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Genetic analysis and interrelationships among yield attributing traits in pole and bush type dolichos bean (*Lablab purpureus* L.)

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ABSTRACT

Evaluation of thirteen pole and seven bush type advanced lines/varieties of dolichos bean was carried out in two consecutive years to study the genetic variability and character associationships among different quantitative characters with pod yield. Significant variation among eight quantitative traits irrespective of genotypes having differences in growth habit was observed. Higher estimates of PCV and GCV were observed for number of pods per plant and pod weight in pole and bush types, and pod length in bush type, indicating much scope for their improvement through selection. The characters pod weight, number of pods per plant, pod length and pod width were characterised by high heritability coupled with high genetic advance in both types. Interrelationships among component characters and pod yield revealed a significant and positive correlation with number of pods per plant at genotypic level in pole type and none of the traits in bush type. However, positive correlation with pod yield was depicted by pod length, pod width and number of seeds per pod in pole type and by number of pods per plant in bush type. Study on path coefficient analysis suggested that yield of dolichos bean could be improved through direct selection for number of pods per plant and pod weight in pole type, and number of pods per plant, pod weight and number of seeds per pod in bush type.

Keywords **:** Dolichos bean, genetic variability, heritability, path analysis

Dolichos bean (*Lablab purpureus* L.) is an indigenous legume vegetable grown as vegetable (*Lablab purpureus* var. *typicus*) and pulse (*Lablab purpureus* var. *lignosus*) throughout India. A wide range of variation exists for the morphological and reproductive characters amongst the landraces grown all over the country (Chattopadhyay and Dutta, 2010; Parmar *et al*., 2013). Both photo- and thermo-sensitive types are dominant and insensitive type is rarely found in India. Preponderance of indeterminate (pole) type over determinate (bush) type is usually noticed and grown on a commercial scale in the country. Much concerted efforts are needed to develop an ideotype having semi-determinate growth, early flowering habit with desirable pod quality suitable for vegetable purpose and do not require cost intensive trellising.

The success of any crop improvement programme generally depends upon the genetic variability present in the available germplasm of a particular crop. The development of suitable plant type is of great importance for all the crops through planned design programme. Attempts have, therefore, been made by several scientists to analyse different yield component traits to provide meaningful information about the significance of characters in relation to pod yield in dolichos bean. An ideal plant ideotype would only be defined if the different components of green pod yield of dolichos bean are analysed and their relative importance can be assessed. Since, most of the quantitative traits are governed by polygenes and highly influenced by environment; the progress of breeding is, however, dependent on the magnitude, nature and interrelationship of genotypic and non-genotypic variation. Moreover, highly heritable characters which are least influenced by the environment serve as an indicator of yield in selection process. Therefore, selection on the basis of green pod yield alone is usually not effective. However, selection based on its components and secondary characters could be more efficient and reliable. Evaluation of dolichos bean genotypes consisting of a mixture of pole or bush type (Rai *et al*., 2010; Singh *et al*., 2011) is creating lots of confusion for identification of selection indices for the yield improvement of crop irrespective of their growth habits. Rather, it would make a clear picture to evaluate the genotypes having differences in growth habit separately. The purpose of this study was thus to gain sufficient knowledge of the interrelationship, path coefficient between yield and its components as well as heritability among both pole and bush type dolichos bean to determine criteria for selection that could be effectively used to identify the desirable lines with potential for high yield.

MATERIALS AND METHODS

A set of twenty advanced breeding lines/varieties comprising of thirteen pole types and seven bush types were collected from Indian Institute of

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Vegetable Research, Varanasi, India and evaluated in the Gangetic alluvium of West Bengal under All India Coordinated Research Project on Vegetable Crops, Bidhan Chandra Krishi Viswavidyalaya, West Bengal during autumn-winter season during the year 2012 and 2013 in a randomized complete block design with three replications. The experimental plot was kept 4.5 × 4.5 m, spaced at 1.5 m apart in both ways for pole type and 0.5m apart in both ways for bush type. Pole type genotypes were provided with trellises. Inorganic fertilizers @ N:P:K 30:60:50 kg ha^{-1} were applied as a basal dose. The cultural practices as scheduled to raise a good crop were followed in time (Chattopadhyay *et al*., 2007).

