bean genotypes were grouped into seven clusters depending upon the genetic architecture and characters uniformity. High heritability were expressed by days to first flower, days to first picking, pod length and pods yield/ plant. Pod yield/ plant showed maximum positive significant association with number of pods per plant (0.708) at both genotypic and phenotypic levels. Path analysis revealed positive association with number of pods per plant, pod length, pod width and seed length, while days to first flowering had negative direct effect on pod yield per plant. Cluster I had maximum number of genotypes (25) followed by cluster V (24). The maximum inter cluster distance was recorded between cluster III and VII (10.820) followed by clusters II and VII (9.247). Cluster II exhibited the maximum intra cluster distance (4.447), whereas minimum was recorded by cluster VII (0.001). The maximum mean value for pod yield/ plant (2.757) was recorded in cluster VII due to maximum pod width (2.633) and number of seeds/pod (4.667).

Key words: Cluster analysis, Correlation analysis, Hyacinth bean, *Lablab purpureus*, Path analysis

Introduction

Hyacinth bean has unique position among legume vegetables (Biju *et al.* 2001). D^2 analysis helps the breeders in grouping of genotypes possessing similar characters in different clusters and to identify genotypically diverse and desirable genotypes. Genetic variability, character association and path coefficient are pre-requisite for improvement of any crop for the selection of superior genotypes and improvement of any traits. It is very difficult to judge whether observed variability is heritable or due to environment alone. Moreover, knowledge of heritability is essential for selection based

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improvement as it indicates the extent of transmissibility of a character in future generations. Knowledge of correlation between yield and its contributing characters are basic and for most endeavor to find out guide lines for plant selection. Partitioning of total correlation into direct and indirect effect by path coefficient analysis helps in making the selection more effective. Keeping in view the above facts, the present investigation was undertaken to assess the genetic diversity of 73 Hyacinth bean genotypes collected from Uttar Pradesh based on morphological variations.

Materials and methods

The present investigation was carried out at Indian Institute of Vegetable Research, Varanasi with 73 genotypes of Hyacinth bean during Kharif 2006 and 2007. The experiment was laid out in randomized completely block design with three replications. Each genotype was sown at 2m x 1m row to row and plant to plant distance, respectively. Recommended fertilizer dose and cultural practices including need-based plant protection measures were followed to raise a good crop. Observations from five randomly selected plants of each genotype in each replication were recorded on eleven quantitative traits viz. days to first flower, days to first picking, number of pods per plant, per cent fruit set per cluster, pod length, pod width, number of seeds per pod, seed length, seed width, 100-seed weight and pod yield per plant. The variability for different quantitative characters was estimated as per procedure suggested by Panse and Sukhatme (1985), GCV and PCV by Burton and De Vane (1953) and heritability and genetic advance by Johnson *et al.* (1955). Correlation coefficient was worked out as per Al-Jbouri *et al.* (1958) and path coefficient was calculated by the formula given by Dewey and Lu (1959).

Results and discussion

Variability, heritability and genetic advance analysis

Result showed considerable variability of data in all the traits and over 75% heritability values were observed for all the characters, except number of seeds per pod and 100-seed weight indicated very good scope of selection in this crop (Table 1). Close relationship between GCV and PCV was found in all the characters and PCV values that were slightly greater than GCV and revealed a very little influence of environment for their expression. In this investigation, the results showed closely relationship between genotypic and phenotypic coefficient of variability for most of the characters indicating that there was less effect of environment for the expression of the characters. The

characters namely days to first flower, number of pods/plant, pod width and pod yield/plant showed high GCV accompanied with high heritability indicated additive gene action which offered scope for their improvement through selection as they were less affected by environment. Ali, *et al*. (2005) and Lal *et al*. (2005), Rai, *et al*. (2008) in Indian bean and Majid, *et al*. (1982) in Black gram have reported that phenotypic variance was larger than genotypic variance for most of the yield contributing traits. The highest heritability in the broad sense was obtained for days to first flowering (99.7) followed by pods yield per plant (99.1), pod length (98.9) and days to first picking (98.8). The expected genetic advanced expressed as percent of mean along with high heritability was observed for pods per plant (56.02) followed by days to first flower (46.58) and days to first picking (39.18) indicating that these characters can be improved directly through selection. The highest genetic gain and heritability for the character pods per plant, days to first flowering and picking were also reported by Singh, *et a.,* (1985), Ali, *et al.* (2005) and Rai, *et al*. (2008) in Indian bean.

