

**Estimation of genetic variability for yield and yield attributing traits in Dolichus bean
[*Lablab purpureus* (L.) sweet var. *typicus*] genotypes.**

ABSTRACT

Dolichos bean is an indigenous legume 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 land races of Indian Bean grown all over the country. Perennial climbing races with long pods and annual bushy races with small pods are the two groups of *Dolichos lablab* species available in India. Much concerted efforts are needed to develop an ideotype having semi-determinate growth habit with early flowering and having desirable pod quality, suitable for vegetable purpose that do not require cost intensive trellising. A wide range of variability exists in pod shape, size and colour and other agronomic characters in Dolichos bean. Therefore it is necessary to select variety having desired pod quality with high yield potential. Despite of these good attributing characters it is still regarded as underexploited vegetable because of low productivity, long duration and photosensitivity, flowering irregularity, growth habit and preference of consumers with respect to pod shape, pod size, pod colour, pod aroma. Keeping this in view the present investigation was conducted at All India Co-ordinated Research Project on Vegetable Crops, Odisha University Of Agriculture and Technology, Bhubaneswar during Rabi, 2020-21 for evaluating the yield and yield attributing characters, for estimating the variability, heritability, genetic advance and the association between yield and yield attributing characters for an effective selection to estimate the genetic variability in Dolichos bean [*Lablab purpureus* (L.) sweet var. *typicus*] genotypes for further crop improvement study. The genotypic variance ranged from 0.02 for pod weight per plant to 2435 for average leaf area. The phenotypic variance ranged from 0.023 for pod weight per plant to 2879.8 for average leaf area. Phenotypic coefficient of variation (PCV) was higher than genotypic coefficient of variation (GCV) for all the 14 characters taken. This happened because PCV estimates includes variations due to environment (E) and genotype and environment (GE) interaction. PCV was highest (60.31) for pod yield per plant followed by average leaf area (35.09) indicating the presence of wide range of genetic variability in the germplasm for these traits. Higher value of GCV was found for characters like pod yield per plant (59.80) followed by average leaf area (32.26) and number of pods per plant (31.94). Highest estimates of heritability in broad sense was observed in Pod weight per plant (98.30) followed by number of pods per plant (96.17), average leaf area (84.55), number of pods per inflorescence (83.91), pod length (82.22), plant height (78.82), pod yield per hectare (78.66) indicating that these characters are less influenced by environment.

Keywords: Genetic variability, heritability, genetic advance, PCV, GCV

1. Introduction

Dolichos bean [*Lablab purpureus* (L.) sweet var. *typicus*] is also called as Indian bean, Sem, Field bean, Hyacinth bean, Bonavist bean, Egyptian bean and Lablab bean. It belongs to the family Fabaceae, sub family Faboideae, tribe phaseoleae and sub tribe phaseolineae (Dewangan *et al.*, 2018), having chromosome number $2n = 2x = 22$. Dolichos bean is an indigenous legume 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 land races of Indian Bean grown all over the country (Parmar *et al.*, 2013). India is considered as the centre of diversity of *Dolichos* bean and large number of indigenous strains are available in northern India (Sahu and Bahadur, 2018). Vavilov (1931) has reported India as its centre of origin from where it spread throughout the world. The crop is mostly grown throughout tropical regions of Asia, Africa and America.

Perennial climbing races with long pods and annual bushy races with small pods are the two groups of *Dolichos lablab* species available 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 habit with early flowering and having desirable pod quality, suitable for vegetable purpose that do not require cost intensive trellising (Das *et al.*, 2015)

A wide range of variability exists in pod shape, size and colour and other agronomic characters in *Dolichos* bean. Therefore, it is necessary to select variety having desired pod quality with high yield potential. It also possesses antimicrobial, anti-fungal, anti-inflammatory, aphrodisiac, hypocholesterolemic, galactagogue, appetite suppressants and antispasmodic properties that prevents from various types of ailments. *Dolichos* bean is grown throughout the country mainly for its green pods. As a dual purpose (food and feed) legume, it can be grown as a monocrop or in intercrop systems (Tapkeer *et al.*, 2017). Its foliage are also used as hay, silage and green manure. Its seeds contain water soluble polysaccharides comprised of rhamnose, xylose, arabinose, galactose, glucose, uronic acid, unidentified sugars and proteins. Apart from the nutrients, the *lablab* beans, as is the case with other legume grains, may also contain varying amounts of anti-nutritional factors such as tannins, phytic acid and trypsin inhibitors. Despite of these good attributing characters it is still regarded as underexploited vegetable because of low productivity, long duration and photosensitivity, flowering irregularity, growth habit and preference of consumers with respect to pod shape, pod size, pod colour, pod aroma. Limited area planted to this crop and efforts towards its genetic improvement truly qualities its tag as an underutilized crop (Ramesh & Byregowda, 2016).

