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Susant Sahu
Department of Horticulture, Naini Agricultural Institute Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad, Utter Pradesh, India

Vijay Bahadur
Department of Horticulture, Naini Agricultural Institute Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad, Utter Pradesh, India

Correspondence
Susant Sahu
Department of Horticulture, Naini Agricultural Institute Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad, Utter Pradesh, India

Genetic analysis of dolichos bean (*Lablab purpureus* L.) genotypes for horticultural traits

Susant Sahu and Vijay Bahadur

Abstract
The present investigation was carried out to study the genetic variability, heritability and genetic advance for 18 traits in dolichos bean. The experimental material comprised of 40 genotypes of dolichos bean (*Lablab purpureus* L.). The highest value of genotypic coefficient of variation (33.99) and Phenotypic coefficient of variation (34.36) were recorded for Pod Weight (10 Pods). The highest heritability estimate was observed for The highest heritability was recorded for the characters 100 Seed Weight (98.89), Days to first Flowering (98.77), Green Pod Yield Per Plot (98.32), Days to 100% Flowering (98.28), Days to 50% flowering (98.13), Green Pod Yield Per Plot (98.13), Days to 100% flowering(98.28), Green Pod Yield Per plant (98.32), Pod Weight (10 Pods) (97.89), Inflorescence Length (97.35), and Days to First Green Pod Harvest (97.35), Vine Length (95.16), Green Pod Yield Per Hectare (93.33), Pod Length (93.86), Days to Last Green Pod Harvest (91.38), Pod Width (90.69), Seed Per pod (79.57), Pod Per Inflorescence (77.05), Flower Per inflorescence (71.58),. The highest genetic advance as percent of mean observed for Pod Weight (10 Pods) (69.28) while recorded lowest for Days to last green pod harvest (9.46). Hence selection will be effective for these traits. The divergence analysis revealed that the presence of appreciable amount of genetic diversity in the tested genotypes. Cluster IV had highest number of genotypes (13) followed by cluster II (10), cluster V (9), cluster I (6), cluster III, cluster VI and cluster VII, having 1 genotype. The maximum inter cluster distance was observed between cluster no. I and VI (2898.05) and cluster no. VI and VII (1569.61) showed minimum inter cluster distance. The highest intra cluster distance was recorded for cluster no. IV (845.17) and cluster no. 2 (345.56) showed minimum intra cluster distance.

Keywords: genetic variability, heritability, genetic advance and genetic divergence

Introduction
Dolichos bean (*Lablab purpureus* L.) is an important leguminous vegetable crop grown throughout the country and distributed in Madhya Pradesh, Maharashtra, Andhra Pradesh, Tamil Nadu and North Eastern states. India is world's largest producer of vegetables next to China with an annual production around 166.60 (million MT) from 9.57 (mha) of land with the productivity of 17.3 MT/ha.

India is the center of diversity of dolichos bean and large number of indigenous strains are available in northern India. Although this crop has originated in India but very little work has been done for the genetic improvement of yield and quality. A great range of variation exits for the plant and pod characters amongst the accessions gro success of any breeding programme in general and improvement of specific trait through selection in particular, totally depends upon the genetic variability present in the available germplasm of a particular crop (Parmar *et al.* 2013) [6]. Since, many of the plant characters are governed by polygenes and great influenced by environmental conditions. The progress of breeding is, however, conditioned by the magnitude, nature and interrelationship of genotypic and non-genotypic variation. Among the quantitative characters, yield is a complex character, which is dependent on a number of yield contributing characters.

Heritability of metric characters is a parameter of particular significance to the breeder, as it measures the degree of resemblance between the parent and the offspring and its magnitude indicates the heritability with which genotypes can be identified by its phenotypic expression, while genetic advance aids in exercising the necessary selection pressure. The knowledge of heritability and genetic advance guides the breeder to select superior parents to initiate an effective and fruitful crossing programme (Johnson *et al.,* 1955) [3]. The assessment of variation provides us a correct picture of the extent of variation, further helping us to improve he genotypes.

