Int.J.Curr.Microbiol.App.Sci (2024) *13*(10): 7-14

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 13 Number 10 (2024)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2024.1310.002

Variability and Association Analysis for Yield and Related Attributes in Indian Bean [*Lablab purpureus* (L.) Sweet]

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Keywords

Genetic variability, Heritability, Genetic advance, Indian bean

Article Info

Received:
18 August 2024
Accepted:
24 September 2024
Available Online:
10 October 2024

A B S T R A C T

The present experiment was carried out to evaluate 142 genotypes of Indian bean for different qualitative and quantitative characters. The genotypes showed considerable variation for flower bud colour, standard and wing colour, pod curvature, pod constriction, pod colour, pod attachment, fresh and dry seed colour, fresh seed shape and dry seed texture. The analysis of variance revealed the significant differences among the mean sum of squares with respect to plant height, pod length, pod width, pod weight and seed yield per plant under study. This showed that a sufficient amount of variability is present within the material under study for these traits. Progenies exhibited higher values of GCV and PCV for seed yield per plant indicating the greater scope of improving this character by applying selection in an appropriate direction. High heritability coupled with high genetic advance as per cent mean were observed for plant height, pod weight and seed yield per plant indicating the role of additive gene effects and less effects of environmental factors on the expression of the traits. Thus, the improvement of these traits could be achieved through direct phenotypic selection.

Introduction

Indian bean [*Lablab purpureus* (L.) Sweet] (2n=22) Syn. *Dolichos lablab* L., belongs to the family Fabaceae (Leguminoceae). It originated in India and was introduced to Africa from South-East Asia during the 8th century (Deka *et al.,* 1990), however according to Maass (2016) lablab originated in Eastern and Southern Africa.

Indian bean is consumed locally as a grain legume and green vegetable as well as fodder. Indian bean is remarkably adaptable to wider areas under diverse environmental conditions such as arid, semi-arid, sub-tropical and humid regions. Since it is a legume crop, it can also fix atmospheric nitrogen in the soil (up to 170 kg/ha) and also enrich the soil with the organic matter by leaving enough crop residue. It is extremely drought tolerant than other related legumes like common bean and cowpea (Maass *et al.,* 2010), so it can be grown in the area of water scarcity and limited rainfall.

The *Lablab* species is popular for being very diverse. Genotypes are distinguished based mostly on variation in size, shape, colour of pods, flowers and leaves. Due to

synchronous flowering and maturity, determinate growth habit and photoperiod insensitive flowering allows solitary cultivation as well as intercropping especially in plantation crops throughout the year.

Germplasm characterization is the recording of highly heritable and distinctly identifiable characteristics. Generally, gene bank managers, breeders and other specialists work together to develop the set of traits that provide the basic description of species diversity. For any genetic improvement programme genetic variability must be present in base population and it is prime importance for that programme.

Variability in the progeny is due to either genetic constitution or environmental factor. It is difficult to conclude that the observed variability is heritable or non-heritable. The partitioning of both heritable and non-heritable component gives idea whether selected trait is inherited to the progenies or not. The characters for which variability is present should be highly heritable for the success of crop improvement programme. If heritability is high, more will be the genetic advance and ultimately more improvement can be achieved. Yield is a complex trait. It is collectively influenced by the various yield attributing characters that are quantitative in nature and influenced by the non-heritable variation. For improvement of these traits effective selection is required, which is determined by the magnitude and nature of the interaction between heritable and non-heritable variables.

Materials and Methods

The experiment was carried out at College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari during *Rabi,* 2020-21. Total 138 derived germplasm lines were laid out along with checks GNIB-21, GNIB-22, W-19-58 and V-19-154 in Augmented Block Design where every check was replicated in three blocks.

Each row comprised of 13 plants of single progeny with 60 cm and 20 cm inter and intra row spacing, respectively. The progenies were randomly assigned in every block. All the recommended agronomic practices along with necessary plant protection measures were followed timely for the healthy crop.

Morphological characters of 138 Indian bean genotypes were studied for descriptors. Observations on DUS descriptors were recorded at different growth stages as per Byregowda *et al.,* (2015). List of descriptors for Indian bean is given in Table 1.0

The observations were recorded on five randomly selected plants from each row in each block except for days to 50 per cent flowering and days to maturity. Selected plants were tagged before the first flower emergence. Data for days to 50 per cent flowering and days to maturity were recorded on a population basis.