Data were taken from all six plants of pole type genotypes and twenty randomly selected plants from bush type genotypes for days to first flowering, days to 50% flowering, pod weight, number of pods per plant, pod length, pod width, number of seeds per pod and pod yield per plant. Correlation coefficient was computed from variance and covariance components as suggested by Burton (1952). The correlation coefficient was partitioned into direct and indirect effects according to Dewey and Lu (1959). The

Table 1: Quantitative and qualitative characters of pole type dolichos bean (Pooled)

Genotype	DFF[z]	D50F	NPPP	PW	PL	PWT	NSPP	PYPP	Flower color	Pod color	Pod curvature
DOLP VAR 1	95	100	382	2.5	11.1	11.5	4	4.5	White	Dark green	Straight
DOLP VAR 2	97	104	505	1.9	7.3	8.5	4	4.6	Purple	Green	Curved
DOLP VAR 3	92	102	773	2.5	12.1	8.2	4	6.3	White	Dark green	Curved
DOLP VAR 4	93	97	1243	2.4	8.4	4.8	5	6.0	White	Whitish	Slightly curved
DOLP VAR 5	76	87	686	1.8	12.7	8.2	6	5.7	Purple	Dark green with purple suture	Straight
DOLP VAR 6	92	101	1003	2	12.8	5.0	5	5.0	Purple	Dark green	Curved
DOLP VAR 7	97	110	1011	2.5	11.7	5.5	4	5.5	White	Dark green	Curved
DOLP VAR 8	66	76	1320	2.1	9.4	4.9	5	6.5	Purple	Purple	Curved
DOLP VAR 9	78	85	1401	1.9	10.1	5.5	5	7.9	White	Light green	Curved
DOLP VAR 10	96	107	690	2.8	12.6	9.7	5	6.4	White	Dark green	Slightly curved and wavy
BCDB1	95	105	787	3.1	10.7	10.0	5	7.7	Purple	Purple	Flat
BCDB2	85	91	954	2.9	11.4	7.2	4	7.0	Purple	Light green	Flat
Swarna Utkrist	87	93	1022	2.1	10.5	6.1	4	6.8	Purple	Light green	Flat
LSD (0.05)	**4.50**	**6.40**	**73.37**	**0.56**	**0.35**	**0.19**	**0.91**	**0.75**	**-**	**-**	**-**

DFF[z] = Days to 1st flowering; D50F= Days to 50% flowering; NPPP= Number of pods per plant; PW= Pod width (cm); PL= Pod length (cm); PWT= Pod weight (g); NSPP= Number of seeds per pod; PYPP= Pod yield per plant (kg)

Table 2 : Quantitative and qualitative characters of bush type genotypes of dolichos bean (Pooled)

Genotypes	DFF[z]	D50F	NPPP	PW	PL	PWT	NSPP	PYPP	Flower color	Pod color	Pod curvature
DOLB VAR 1	46	54	36	2.6	8.8	5.9	4	0.22	White	Deep green	Curved and wavy
DOLB VAR 2	53	63	75	2.2	5.5	3.3	4	0.25	White	Light green	Curved
DOLB VAR 3	44	49	46	1.5	7.6	4.7	4	0.26	White	Light green	Curved
DOLB VAR 4	45	50	85	1.5	7.7	3.0	3	0.24	White	Deep green	Curved
DOLB VAR 5	47	54	41	2.5	10.9	4.6	5	0.18	White	Deep green	Slightly curved
Arka Joy	49	58	43	1.4	8.9	4.5	5	0.21	Purple	Light green	Curved
Arka Vijay	57	64	45	1.2	6.8	4.2	4	0.19	Purple	Deep green	Curved
LSD(0.05)	**3.876**	**5.08**	**12.78**	**0.18**	**0.34**	**0.15**	**0.71**	**0.06**	**-**	**-**	**-**

genotypic and phenotypic correlations between yield and its components among themselves were worked out as per the methods suggested by Johnson *et al.* (1955) while heritability in broad sense and genetic advance as percentage of mean were computed according to the procedure described by Singh and Chaudhary (1985). All the data were analyzed using GENSTAT, 2009 edition. All the genetic components were estimated on two years pooled data.