Materials and Methods

The experiment was carried out at the Horticulture Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad U.P. The experiment was conducted in Randomized Block Design having 40 genotypes collected from different part of Chhattisgarh in three replications. The allocation of treatments of the individual plots using random number in each replications with spacing 1.5× 1.5 m row to row and plant to plant respectively. Four plants from each replication were taken for recording observation on 18 characters *viz.* days to first flowering, days to 50% flowering,100% flowering inflorescence length, number of flowers per inflorescence, number of pods per inflorescence, days to first green pod harvest, days to last pod harvest, number of green pod pickings, pod length, pod width, pod weight, number of seeds per pod, vine length, 100 seed weight, green pod yield per plant, green pod yield per plot, green pod yield per hectare. The Genotypic coefficient of variation (GCV) and Phenotypic coefficient of variation (PCV) were calculated according to Sivasubramanian and Madhavamenon (1973) [10]. An attempt has been made in the present investigation to estimate heritability in broad sense Heritability estimates were categorised in to 3 group High heritability (> 60), Moderate heritability (30-60), Low heritability (< 30). as suggested by (Johnson *et al*., 1955) [3].

Genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) are categorized as low (<10%), moderate (10-20%) and high (>20%). as suggested by Sivasubramanian and Madhavamenon (1973) [10].

Results and Discussion

Analysis of variance

Data were recorded on 18 traits viz. days to first flowering, days to 50% flowering, days to 100% flowering, inflorescence length, number of flowers per inflorescence, number of pods per inflorescence, days to first green pod harvest, days to last pod harvest, number of green pod picking, vine length, pod length, pod width, pod weight, number of seeds per pod, 100 seed weight, green pod yield per plant, green pod yield per plot, green pod yield per hectare were subjected to analysis of variance to test the significance of difference among the genotypes. Analysis of variance presented in showed that the genotypes differed significantly for all the 18 characters and the mean performance of 40 genotypes of dolichos bean are depicted.

These findings are in general agreement with the findings of Pandita *et al.* (1980) [5], Wahabuddin *et al.* (1986) [12], Borah *et al.* (1992) [2], Bendal *et al.* (2008) [1], Upadhyay (2008) [11] and Patel (2010) [7].

Genotypic and phenotypic coefficient of variation

Genotypic and phenotypic coefficient of variation are simple measure of variability, these measures are commonly used for the assessment of variability. The relative value of these types of coefficients gives an idea about the magnitude of variability present in a genetic population. Thus, the component of variation such as genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were computed. The phenotypic coefficient of variation was marginally higher than the corresponding genotypic coefficient of variation indicating the influence of environment in the expression of the character under study.

Genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) are categorized as low (<10%), moderate (10-20%) and high (>20%) as suggested by Sivasubramanian and Madhavamenon (1973) [10].

Genotypic and phenotypic coefficients of variation of different characters are presented in Table 2 High magnitude of genotypic as well as phenotypic coefficient of variations were recorded for traits *viz*., High magnitude of genotypic as well as phenotypic coefficient of variations were recorded for traits *viz*., Pod Weight (10 Pods) (33.99 & 34.36), Pod Width (32.75 & 34.39), Pod Length (26.11 & 26.84), 100 Seed Weight (23.64 & 23.77) and Inflorescence Length (25.61 & 25.95). Moderate GCV was recorded in Days to First Flowering (15.39), Days to 50% Flowering (14.67), Days to 100% Flowering (14.16), Pods Per Inflorescence (15.00), Days to First Green Pod harvest (16.16), Vine Length (13.22), Seeds Per Pod (13.07), Green Pod Yield Per Plant (17.95),

Green Pod Yield Per Plot (17.97) and Moderate PCV was recorded in Days to First Flowering (15.49), Days to 50% Flowering (14.81), Days to 100% Flowering (14.28), Flowers Per Inflorescence (11.10), Pods Per Inflorescence (17.09), Days to First Green Pod harvest (16.37), Number of Green Pod Picking (11.21), Vine Length (13.55), Seeds Per Pod (14.66) and Green Pod Yield Per Plant (18.11). Green Pod Yield Per Plot (18.14) and Green Pod Yield Per Hectare (18.18). Characters like Flowers Per Inflorescence (9.39), Days to Last Green Pod harvest (4.80), Number of Green Pod Picking (8.14), Green pod yield per hectare (7.62) had low genotypic coefficient of variation. Where as the characters like Days to Last Green Pod harvest (5.03) had low phenotypic coefficient of variation.