Despite of being originated in India, very little work has been done in the field of yield and quality aspect of *Dolichos* bean. A great range of variation exists for the plant and pod characters amongst the accessions grown all over the country (Parmar, 2013).

Study of genetic variability, heritability and genetic advance are pre-requisite for improvement of any crop for the selection of superior genotypes and improvement of any trait. It is very difficult to judge whether observed variability is heritable or due to environment alone. Knowledge of heritability is essential for selection based improvement as it indicates extent of transmissibility of character in future generations. *Dolichos* bean is very popularly grown in Odisha during rabi season as an offseason crop and there exists more genetic variability among the varieties available in Odisha. So, keeping in view the above facts, this study is done for further crop improvement to select superior bush type genotypes in *Dolichos* bean.

2. MATERIALS AND METHODS

The present investigation was conducted at All India Co-ordinated Research Project on Vegetable Crops, Odisha University Of Agriculture and Technology, Bhubaneswar during Rabi, 2020-21 to **estimate the genetic variability in Dolichus bean [*Lablab purpureus* (L.) sweet var. *typicus*] genotypes for yield and yield attributing traits.** It is located at a latitude of 20°15'N and longitude of 85°52'E with an altitude of 25.5 m above mean sea level (MSL). The selected experimental site comes under the fourth agro-climatic zone of Odisha (East and South Eastern Coastal Plain) having hot and humid climate with mild winter. The average temperature varied from 15°C in winter, 40°C in summer and 30°C in rainy season and R. H. varied from 60% - 80% during December and January. The experiment was laid out using statistical design Randomized Block Design (RBD) having 12 number of Genotypes as treatments with three replications. The 12 genotypes are V1:2017/DBB VAR-1 from AVT-2, AICRP on Vegetable crops, OUAT, V2: 2017/DBB VAR-2 from AVT-2, AICRP on Vegetable crops, OUAT, V3: 2017/DBB VAR-4 from AVT-2, AICRP on Vegetable crops, OUAT, V4: 2017/DBB VAR-5 from AVT-2, AICRP on Vegetable crops, OUAT, V5: 2017/DBB VAR-6 from AVT-2, AICRP on Vegetable crops, OUAT, V6: 2017/DBB VAR-7 from AVT-2, AICRP on Vegetable crops, OUAT, V7: 2017/DBB VAR-8 from AVT-2, AICRP on Vegetable crops, OUAT, V8: 2018/DOLBVAR-2 AVT-1, AICRP on Vegetable crops, OUAT, V9: 2018/DOLBVAR-4 from AVT-1, AICRP on Vegetable crops, OUAT, V10: 2018/DOLBVAR-6 from AVT-1, AICRP on Vegetable crops, OUAT, V11: ARKA AMOGH from IIHR, Bangalore and V12: ESWARA from B Bio Seeds. These twelve genotypes taken were randomly distributed in each replication. Sowing was done on 15th October, 2020. Healthy and Bold seeds were selected from all the twelve genotypes and were sown in different plots of each replication randomly. The data recorded for different characters were subjected to statistical analysis based on their sample means. Observations of all the characters were analysed for ANOVA and variability and other genetic parameters related to fruit yield were taken for estimation of genetic variability for yield and yield attributing characters.

3. Results and Discussion

The present study was conducted for evaluating the yield and yield attributing characters, for estimating the variability, heritability, genetic advance and the association between yield and yield attributing characters for an effective selection.

The Table 1 presents the analysis of variance i.e., the mean sum of squares between twelve genotypes of bush type of Dolichos bean for 14 characters to study the genetic variability. The data revealed the existence of significant differences among the genotypes for all the characters studied. The mean sum of square for genotypes was maximum in case of average leaf area followed by number of pods per plant. The characters like pod yield per plant, pod width, number of flowering nodes per inflorescence, number of flowering nodes per inflorescence, number of compound leaves, Number of primary branches showed minimum values for genotypic mean sum of squares.