RESULTS AND DISCUSSION

Thirteen pole type and seven bush type genotypes of dolichos bean were evaluated during two consecutive years and characterized on the basis of morphological and eight yield component characters. The mean of two years data showed significant variations among different characters as revealed from table-1 and 2, respectively. Earliness of genotype is one of the most desirable selection parameters to get high return from the market as well as to fit the genotype in multiple cropping systems. Regarding earliness of the genotype, DOLP VAR 8 took minimum days to produce 1st flowering (66.00) and 50% flowering (76.00) in pole type, and DOLB VAR 3 took 44 and 49 days to produce1st flowering and 50% flowering, respectively in bush type. More number of pods per plant was produced by DOLP VAR 9 (1401) in pole type and DOLB VAR 4 (85) in bush type. Pod width is an important criterion for greater acceptability by the consumer. The maximum pod width was noticed in BCDB 1 (3.10 cm) in pole type and DOLB VAR 1 (2.60) in bush type. So far as the pod length is concerned, the genotype DOLP VAR 6 produced the longest pod (12.80 cm) in pole type and DOLB VAR 5 (10.90 cm) in bush type. The highest pod weight was observed in DOLP VAR 1 (11.50 g) and DOLB VAR 1 (5.90 g) for pole and bush type, respectively. Number of seeds per pod did not vary greatly among the genotypes having different growth habits. Pod yield per plant is influenced by so many component characters. The pod yield of pole types varied from 4.50 (DOLP VAR 1) to 7.90 kg (DOLP VAR 9) and of bush type from 0.18 (DOLB VAR 5) to 0.26 kg (DOLB VAR 3). From the study, it emerged apparently that high yield of dolichos bean genotypes could be realized through selection of more number of pods per plant in pole type and heavier pod weight in bush type. However, this observation could be confirmed further by the study of inter-relationship.

In the present investigation, phenotypic co-efficient of variation (PCV) agreed closely with the genotypic co-efficient of variation (GCV) but the magnitude of PCV was higher than GCV for almost all the traits irrespective of genotypes belonging to different growth habit, indicating low environment effect on the expression of most of the traits and is suggestive of the heritable nature of the traits (Table 3). These results are in agreement with the findings of previous workers (Ganesh *et al*., 2005; Chaitanya *et al*., 2014). Number of seeds per pod in pole type and pod yield per plant in bush type recorded wider differences between PCV and GCV values indicating dominant role of the environment in the expression of these traits. Our observations did not agree with the findings of earlier workers (Upadhyay and Mehta, 2010; Chaitanya *et al*., 2014) who reported significant role of the environment in the expression of pod yield per plant in pole type dolichos bean. PCV and GCV values were categorized as moderate (10.00-20.00%) and high (>20.00%) as per Sivasubramanian and Menon (1973). Number of pods per plant and pod weight exhibited high estimates of PCV and GCV in both pole and bush types and pod length in bush type, indicating the higher magnitude of variability for these traits and consequently more scope for their improvement through selection. Similar results were observed by Savitha (2008) for number of pods per plant in bush type and Chaitanya *et al*. (2014) for pod weight and number of pods per plant in pole type bean. While, moderate estimates of PCV and GCV were observed for rest of the studied traits irrespective of growth habits, suggesting equal importance of additive and non-additive genetic control for the expression of these traits. These results corroborate the findings of Golani *et al*. (2007) and Chaitanya *et al*. (2014) in pole type dolichos bean. None of traits showed low estimates of PCV and GCV which is an indicative of remote scope for effective selection. High proportion of GCV to PCV is desirable in selection process because it depicts that the traits are much under the genetic control rather than the environment (Kaushik *et al,* 2007). The proportion of GCV in PCV observed ranged from 66.03 % (number of seeds per pod) to 99.09% (number of pods per plant) in pole type and from 55.47% (pod yield per plant) to 99.41 % (pod weight) in bush type. The traits with high proportion of GCV in PCV are reliable for selection in genetic improvement of the dolichos bean genotypes.