Table 1. Variability, Heritability and genetic advance for the 11 characters in Hyacinth bean.

Characters	Range	General mean	Variability		Heritability (%)	Genetic advance	Genetic advance as % of mean
			PCV	GCV			
Days to first flower (DAS)	31.33-132.67	106.32	21.32	21.30	99.7	46.58	43.81
Days to first picking (DAS)	51.00-165.67	138.60	13.89	13.81	98.8	39.18	28.27
Pods/plant (N0.)	75.33-829.00	209.53	65.25	62.21	90.9	56.02	22.19
Fruit set/cluster (%)	27.00 -74.33	51.98	18.36	17.57	91.6	18.00	34.63
Pod length (cm)	5.37 - 13.70	9.71	19.94	19.83	98.9	3.94	40.58
Pod width (cm)	0.76 - 2.81	2.03	35.08	34.27	95.4	1.40	68.88
Seeds/ pod (N0.)	2.67- 5.67	4.34	17.95	11.84	43.5	0.70	16.14
Seed length (cm)	0.92 - 1.45	1.15	13.12	12.28	87.5	0.27	23.48
Seed width (cm)	0.65 -0.95	0.80	10.71	9.40	77.0	0.14	17.47
100-seed weight (g)	21.67-41.33	32.89	13.80	10.65	59.6	5.57	16.94
Pod yield/plant (Kg)	0.50 - 3.05	1.29	60.56	60.31	99.1	1.59	123.70

Correlation analysis

Phenotypic and genotypic correlations of eleven characters in all possible combinations were calculated to know of relationship among them in general genotypic correlation coefficient were higher than corresponding phenotypic correlation coefficient (Table 2). Pod yield/plant showed maximum positive and significant association with number of pods/plant (0.708) at both genotypic and phenotypic levels. The days to first flower showed the positive correlation with days to first picking (0.763). The pod length had positive correlation with number of seeds /pod (0.455), seed length (0.444), seed width (0.384) and 100-seed weight (0.350). The pod width was observed positive correlation with seed length (0.526) and seed width (0.471). The number of seeds/pod showed the

positive correlation width seed length (0.422). The seed length also had positive correlation with seed width (0.371). In this investigation, pod yield/plant had maximum significant values for number of pods/plant (0.708) followed by seed length (0.413) and pod width (0.378). Lal, *et al.* (2005) and Rai, *et al.* (2008) bean have also found for number of pods/plant in Indian.

Table 2 Genotypic and Phenotypic correlation coefficients for 11 characters in Hyacinth bean.

G → P ↓	Days to first flower	Days to first picking)	Pods /plant (No.)	Fruit set/ cluster (%)	Pod length (cm)	Pod width (cm)	Seeds /pod (No.)	Seed Length (cm)	Seed width (cm)	100-seed weight (g)	Pod yield per plant (Kg)
Days to first flower (DAS)		0.763 **	0.195	0.203	-0.246	-0.214	-0.070	-0.126	-0.055	-0.146	-0.107
Days to first picking (DAS)	0.762 **		0.187	0.085	-0.115	-0.075	-0.050	0.006	-0.090	-0.062	0.024
Pods/plant (No.)	0.184	0.171		0.124	-0.054	-0.069	0.042	0.031	-0.082	-0.269	0.708**
Fruit set/ cluster (%)	0.193	0.078	0.107		-0.044	0.000	0.052	-0.040	0.112	0.042	-0.024
Pod length (cm)	-0.243	-0.114	-0.050	-0.040		0.258	0.455 **	0.444**	0.384*	0.350*	0.261
Pod width (cm)	-0.208	-0.073	-0.066	0.001	0.256		0.107	0.526**	0.471**	0.055	0.378*
Seeds/pod (No.)	-0.045	-0.018	0.049	0.034	0.297	0.098		0.422**	0.182	0.168	0.155
Seed length (cm)	-0.118	0.005	0.027	-0.035	0.406*	0.478**	0.246		0.371*	0.233	0.413*
Seed width (cm)	-0.049	-0.080	-0.057	0.105	0.331 *	0.405*	0.134	0.310 *		0.249	0.229
100-seed weight (g)	-0.113	-0.052	-0.237	0.078	0.274	0.032	-0.020	0.200	0.204		-0.105
Pod yield per plant (Kg)	-0.106	0.024	0.670 **	-0.019	0.260	0.371*	0.104	0.390 *	0.200	-0.073	