Table 1 Analysis of Variance (mean sum of squares) for 14 characters of 12 genotypes of bush type Dolichos bean

Sl. No.	Characters (df)	Mean sum of squares		
		Replications (2)	Genotypes (11)	Error (22)
1	Plant height (cm)	2.3721	47.69**	3.9201
2	Number of compound leaves	2.6678	3.10**	0.7854
3	Number of primary branches	0.0478	3.87**	0.4708
4	Average leaf area (cm ²)	276.6799	7749.55**	444.8177
5	Days to 1st flowering	0.6286	12.51**	3.1129
6	Days to 50% flowering	0.1733	13.72**	4.1358
7	Inflorescence length (cm)	4.6150	18.78**	1.7401
8	Number of flowering nodes per inflorescence	1.0978	2.29*	0.7451
9	Number of pods per inflorescence	0.7678	4.67**	0.2805
10	Number of pods per plant	22.6609	568.99**	7.4621
11	Pod length (cm)	3.9994	19.01**	1.2776
12	Pod width (cm)	0.4090	0.61**	0.0913
13	Pod yield per plant (kg)	0.0011	0.07**	0.0004
14	Yield in t/ha	0.9695	21.38**	1.7725

*Significant at 5% level, **Significant at 1% level

3.1 Genetic variability

Germplasm evaluation is a necessary and preliminary step for genetic improvement of any crop. The effectiveness of selection as well as hybridization programme depends on the amount of variation present in the material and the extent to which it is heritable. Variability refers to the presence of differences among the individuals of plant population. Variability results due to differences either in the genetic constitution of the individual of a population or in the environment in which they are grown. Hence the presence of genetic variability in the available germplasm of a crop is of immense value to design a selection procedure and to identify the superior genotypes. An assessment of the nature and extent of variability is, therefore, one of the basic approach towards successful breeding assignment.

The estimation of genetic parameters such as mean, range, genotypic variance and phenotypic variance in the present study are presented in Table 2 and the respective genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability in broad sense, genetic advance and genetic advance as percentage of mean of different characters are presented in Table 3.

Table 2 General mean, range, genotypic variance, phenotypic variance for 14 characters in bush type of Dolichos bean genotypes

Sl. No.	Characters	General mean	Range	GV	PV
1	Plant height (cm)	67.51	60.04 - 75.66	14.6	18.6
2	Number of compound leaves	18.26	15.6 - 20.4	0.8	1.6
3	Number of primary branches	6.24	3.6 - 7.8	1.13	1.7
4	Average leaf area (cm ²)	152.94	100.4 - 286.16	2435	2879.8
5	Days to 1st flowering	40.95	36.2 - 45.6	3.13	6.24
6	Days to 50% flowering	45.68	40.8 - 50.4	3.19	7.33
7	Inflorescence length (cm)	22.91	19.6 - 29.22	5.7	7.41
8	Number of flowering nodes per inflorescence	8.09	5.2 - 10.6	0.6	1.26
9	Number of pods per inflorescence	6.71	4.4 - 10	1.46	1.8
10	Number of pods per plant	42.84	20 - 71.5	187.17	194.7
11	Pod length (cm)	9.06	3.1 - 13.8	6	7.18
12	Pod width (cm)	1.93	1.2 - 3.3	0.17	0.26
13	Pod yield per plant (kg)	0.25	0.040 - 0.484	0.02	0.023
14	Yield in t/ha	10.00	5.38 - 15.430	6.6	8.30

The general mean results indicated wide variation ranging from pod yield per plant (0.25 kg) to average leaf area (152.94 cm²). The range was highest in case of average leaf area (100.4 - 286.16 cm²) and lowest range was observed in pod weight per plant (0.04-0.48 kg). Results from table 2 indicated that the genotypic variance ranged from 0.6 for number of flowering nodes per inflorescence to 2435 for average leaf area. The phenotypic variance ranged from 0.023 for pod yield per plant to 2879.8 for average leaf area.