High magnitude of broad sense heritability estimates (more than 70 %) were shown by the characters days to first flowering, days to 50% flowering, pod weight, number of pods per plant, pod length, pod width, number of seeds per pod and pod yield per plant irrespective of genotypes having difference in growth habit except number of seeds per pod in pole type and pod yield per plant in bush

type (Table 3). Low heritability estimates of number of seeds per pod in pole type and pod yield per plant in bush type were exhibited due to high environmental effects. Johnson *et al*. (1955) had suggested that heritability estimates along with genetic gain is usually more helpful than the heritability alone in predicting the resultant effect from selecting the best individuals. The values of genetic advance (GA) expressed as percentage of mean was high (> 20.00 %) for the characters like days to 1st flowering, pod weight, number of pods per plant, pod length, pod width and pod yield per plant in pole type, and for pod weight, number of pods per plant, pod length, pod width, number of seeds per pod in bush type. In other words, pod weight, number of pods per plant, pod length and pod width were characterised by high heritability and high genetic advance, an indicative of additive gene effects (Panse, 1957) irrespective of growth habit of genotypes**.** The present findings were similar with the observations of Rai *et al*. (2006) and Savitha (2008) for number pods per plant; Bendale *et al*. (2004) and Ganesh (2005) for pod length; Chaitanya *et al*. (2014) for pod weight and pod width. According to such characters were controlled by additive gene effects. High heritability accompanied with moderate genetic advance for the characters like days to 50 % flowering in pole type and days to 1st flowering and days to 50% flowering in bush type suggesting that these characters were influenced by non additive gene action and considerable influence of environment on the expression of these traits. These traits could be improved through heterosis breeding. Low heritability coupled with low genetic advance for the character like number of seeds per pod in pole type and pod yield per plant in bush type indicating that these traits were highly influenced by environmental effect and selection based on these characters would be ineffective.

Association analysis of different morphological characters with pod yield of dolichos bean genotypes and their inter-relationships were investigated through the study of both phenotypic and genotypic correlation co-efficients for seven characters (Table 4). Phenotypic and genotypic correlation co-efficients, in general, agreed closely. The result further showed that genotypic correlation coefficients were higher than both phenotypic and environmental correlation coefficients for most of the parameters studied. Since environmental correlation coefficients approximate phenotypic correlation coefficients in this study, characters with strong genotypic association with pod yield will demonstrate consistent performance across

Table 3: Estimation of genetic parameters pooled over two years

Genetic parameter	Days to 1st flowering		Days to 50% flowering		Pod weight (g)		Pods plant^{-1} (No.)		Pod length (cm)		Pod width (cm)		Seeds per pod (No.)		Pod yield plant^{-1} (kg)	
	Pole	Bush	Pole	Bush	Pole	Bush	Pole	Bush	Pole	Bush	Pole	Bush	Pole	Bush	Pole	Bush
GCV (%)	10.79	10.15	10.07	10.00	29.47	22.41	33.76	34.94	15.51	21.39	17.36	30.13	10.34	15.07	17.13	10.39
PCV (%)	11.16	10.27	10.78	11.19	30.12	22.54	34.07	37.49	15.80	21.52	18.54	30.47	15.66	17.93	18.49	18.73
GCV : PCV	96.72	90.07	93.43	88.89	97.86	99.41	99.09	93.20	98.19	99.39	93.65	98.88	66.03	84.01	92.65	55.47
Heritability(%) in b.s.	93.54	81.13	87.30	79.03	95.77	98.83	98.19	86.86	96.41	98.78	87.71	97.78	43.60	70.58	85.85	38.86
Genetic advance as (%) of mean	21.51	17.17	19.39	18.22	59.43	45.90	68.91	67.08	31.38	43.81	33.50	61.39	14.06	26.08	32.70	12.91

Table 4 : Genotypic, phenotypic and environmental correlation coefficients and direct effects at genotypic level with pod yield per plant in pole and bush type genotypes of dolichos bean (Pooled)

Character	Genotypic correlation		Phenotypic correlation		Environmental correlation		Direct effects at genotypic level	
	Pole	Bush	Pole	Bush	Pole	Bush	Pole	Bush
Days to 1st flowering	-0.386	-0.548	-0.354	-0.323	-0.114	-0.134	-0.202	-1.175
Days to 50% flowering	-0.388	-0.511	-0.280	-0.233	0.354	0.051	0.204	0.128
Pod weight (g)	-0.176	-0.236	-0.183	-0.187	-0.396	-0.633	1.935	1.411
No. of pods plant^{-1}	0.586*	0.559	0.527	0.435	-0.109	0.484	2.431	1.458
Pod length (cm)	0.048	-0.752	0.025	-0.378	-0.399	0.404	0.252	-2.112
Pod width (cm)	0.319	-0.062	0.311	-0.068	0.263	-0.277	-0.133	-0.173
No. of seeds per pod	0.414	-0.751	0.173	-0.328	-0.335	0.049	-0.333	1.229