*, ** Significant at 5 and 1 % levels.

Path analysis

Path analysis revealed that number of pods per plant, pod length, pod width and seed length had positive, while days to first flowering had negative direct effect on pod yield per plant (Table 3). These results were closely conformity with the findings of those Baswana, *et al.* (1980), Biju, *et al*. (2001) and Lal, *et al.* (2005) in Indian bean. The highest indirect effect on pod yield/plant (0.761) on pod yield was obtained through days to first flower (0.148), days to first picking (0.142) and per cent fruit set/cluster (0.095). The high indirect effect of pod with exhibited through seed length (0.122), seed with (0.110) and pod length (0.060) were observed. A positive indirect effect of seed length was obtained high through pod width (0.122) and pod length (0.052).

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Pod length showed the highest positive indirect effect through seed length (0.081) and pod width (0.060). On contrary, days to first flower (-0.194) exerted the maximum negative direct effect followed by %fruit set/cluster (-0.079), number of seeds/pod (-0.049) and 100 seeds weight (-0.032). Thus, path coefficient analysis revealed the importance of characters such as number of pods per plant, pod length, pod width and seed length in selection of superior genotypes for pod yield/plant. Result showed the number of pods per plant that were also reported by Lal, *et al.* (2005), Rai, *et al.* (2008) in Indian bean.

Table 3. Genotypic and Phenotypic direct and indirect effect on 11 characters in Hyacinth bean.

Characters		Days to first flower	Days to first picking	Pods/ plant (No.)	Fruit set/ cluster (%)	Pod length (cm)	Pod width (cm)	Seeds /pod (No.)	Seed Length (cm)	Seed width (cm)	100 seeds weight (g)	Correlation with yield/ plant (Kg)
Days to first flower (DAS)	G	**-0.194**	-0.148	-0.038	-0.039	0.048	0.041	0.014	0.024	0.011	0.028	-0.107
	P	**-0.187**	-0.143	-0.034	-0.060	0.045	0.039	0.009	0.022	0.009	0.021	-0.106
Days to first picking (DAS	G	0.053	**0.070**	0.013	0.006	-0.008	-0.005	-0.003 -	0.000	-0.006	-0.004	0.024
	P	0.063	**0.083**	0.014	0.006	-0.009	-0.006	0.001	0.000	-0.007	-0.004	0.024
Pods/plant (No.)	G	0.148	0.142	**0.761**	0.095	-0.041	-0.053	0.032	0.023	-0.062	-0.205	0.708
	P	0.132	0.123	**0.721**	0.077	-0.036	-0.048	0.035	0.019	-0.041	-0.171	0.670
Fruit set/ cluster (%)	G	-0.016	-0.007	-0.010	**-0.079**	0.003	0.000	-0.004	0.003	-0.009	-0.003	-0.024
	P	-0.012	-0.005	-0.006	**-0.036**	0.002	0.000	-0.002	0.002	-0.006	-0.005	-0.019
Pod length (cm)	G	-0.029	-0.014	-0.006	-0.005	**0.118**	0.030	0.054	0.052	0.045	0.041	0.261
	P	-0.029	-0.013	-0.006	-0.005	**0.118**	0.030	0.035	0.048	0.039	0.032	0.260
Pod width (cm)	G	-0.050	-0.017	-0.016	0.000	0.060	**0.232**	0.025	0.122	0.110	0.013	0.378
	P	-0.054	-0.019	-0.017	0.000	0.066	**0.257**	0.025	0.123	0.104	0.008	0.371
Seeds/pod (No.)	G	0.003	0.002	-0.002	-0.003	-0.022	-0.005	**-0.049**	-0.021	-0.009 -	-0.008	0.155
	P	0.002	0.001	-0.002	-0.002	-0.014	-0.004	**-0.046**	-0.011	0.006	0.001	0.104
Seed length (cm)	G	-0.023	0.001	0.006	-0.007	0.081	0.096	0.077	**0.182**	0.067	0.042	0.413
	P	-0.020	0.001	0.005	-0.006	0.069	0.081	0.042	**0.169**	0.053	0.034	0.390
Seed width (cm)	G	-0.005	-0.008 -	-0.007	0.010	0.035	0.043	0.016	0.034	**0.090**	0.023	0.229
	P	-0.003	0.004	-0.003	0.006	0.018	0.022	0.007	0.017	**0.055**	0.011	0.200
100-seed weight (g)	G	0.005	0.002	0.009	-0.001	-0.011	-0.002	-0.005	-0.007	-0.008	**-0.032**	-0.105
	P	0.000	0.000	0.000	-0.000	-0.000	-0.000	-0.000	0.000	0.000	**-0.001**	-0.073