The study of data in Table 3 revealed that the phenotypic coefficient of variation (PCV) was higher than the genotypic coefficient of variation (GCV) for all the 14 characters taken. This happened because PCV estimates includes variations due to environment (E) and genotype and environment (GE) interaction. PCV was highest (60.31) for pod yield per plant followed by (35.09) for average leaf area. PCV was lowest (5.93) for days to 50% flowering, followed by (6.10) for days to 1st flowering, (6.37) plant height (cm), (6.83) number of compound leaves in ascending order. The characters like inflorescence length (11.89), number of flowering nodes per inflorescence (13.88), number of pods per inflorescence (19.69) exhibited moderate values of PCV (10-20%). Relatively higher PCV (>20%) was observed in rest of the characters. Relatively higher value of GCV was found for characters like pod yield

per plant (59.80) followed by average leaf area (32.26) and number of pods per plant (31.94). Moderate values were obtained in 4 characters. Lowest values were observed in days to 50% flowering (3.91), days to 1st flowering (4.32) and number of compound leaves (4.81) in ascending order. The GCV and PCV for yield traits is given in the Fig:1, From the figure it is clear that among all the characters GCV and PCV was recorded highest for Pod yield per plant and lowest is recorded for Days to 1st flowering and Days to 50% flowering

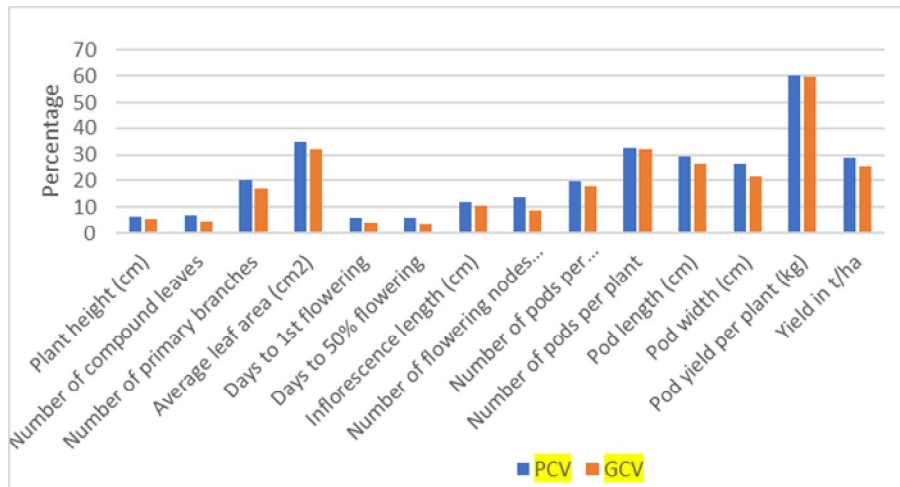


Fig 1: GCV and PCV for yield traits in Dolichos bean

3.2 Heritability

Knowledge of heritability is essential for selection based improvement as it indicates the transmissibility of a character from parents to their offspring. The concept of heritability is useful in determining whether the phenotypic differences among individuals are genetical or as a result of environmental factors.

The heritability (broad sense) estimates for 14 characters as presented in Table 3 ranged from 40.90% in number of flowering nodes per inflorescence to 98.30% in pod yield per plant. Moderate heritability was observed in number of flowering nodes per inflorescence (40.90), days to 50% flowering (43.59), number of compound leaves (49.53) and days to 1st flowering (50.16). All the other characters recorded high heritability (> 60%).

3.3 Genetic advance

The range of genetic advance (GA) among different characters as presented in table 3 varied from 0.31% in pod yield per plant to 93.47% in average leaf area. The GA as % of mean was found to be in a range of 5.32% in days to 50% flowering to 122.13% in pod yield per plant. Expected GA was found to be low (<10%) for traits like days to 50% flowering (5.32%), days to 1st flowering (6.31) and number of compound leaves (6.97). Similarly moderate value of GA (10-20%) was recorded for plant height (10.35%), number of flowering nodes per inflorescence (11.69%), inflorescence length (18.75%) whereas relatively higher value of GA as % of mean (>20%) was recorded for rest of the characters. Heritability (Broad sense) and Mean for Genetic advance is given in the Fig:2, from the figure below it is clearly understood that. High genetic advance and heritability is for pod yield per plant similarly high heritability and low genetic advance is recorded for Number of pods per plant, lowest

genetic advance is recorded in days to 1st flowering and days to 50 % flowering. Lowest heritability is seen in Number of flowering nodes per inflorescence.