Data for other characters were collected from the arbitrarily selected five plants on an individual plant basis for different characters and their averages were used in the statistical analysis. The observations were recorded on Days to 50 % flowering, Days to maturity, Plant height (cm), Racemes per plant, Pods per raceme, Pods per plant, Pod length (cm), Pod width (cm), Pod weight (g), Seeds per pod and Seed yield per plant (g).

Analysis of variance for the characters was done as per standard statistical procedure for Augmented Randomized Complete Block Design (Augmented Design II) as given by Federer (1956). The variability parameters *viz.,* genotypic coefficient of variance, phenotypic coefficient of variance, heritability and genetic advance were estimated as per procedure suggested by Burton (1952) and Allard (1960).

Results and Discussion

Characterization of Genotypes

Morphological characterization of diverse germplasm holds immense potential for their utilization in the breeding programme. For characterization of germplasm lines, observations for eighteen descriptors were taken.

Among the genotypes studied 56.33% had no pigmentation, 42.95% had extensive and 0.70% had almost solid pigmentation. All germplasm had same leaf colour, leaf pubescence, pod pubescence, leaf shape and keel petal colour.

Total 48.59% genotypes exhibited light yellow flower bud colour and 51.40% purple flower bud colour. While white, pink and purple colour of standard petal were observed with proportion of 46.47%, 13.38%, and 40.14% respectively. Whereas, 48.59% white, 2.11% pink and 49.29% purple wing colour were observed. Majority of germplasm lines had straight (54.92%) and

slightly curved (43.66%) pod curvature and slightly constricted (73.94%) and intermediate (62.67%) type of pod attachment.

Green (21.12%) and cream (77.44%) colored fresh seeds were observed in most of the germplasm lines. Moreover, 89.43% of genotypes showed oval seed shape. Most of the dry seeds had cream (78.87%) and black (11.97%) colour as well as smooth (80.98%) seed texture were observed (Table 1).

Analysis of Genetic Variability and Heritability

The analysis of variance (Table 2) revealed significant progeny mean square values for plant height, pod length, pod width, pod weight and seed yield per plant. The progenies exhibited higher values of GCV and PCV for seed yield per plant indicating the greater scope of improving this character by applying the selection in an appropriate direction and also showed greater diversity among the F_6 progenies for this trait.

The less difference between estimates of GCV and PCV indicated less influence of the environment on this trait and selection could be effective for this trait.

Similar results were also observed by Asaduzzaman *et al.,* (2015); Chandran *et al.,* (2015); Singh *et al.,* (2015); Choudhary *et al.,* (2016); Hadavani *et al.,* (2018); Peer *et al.,*(2018) and Ingle *et al.,* (2020).

Moderate GCV and PCV values (Table 3) were observed for the traits *viz.,* plant height and pod weight. This indicated that the extent of response of these traits for selection would be less. Similar results were also recorded for plant height by Kamble *et al.,* (2016); Ingle *et al.,* (2020) and Shilpa *et al.,* (2020); for pod weight by Afsan and Roy (2020).

High heritability was observed for plant height, pod length, pod width, pod weight and seed yield per plant indicating that these traits are less influences by environment and phenotype could provide a good measure of genotypic effect so, improvement for these traits could be made by simple phenotypic selection.

Same results were also observed for plant height and pod length by Shilpa *et al.,* (2020); Shulee *et al.,* (2020) and Chauhan and Kundu (2021); for pod width by Gamit *et al.,* (2020) and Shulee *et al.,* (2020); for pod weight by Noorjahan *et al.,* (2019a); Shilpa *et al.,* (2020) and Shulee *et al.,* (2020); for seed yield per plant by Hadavani *et al.,* (2018); Peer *et al.,* (2018) and Ingle *et al.,* (2020).

However, genetic advance can help to predict the extent of improvement that can be achieved for the traits. The high genetic gain along with high heritability would suggest better conditions for making an effective selection.

High genetic advance as percent of mean was recorded for plant height, pod weight and seed yield per plant. Similar results were also observed for plant height by Shilpa *et al.,* (2020) and Shulee *et al.,* (2020); for pod weight by Shilpa *et al.,* (2020) and Shulee *et al.,* (2020); for seed yield per plant by Hadavani *et al.,* (2018) and Ingle *et al.,* (2020).