Clusters grouping analysis

Seventy three genotypes were grouped into seven clusters under study by Tocher's method of D^2 analysis (Table 4). Cluster I had maximum number of

genotypes (25) followed by cluster V (24). However, cluster IV showed 11 genotypes, cluster II and VI comprised of 5 equal numbers of genotypes, while cluster III and VII exhibited minimum 2 and 1 genotypes, respectively.

Table 4. Grouping of 73 genotypes of Hyacinth bean in different clusters.

Cluster	No. of genotypes	Name of genotypes
I	25	'VR SEM-708', 'VR SEM-765', 'VR SEM-727', 'VR SEM-703', 'VR SEM-755', 'VR SEM-712', 'VR SEM-920', 'VR SEM-743', 'VR SEM-804', 'VR SEM-732', 'VR SEM-704', 'VR SEM-705', 'VR SEM-719', 'VR SEM-730', 'VR SEM-701', 'VR SEM-707', 'VR SEM-742', 'VR SEM-734', 'VR SEM-735', 'VR SEM-759', 'VR SEM-764', 'VR SEM-713', 'VR SEM-728', 'VR SEM-749', 'VR SEM-758'
II	5	'VR SEM-746', 'VR SEM-752', 'VR SEM-740', 'VR SEM-747', 'VR SEM-720'
III	2	'VR SEM-744', 'VR SEM-745'
IV	11	'VR SEM-733', 'VR SEM-714', 'VR SEM-736', 'VR SEM-756', 'VR SEM-737', 'VR SEM-706', 'VR SEM-711', 'VR SEM-739', 'VR SEM-726', 'VR SEM-721', 'VR SEM-722'
V	24	'VR SEM-709', 'VR SEM-760', 'VR SEM-753', 'VR SEM-717', 'VR SEM-738', 'VR SEM-754', 'VR SEM-710', 'VR SEM-757', 'VR SEM-748', 'VR SEM-761', 'VR SEM-725', 'VR SEM-715', 'VR SEM-723', 'VR SEM-751', 'VR SEM-718', 'VR SEM-729', 'VR SEM-940', 'VR SEM-741', 'VR SEM-881', 'VR SEM-953', 'VR SEM-945', 'VR SEM-937', 'VR SEM-763', 'VR SEM-724'
VI	5	'VR SEM-731', 'VR SEM-702', 'VR SEM-799', 'VR SEM-762', 'VR SEM-914'
VII	1	'VR SEM-716'