*Note: * Significant at P= 0.05; Residual effect = 0.029 (Pole type), 0.021 (Bush type)*

wide range of environment. These could occur when the genes governing two traits were similar and environmental factors played a non-significant role in the expression of these traits. Result showed that only one character *i.e.* number of pods per plant (rg=0.586*, at 0.05% level) significantly and positively correlated with pod yield per plant at genotypic level in pole type and none of the characters in bush type correlated significantly and positively with pod yield per plant. Positive but non-significant correlation with pod yield per plant was shown by pod length, pod width and number of seeds per pod in pole type and by number of pods per plant in bush type. Such associations with pod yield per plant in pole type bean have already been observed by previous workers (Kabir and Sen, 1987; Chattopadhyay and Dutta, 2010; Patil *et al*., 2011). However, some of the traits that exercise negative correlation with one another will be difficult to select for characterization of desirable traits, those with negative association but non significant correlation will be disregarded in selection for crop or variety improvement programme (Ariyo *et al*., 1987). In the present study, days to 1st flowering, days to 50 % flowering and pod weight exhibited negative correlation with pod yield per plant in pole type at both genotypic and phenotypic levels. On the other hand, days to 1st flowering, days to 50 % flowering, pod weight, pod length, pod width and number of seeds per pod in bush type at both genotypic and phenotypic levels. This indicated that delay in first flowering, 50% flowering and lighter pod weight in pole type, and delay in first flowering, 50% flowering, lighter pod weight, short and narrow pod with less number of seeds helped in improving pod yield per plant.

Pod width has high positive environmental, genotypic and phenotypic correlation coefficients with pod yield per plant (re=0.263; rg=0.319 and rp=0.311, respectively) in pole type. Similarly, positive environmental, genotypic and phenotypic correlation coefficients exist between number of pods per plant and pod yield per plant (re=0.484; rg=0.559 and rp=0.435, respectively) in bush type. The results suggest that these two traits, pod width for pole type and number of pods per plant for bush type are less influenced by the environment and they could be improved in diverse environments.

The complexity of character relationships among themselves and with pod yield becomes evident from the discussion alone did not provide a comprehensive picture of relative importance of direct and indirect influences of each characters to the pod yield, as these traits were the resultant product of combined effects of various factors complementing or counteracting. In the present study, the genotypic correlation was partitioned into direct and indirect effects to identify relative importance of yield components towards pod yield of pole and bush type dolichos bean (Table 4).

Green pod in dolichos bean is important as this is utilized as vegetable throughout the country. Hence the direct effect and positive association with pod yield per plant was considered essential. Highly positive direct effects on pod yield per plant were shown by number of pods per plant and pod weight in pole type and by number of pods per plant, pod weight and number of seeds per pod in bush type. The direct effects of other characters as well as their indirect effects via other characters were low to moderate. Interestingly, negative genotypic correlation exists between pod yield per plant and pod weight in pole type, and between pod weight and number of seeds per pod with pod yield per plant in bush type. However these characters showed high direct effects with pod yield per plant. Therefore, the direct selection for number of pods per plant and pod weight in pole type and number of pods per plant, pod weight and number of seeds per pod in bush type could be beneficial for yield improvement of dolichos bean. The results are in conformity with the observations of Chattopadhyay and Dutta (2010) and Magalingam *et al*. (2013) for number of pods per plant and pod weight in pole type bean. Very low residual effects were found in both pole and bush type suggesting inclusion of maximum pod yield influencing characters in the present analyses (Chattopadhyay and Dutta, 2010).

The genotypes used in the present study is of diverse nature and could be used in further breeding programme for developing improved varieties. Higher estimates of GCV, heritability and genetic advance exist for pod weight, number of pods per plant, pod length and pod width irrespective of growth habit of the genotypes and selection of genotypes based on these traits would be more reliable for crop improvement programme. The study also revealed that yield of dolichos bean could be improved through direct selection for number of pods per plant and pod weight in pole type, and number of pods per plant, pod weight and number of seeds per pod in bush type.

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