Moderate genetic advance as per cent of mean was observed for pod length and pod width. Similar results were also observed for pod length by Mohan *et al.,* (2014); for pod width by Verma *et al.,* (2015).

Heritability coupled with genetic advance as per cent of mean is more valuable than heritability alone in predicting the response of selection. The high heritability coupled with high genetic advance was observed for plant height, pod weight and seed yield per plant, indicating the role of additive gene effects and less effect of environmental factors on the expression of the traits.

Thus, the improvement of these traits could be achieved through direct phenotypic selection. Similar results were also observed by Peer *et al.,* (2018); Shilpa *et al.,* (2020) and Shulee *et al.,* (2020).

High heritability coupled with moderate genetic advance was observed for pod length and pod width, suggesting predominance of non-additive gene action in governing these traits.

Thus, there is a limited scope of improvement of these traits. Similar results were also observed for pod length and pods per plant by Asaduzzaman *et al.,* (2015); Jyothireddy *et al.,* (2018a) and Gamit *et al.,* (2020).

Overall study indicates that plant height had moderate to high GCV and PCV values, high heritability coupled with high genetic advance as per cent mean. So, this trait is most important for improvement in seed yield per plant in context to "*Wal"* type determinate varieties.

Table.1 List of descriptors of Indian bean genotypes for morphological traits

Sr. No.	Descriptor	States	Note	No. of Germplasm	Proportion (%)	Stage of observation	Type of assessment
1.	Stem pigmentation	No pigmentation	0	80	56.33	Before flowering	VG
		Localized to node	3	-	-		
		Extensive	5	61	42.95		
		Almost solid	7	1	0.70		
2.	Vein colour	Green	1	142	100	Before flowering (Fully developed leaves)	VG
		Purple	2	-	-		
3.	Leaf colour	Pale green	1	-	-	Before flowering (Fully developed leaves)	VG
		Green	3	142	100		
		Dark green	5	-	-		
		Purple	7	-	-		
		Dark Purple	0	-	-		
4.	Leaf shape	Round	1	-	-	Before flowering (Fully developed leaves)	VG
		Ovate	3	142	100		
		Ovate Lanceolate	5	-	-		
5.	Flower bud colour	White	1	-	-	50% flowering	VG
		Cream	2	-	-		
		Light yellow	3	69	48.59		
		Pink	4	-	-		
		Purple	5	73	51.40		
6.	Standard colour	White	1	66	46.47	50% flowering	VG
		Cream	2	-	-		
		Light yellow	3	-	-		
		Pink	4	19	13.38		
		Purple	5	57	40.14		
7.	Wing colour	White	1	69	48.59	50% flowering	VG
		Cream	2	-	-		
		Light yellow	3	-	-		
		Pink	4	3	2.11		
		Purple	5	70	49.29		
8.	Keel colour	White	1	142	100	50% flowering	VG
		Cream	2	-	-		
		Light yellow	3	-	-		
		Pink	4	-	-		
		Purple	5	-	-		
9.	Pod curvature	Straight	0	78	54.92	Fully developed fresh pods	VG
		Slightly curved	3	62	43.66		
		Curved	5	2	1.40		
10.	Leaf pubescence	Glabrous	0	142	100	Before flowering (Fully developed	VG
		Low pubescent	3	-	-		

		Moderately pubescent	5	-	-	leaves)	
11.	Pod pubescence	Glabrous	0	142	100	Fully developed fresh pods	VG
		Moderately pubescent	3	-	-		
		Pubescent	5	-	-		
12.	Pod constriction	No constriction	0	34	23.94	Fully developed fresh pods	VG
		Slightly constricted	3	105	73.94		
		Constricted	5	3	2.11		
13.	Pod colour	White	1	-	-	Premature stage of pod	VG
		Cream	2	83	58.45		
		Green	3	57	40.14		
		Green with purple suture	4	-	-		
		Purple	5	2	1.40		
		Dark purple	6	-	-		
		Red	7	-	-		
14.	Pod attachment	Erect	1	53	37.32	Fully developed fresh pods	VG
		Intermediate	2	89	62.67		
		Pendant	3	-	-		
15.	Seed colour (fresh)	Green	1	30	21.12	Ripened seed in fresh pod	VG
		Cream	2	110	77.44		
		Purple	3	2	1.44		
		Brown	4	-	-		
		Black	0	-	-		
16.	Seed shape	Round	1	15	10.56	Ripened seed in fresh pod	VG
		Oval	2	127	89.43		
		Flat	3	-	-		
17.	Seed colour (dry)	Green	1	4	2.81	After harvesting of dry pods	VG
		Cream	2	112	78.87		
		Purple	3	3	2.11		
		Brown	4	6	4.22		
		Black	5	17	11.97		
18.	Seed texture (dry)	Smooth	3	115	80.98	After harvesting of dry pods	VG
		Moderately ridged	5	25	17.60		
		Markedly ridged	7	2	1.40		