Phenotypic coefficient of variation (PCV) was higher than the genotypic coefficient of variation (GCV) for all the traits indicating that environmental factors were influencing their expression. Wide difference between phenotypic and genotypic coefficient of variations indicated their sensitiveness to environmental fluctuations whereas narrow difference showed less environmental interference on the expression of these traits.

Heritability

Heritability estimate provide the information regarding the amount of transmissible genetic variation to total variation and determine genetic improvement and response to selection. Heritability estimate along with genetic advance are normally more useful in predicting the gain under selection than that of heritability alone. However, it is not necessary that a character showing high heritability will also exhibit high genetic advance (Johnson *et al*., 1955) [3]. An attempt has been made in the present investigation to estimate heritability in broad sense Heritability estimates were categorised in to 3 group High heritability (> 60), Moderate heritability (30-60), Low heritability (< 30).as suggested by (Johnson *et al*., 1955) [3].

In the present investigation high magnitude of heritability was recorded for almost all characters except number of green pod picking. The highest heritability was recorded for the characters days to first flowering and 100 Seed Weight (91.23), days to 50% flowering, days to 100% flowering, Pod Weight (10 Pods), Green Pod Yield Per Plant, Green Pod Yield Per Plot (86.51), Inflorescence Length and Days to First Green Pod harvest (83.32), Days to Last Green Pod harvest and Pod Width (91.00), Green Pod Yield Per Hectare and Pod Length (14.05), Vine Length (77.65), Seeds Per Pod (77.05), Flowers Per Inflorescence (63.69),

Pods Per Inflorescence (83.14). Moderate heritability was recorded for Number of Green Pod Picking (57.69).

The heritability value alone however, provides no indication of the amount of genetic improvement that would result from selection of superior genotypes. The heritability estimates would be reliable if it is limited in broad sense, additive and non additive gene effect are accompanied with high genetic advance. To facilitate the comparison of progress in various characters of different genotypes genetic advance was calculated as percentage of mean. The magnitude of genetic advance as percentage of mean is categorized as suggested by Johnson *et al*., (1955) [3].

Genetic advance

In the present investigation high magnitude of genetic advance was recorded for Days to First Flowering (28.43), Days to 50% Flowering (29.25), Days to 100% Flowering (29.06), Days to First Green Pod harvest (33.48) and Pod Weight (10 Pods) (54.63). Moderate genetic advance was recorded for Inflorescence Length (10.64), Days to Last Green Pod harvest (18.03), 100 Seed Weight (18.73) and Green Pod Yield Per Hectare (16.72). The lowest genetic advance was recorded for the characters Flowers Per Inflorescence (1.85), Pods Per Inflorescence (1.53), Number of Green Pod Picking (0.82), Vine Length (1.47), Pod Length (4.74), Pod Width (1.13), Seeds Per Pod (0.96), Green Pod Yield Per Plant (0.70) and Green Pod Yield Per Plot (2.79).

Genetic Divergence

The concept of D^2statistics was originally developed by Mahalonobis (1936) [4]. Then Rao (1952) [8] suggested the application of this technique for the arrangement of genetic diversity in plant breeding. Now, this technique is being extensively used in vegetable breeding to study the selection of different parents. The problem of selection may further be simplified if one could identify the characters responsible for discrimination between parents. Literatures available on this aspect in dolichos bean are rather scanty. Therefore, the present investigation was aimed at ascertaining the nature and magnitude of genetic diversity among a set of dolichos bean genotypes. Dolichos bean is a predominantly autogamous crop and no information is available suggesting a change in its breeding behaviour under varied environmental conditions. Therefore successful hybridization programme is a difficult task for a vegetable breeder.

On the basis of D2 analysis forty genotype were grouped into seven cluster. Maximum number of genotypes 13 were grouped into cluster no. IV (CG-23, CG-3, CG-7, CG-15, CG-25, CG19, CG-16, CG-26, VRSEM-186, Pusa sem 2, CG-11), followed by cluster no. II having 10 genotypes (CG-3, CG-37, CG-38, CG-33, CG-35, CG-2,CG-28, CG-1, CG-21 and CG-29), cluster no. V having 9 genotypes (CG-8, CG-27, CG-30, CG-9, CG-18, CG-31, CG-12, CG-24 and CG-10), cluster no. II, VI and VII having 1 genotypes (CG-5, CG-14, CG-20), cluster no. I having 6 genotypes (CG-6, CG-13, CG-4, CG-34).