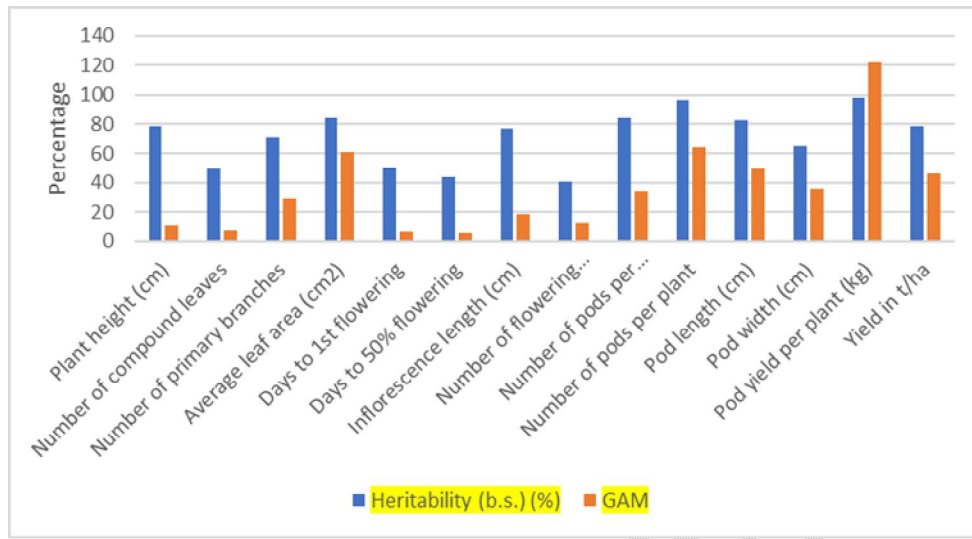


Fig 2: Heritability and Genetic Advance Mean for yield traits in Dolichos bean

Table 3 Genotypic coefficient of variation (GCV), Phenotypic coefficient of variation (PCV), Heritability (Broad sense), Genetic Advance (GA), Genetic Advance as % of Mean (GAM) for 14 characters studied in Dolichos bean

Sl. No.	Characters	PCV	GCV	Heritability (b.s.) (%)	GA (at 5% level)	GAM
1	Plant height (cm)	6.37	5.66	78.82	6.99	10.35
2	Number of compound leaves	6.83	4.81	49.53	1.27	6.97
3	Number of primary branches	20.29	17.05	70.66	1.84	29.53
4	Average leaf area (cm ²)	35.09	32.26	84.55	93.47	61.12
5	Days to 1st flowering	6.10	4.32	50.16	2.58	6.31
6	Days to 50% flowering	5.93	3.91	43.59	2.43	5.32
7	Inflorescence length (cm)	11.89	10.40	76.55	4.30	18.75
8	Number of flowering nodes per inflorescence	13.88	8.88	40.90	0.95	11.69
9	Number of pods per inflorescence	19.69	18.04	83.91	2.28	34.04
10	Number of pods per plant	32.57	31.94	96.17	27.64	64.52
11	Pod length (cm)	29.58	26.82	82.22	4.54	50.11
12	Pod width (cm)	26.62	21.55	65.54	0.70	35.94

13	Pod yield per plant (kg)	60.31	59.80	98.30	0.31	122.13
14	Yield in t/ha	28.81	25.56	78.66	4.67	46.69

3.4 Genetic Variability and Heritability

By examining the ANOVA Table 1 from the present conducted investigation it was found that the nature and magnitude of variability for different quantitative characters are clearly observed among different Dolichos bean as significant. The existence of large amount of variation from all the characters studied provides ample of scope for improvement in this crop. A wide range of variability was observed for average leaf area, number of pods per plant, plant height. As high to moderate range of variation was observed for majority of the characters and related statistics for different characters gives us a strong opportunity for selecting potential and promising genotypes as per our objectives in breeding programme. Similar to the present findings investigations carried out earlier also revealed wide variations for various characters by (Singh *et al.*, 2015 and Noorjahan *et al.*, 2019). Further the coefficient of variation value is less than 20% for all the characters, which indicates high precision was maintained during conducting the experiment.

For understanding the principles of crop improvement programme, two aspects are important *i.e.* (1) Selection in any breeding programme depends upon the amount of already existing variability in the experimental material rather it cannot create new variability by itself. (2) Selection for any character can act effectively only on the basis of heritable differences (Allard, 1960). Therefore, assessing whether the genetic variability for characters under study is significant or not is the most important factor for selection. Further, the phenotypic mean values which are basis of comparison can be misleading while interpreting the data as it may be influenced by environmental factor. To minimise this environmental effect and precise interpretation of recorded data, statistics like variance and coefficient of variations are calculated.