Where,
VG = Visual assessment by a single observation of a group of plants or parts of plant

Table.2 Result of analysis of variance for characters under study

Sources	DF	DFF	DM	PH	RPP	PPR	PPP	PL	PWD	PWG	SPP	SYPP
Block	2	9.00	4.00	21.18	0.21	0.9*	1.21	0.08	0.07*	0.0026	0.01	**0.35**
Entries	141	12.43	12.03	87.02**	0.68	0.59	2.25	0.36*	0.04*	0.04**	0.07	**4.28****
Checks	3	12.67	3.64	55.99*	0.20	1.83**	7.85*	3.92**	0.06*	0.17 **	0.01	**2.88***
Genotypes	137	12.51	12.18	88.27**	0.69	0.56	2.13	0.29*	0.04*	0.03**	0.07	**4.17****
Genotypes vs. Check	1	0.84	17.5	8.92	0.94	0.13	1.50	0.16	0.31**	0.20 **	0.06	**22.55****
Residuals	**6**	**3.67**	**6.22**	**11.69**	**0.33**	**0.17**	**1.44**	**0.07**	**0.01**	**0.0035**	**0.02**	**0.44**

*** P <= 0.05; ** P <= 0.01**

Table.3 Result of measures of variability parameters of all the characters

Trait	Mean	Range		GV	PV	GCV (%)	PCV(%)	h^2_{bs}(%)	GA	GAM (%)
		Min.	Max.							
Days to 50% flowering	39.25	24.00	44.00	-	-	-	-	-	-	**-**
Days to maturity	88.39	73.00	93.00	-	-	-	-	-	-	**-**
Plant height (cm)	46.53	26.40	75.40	76.58	88.27	18.79	20.17	86.76	16.81	**36.10**
Racemes per plant	4.60	3.10	6.60	-	-	-	-	-	-	**-**
Pods per raceme	3.82	2.40	6.00	-	-	-	-	-	-	**-**
Pods per plant	10.64	8.30	13.60	-	-	-	-	-	-	**-**
Pod length (cm)	5.44	4.26	7.58	0.22	0.29	8.60	9.83	76.57	0.85	**15.52**
Pod width (cm)	1.76	1.38	2.90	0.03	0.04	9.33	10.82	74.26	0.29	**16.58**
Pod weight (g)	0.87	0.43	1.71	0.03	0.03	19.95	21.03	89.96	0.34	**39.04**
Seeds per pod	3.86	3.20	4.60	-	-	-	-	-	-	**-**
Seed yield per plant (g)	**5.31**	**2.46**	**18.1**	**3.73**	**4.17**	**35.82**	**37.89**	**89.40**	**3.77**	**69.88**

GCV= Genotypic coefficient of variation (%) PCV=Phenotypic coefficient of variation (%) GAM = GA as per cent of mean (%)

σ^2_g= Genotypic variance σ^2_p= phenotypic variance GA=Genetic advance (%) h^2_{bs}= Heritability (Broad sense)

Author Contributions

Manju Singh: Investigation, formal analysis, writing—original draft. Kruti Gorasiya: Validation, methodology, writing—reviewing. K. G. Modha:—Formal analysis, writing—review and editing.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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How to cite this article:

Manju Singh, Kruti Gorasiya and Modha, K. G. 2024. Variability and Association Analysis for Yield and Related Attributes in Indian Bean [*Lablab purpureus* (L.) Sweet]. *Int.J.Curr.Microbiol.App.Sci.* 13(10): 7-14.
doi: https://doi.org/10.20546/ijcmas.2024.1310.002