Intra and inter cluster analysis

The intra and inter cluster distance represented the index of genetic diversity among the clusters (Table 5). The cluster II recorded a maximum intra cluster distance of 4.447, whereas cluster VII had the minimum distance of 0.001. The maximum inter cluster distance was exhibited between the cluster III and VII (10.820) followed by clusters II and VII (9.247). Genotypes belonging to the cluster with maximum inter cluster distance were generally more diverse, therefore, selection of parents for hybridization should be done from two cluster having wide inter cluster distance. The inter cluster distance was recorded lowest between clusters IV and V (3.964) followed by cluster I and V (4.297), which revealed that these clusters are very close to each other

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and should not be used for a recombination breeding to evolve desirable new genotypes.

Table 5. Average intra and inter cluster divergence (D^2) in 73 genotypes of Hyacinth bean.

Clusters	I	II	III	IV	V	VI	VII
I	3.392	4.637	7.014	4.714	4.297	5.228	8.969
II		4.447	6.328	5.740	5.402	6.356	9.247
III			2.353	6.797	6.792	7.811	10.820
IV				3.239	3.964	4.998	9.085
V					3.268	4.786	8.831
VI						4.402	8.950
VII							0.001

Cluster mean analysis

The cluster comprising one genotype with specific valuable traits and other genotypes falling in highly divergent group will help in broadening the existing genetic base and may produce new genotypes with hitherto unknown combination. Differences in cluster means existed for almost all the characters (Table 6). The maximum mean value for pod yield/plant (2.757) was recorded in cluster VII due to maximum number of seeds/pod (4.667) and higher pod width (2.633). Similarly, the maximum mean value were observed for 100-seed weight (35.253) and seed width (0.876) in cluster I, for pod length (12.200), pod width (2.847) and seed length (1.337) in cluster II, for per cent fruit set/cluster (60.800) and number of pods/plant (336.800) in cluster VI and for number of seeds/pod (4.667) in cluster VII. The minimum days for flowering and fruiting is desirable, hence, cluster III recorded minimum days for flowering (33.167) and fruiting (51.667).

Table 6 Cluster wise mean of 11 characters in Hyacinth bean genotypes.

Cluster	Days to first flower	Days to first picking	pods/ plant (no.)	Fruit set /cluster (%)	Pod length (cm)	Pod width (cm)	Seed /pods (no.)	Seed length (cm)	Seed width (cm)	100-seed weight (g)	Correlation With yield/ plant (kg)
I	104.507	139.067	215.720	53.040	11.023	2.500	4.587	1.231	0.876	35.253	1.595
II	68.333	121.400	172.667	48.133	12.200	2.847	4.400	1.337	0.739	34.067	1.877
III	33.167	51.667	83.167	48.333	7.870	1.688	3.833	1.000	0.770	33.167	0.483
IV	116.030	148.879	128.121	48.727	8.049	1.809	3.364	1.065	0.771	33.242	0.746
V	114.319	142.750	235.667	51.556	9.062	1.385	4.611	1.094	0.755	31.903	1.058
VI	121.067	144.067	336.800	60.800	8.371	2.499	4.000	1.115	0.824	24.267	1.868
VII	115.333	147.000	125.667	52.667	8.500	2.633	4.667	1.100	0.700	30.000	2.757

The estimate of heritability, phenotypic and genotypic coefficient of variations, genetic advance as percentage of mean were found higher for days to first flower, number of pods per cluster and pod width respectively, suggested that the direct selection for these traits would be effective for the improvement in yield Hyacinth bean. It also inferred that day to first flower, number of pods/plant, pod length, number of seeds/pod and seed length had positive direct effect on pods yield/plant indicating these traits are of great importance for yield improvement. The genotypes included in the diverse clusters namely, IV and VI, and I and VI possessed good promises to select parents for obtaining potential segregates and creating large variability for the improvement of pod yield and other horticultural traits in Hyacinth bean.

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