Intra (Diagonal) and inter cluster average distances (D^2) for different quantitative characters in dolichos bean

Highest intra cluster distance was recorded for cluster no. IV (845.17) followed by cluster no. III (804.44), cluster no. VII (548.34), cluster no. I (478.50) cluster no. V (397.17) and cluster no. 2 (345.56) showed minimum intra cluster distance.

It is vivid the table that maximum inter cluster distance was observed between cluster no. I and VI (2898.05) followed by cluster no. I and VII (1493.02), cluster no. 1 and IV (1304.89), cluster no. I and III (1182.53), cluster no. I and II (922.60), cluster no. I and V (857.25), cluster no. II and VI (2964.47), cluster no. II and VII (1668.67), cluster no. II and IV (1635.08), cluster no. II and III (1108.95), cluster no. II and V (1091.67), cluster no. III and VI (5493.04), cluster III and VII (3444.48), cluster no. III and IV (2429.96), cluster no. III and V (2402.95), cluster no. IV and VI (3770.51). cluster no. IV and V (1583.99), cluster no. IV and VII (1245.14), cluster no. V and VI (1288.05), cluster no. V and VII (798.62) and cluster no. VI and VII (1569.616) showed minimum inter cluster distance.

Percent contribution of different quantitative characters towards genetic divergence in dolichos bean genotypes

The selection and choice of parents mainly depends upon contribution of characters towards divergence (Table 5). Contribution of each character towards genetic divergence has been estimated from the number of times that each character appeared in the first rank. The present study showed that, 100 Seed Weight (39.74%) contributed maximum to the total genetic diversity among the genotypes followed by

Green Pod Yield Per Plant (20.26), Days to First Flowering (17.31), Inflorescence Length (7.95), Vine Length (4.10), Pod Weight (10 Pods) (6.15), Days to 50% Flowering (1.41), Pod Width (1.15), Pod Length (1.03) and lowest contributed percentage was recorded in Days to 100% Flowering (0.01), Flowers Per Inflorescence (0.01), Pods Per Inflorescence (0.01), Days to First Green Pod h (0.26), Days to Last Green Pod ha (0.64), Number of Green Pod Picking (0.01), Seeds Per Pod (0.01), Green Pod Yield Per Plot (0.01) and Green Pod Yield Per Hectare (0.01).

Table 1: Analysis of variance for 18 quantitative characters in Dolichos bean

S. No.	Characters	Replicate df = 2	Treatment df=39	Error df=78
1	Days to First Flowering	1.59	580.77**	2.39
2	Days to 50% Flowering	8.06	620.15**	3.90
3	Days to 100% Flowering	3.40	611.14**	3.53
4	Inflorescence Length	0.16	82.93**	0.74
5	Flowers Per Inflorescence	0.070	3.83**	.44
6	Pods Per Inflorescence	0.174	2.37**	0.21
7	Days to First Green Pod harvest	1.73	821.43**	7.36
8	Days to Last Green Pod harvest	0.22	259.40**	7.90
9	Number of Green Pod Picking	0.40	1.77**	0.27
10	Vine Length	0.038	1.64**	0.027
11	Pod Length	0.26	17.26**	0.36
12	Pod Width	0.095	1.037**	0.034
13	Pod Weight (10 Pods)	24.66	2170.93**	15.52
14	Seeds Per Pod	0.17	0.88**	0.070

15	100 Seed Weight	0.021	251.71**	0.931
16	Green Pod Yield Per Plant	0.0017	0.3525**	0.00
17	Green Pod Yield Per Plot	0.02	5.64**	20.035
18	Green Pod Yield Per Hectare	0.35	214.94**	4.52

* and ** significant at 1% and 5% level of significance respectively

Table 2: Genetic variability parameters for 18 characters in Dolichos bean

S. No.	Characters	Genotypic coefficient of variation GCV	Phenotypic cofficient of variation PCV	Heritability (broad sense)	Genetic advance	Genetic advance as percent of mean
1	Days to First Flowering	15.39	15.49	98.77	28.43	31.52
2	Days to 50% Flowering	14.67	14.81	98.13	29.25	29.94
3	Days to 100% Flowering	14.16	14.28	98.28	29.06	28.91
4	Inflorescence Length	25.61	25.95	97.35	10.64	52.04
5	Flowers Per Inflorescence	9.39	11.10	71.58	1.85	16.37
6	Pods Per Inflorescence	15.00	17.09	77.05	1.53	27.12
7	Days to First Green Pod harvest	16.16	16.37	97.35	33.48	32.84
8	Days to Last Green Pod harvest	4.80	5.03	91.38	18.03	9.46
9	Number of Green Pod Picking	8.14	11.21	52.69	0.82	12.17
10	Vine Length	13.22	13.55	95.16	1.47	26.56
11	Pod Length	26.11	26.84	93.86	4.74	51.90
12	Pod Width	32.75	34.39	90.69	1.13	64.25
13	Pod Weight (10 Pods)	33.99	34.36	97.89	54.63	69.28
14	Seeds Per Pod	13.07	14.66	79.57	0.96	24.02
15	100 Seed Weight	23.64	23.77	98.89	18.73	48.42
16	Green Pod Yield Per Plant	17.95	18.11	98.32	0.70	36.67
17	Green Pod Yield Per Plot	17.97	18.14	98.13	2.79	36.67
18	Green Pod Yield Per Hectare	7.62	18.18	93.93	16.72	35.19

Table 3: Distribution of the Forty Genotypes of dolichos bean into Different Clusters

Clusters	No. of genotypes	Name of the Genotypes
Cluster I	6	CG-6, CG-13, CG-4, CG-34,
Cluster II	10	CG-34, CG-37, CG-38, CG-33, CG-35, CG-2, CG-28, CG-1, CG-21, CG-29,
Cluster III	1	CG-5
Cluster IV	13	CG-23, CG-3, CG-7, CG-15, CG-25, CG-19, CG-16, CG-17, CG-26,VRSEM-186, pusa sem-2 and CG-11
Cluster V	9	CG-8, CG-27, CG-30, CG-9, CG-18, CG-31, CG-12, CG-24, CG-10
Cluster VI	1	CG-14
Cluster VII	1	CG-20

Table 4: Intra (Diagonal) and inter cluster average distances (D^2) for different quantitative characters in dolichos bean

Cluster	1 Cluster	2 Cluster	3 Cluster	4 Cluster	5 Cluster	6 Cluster	7 Cluster
1 Cluster	478.50	922.60	1182.53	1304.89	857.25	2898.05	1493.02
2 Cluster		345.56	1108.95	1635.08	1091.6	2964.47	1668.67
3 Cluster			804.44	2429.96	2402.95	5493.04	3444.48
4 Cluster				845.17	1583.99	3770.51	1245.14
5 Cluster					397.17	1288.05	798.62
6 Cluster						0.00	1569.61
7 Cluster							548.34

Table 5: Percent contribution of different quantitative characters towards genetic divergence in dolichos bean genotypes

Source	Contribution %	Times Ranked 1st
1 Days to First Flowering	17.31	135.00
2 Days to 50% Flowering	1.41	11.00
3 Days to 100% Flowering	0.01	0.00
4 Inflorescence Length	7.95	62.00
5 Flowers Per Inflorescence	0.01	0.00
6 Pods Per Inflorescence	0.01	0.00
7 Days to First Green Pod h	0.26	2.00
8 Days to Last Green Pod ha	0.64	5.00
9 Number of Green Pod Picking	0.01	0.00
10 Vine Length	4.10	32.00
11 Pod Length	1.03	8.00
12 Pod Width	1.15	9.00
13 Pod Weight (10 Pods)	6.15	48.00
14 Seeds Per Pod	0.01	0.00
15 100 Seed Weight	39.74	310.00
16 Green Pod Yield Per Plant	20.26	158.00
17 Green Pod Yield Per Plot	0.01	0.00
18 Green Pod Yield Per Hectare	0.01	0.00

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