Burton and Devane (1953) suggested method for calculating the genetic parameters such as phenotypic and genotypic variance along with the coefficients of variations which provides a sound basis to determine the variability components as well as to know the relative amounts of heritable and non-heritable variation for each of these characters studied.

While comparing the phenotypic coefficient of variation and genotypic coefficient of variation values it can be concluded that the PCV values were always higher than the GCV values for all the fifteen characters studied. However, there was close linkage and very minute difference between the values of PCV and GCV with respect to most of the traits except pod width and number of flowering nodes per inflorescence revealing the fact that there was very minor influence of environment on the expression of most of the characters and selection of these characters based on phenotype would be effective. Similar results were disseminated in the findings of (Chaitanya *et al.*, 2014; Jyothireddy *et al.*, 2018; Sahu and Bahadur (2018); Noorjahan *et al.*, 2019; Afsan and Roy (2020) and Gamit *et al.* (2020).

GCV represents the heritable components of total variation. Therefore it is an important parameter for comparing variability of different characters among the 12 genotypes of dolichos bean. The highest genotypic coefficient of variation was observed for Pod yield per plant (59.80) followed by average leaf area (32.26) and number of pods per plant (31.94) which indicated maximum variability existing in the genotypes that provides better scope for genetic improvement in the character through effective simple selection. These research findings found uniformity with results found by (Verma *et al.*, 2014 ; Singh *et al.*, 2015 ; Jyothireddy *et al.*, 2018 and Gamit *et al.*, 2020). Lowest GCV were observed for days to 50% flowering (3.91) followed by days to 1st flowering (4.32) and number of compound leaves (4.81) which reveals that the extent of response of these traits for selection would be less than that of other traits. High GCV alone is not sufficient for determination of heritable variation. So, GCV along with heritability would give the best view of advance to be expected by selection.

Heritability is a measure of transmissibility of character from one generation to another and is of prime interest to plant breeder for selection of elite genotypes from diverse genetic population. Those characters which are less influenced by environment are regarded as highly heritable character (Poehlman and Borthakur, 1972). In the present experiment, the highest estimates of heritability in broad sense were observed for 98.30% in pod yield per plant followed by number of pods per plant (96.17%), average leaf area (84.55%), number of pods per inflorescence (83.91%), pod length (82.22%). High heritability showed the possibility of effective selection based on phenotypic expression. Similar results have been reported by (Dewangan *et al.*, 2017; Jyothireddy *et al.*, 2018; Sahu and Bahadur 2018; Noorjahan *et al.*, 2019 and Gamit *et al.*, 2020).

Heritability estimates along with genetic advance are more valuable than heritability alone in predicting the response of selection. Genetic advance is the quantum of genetic gain expected during a selection process. High heritability coupled with high genetic advance as per cent of mean was recorded for most of the characters, highest in pod yield per plant followed by number of pods per plant, average leaf area, yield in t/ha, pod width, number of pods per inflorescence. These characters had also high GCV which indicated that these characters were least influenced by environmental effects and were governed by additive genes and selection on the phenotypic performance will be rewarding for improvement of such traits. Considering GCV, PCV, Heritability and GAM among fourteen characters pod yield per plant recorded highest for all the above said parameters, this character is considered as good parameter to inherit in next generation, if we use the genotypes in future breeding programme. The studies related to heritability and genetic advance is exactly coinciding with the findings of (Lahari *et al.* 2022, Jyoti *et al.* 2017, Chowdary *et al.* 2016)

4. Conclusion

The present investigation was done to estimate the extent of genetic variability, for yield and yield attributing traits in bush type Dolichos bean [*Lablab purpureus* (L.) sweet var. typicus] genotypes. The genotypic variance ranged from 0.02 for pod weight per plant to 2435 for average leaf area. The phenotypic variance ranged from 0.023 for pod weight per plant to 2879.8 for average leaf area. Phenotypic coefficient of variation (PCV) was higher than genotypic coefficient of variation (GCV) for all the 14 characters taken. This happened because PCV

estimates includes variations due to environment (E) and genotype and environment (GE) interaction. PCV was highest (60.31) for pod yield per plant followed by average leaf area (35.09) indicating the presence of wide range of genetic variability in the germplasm for these traits. Higher value of GCV was found for characters like pod yield per plant (59.80) followed by average leaf area (32.26) and number of pods per plant (31.94). Highest estimates of heritability in broad sense was observed in Pod weight per plant (98.30) followed by number of pods per plant (96.17), average leaf area (84.55), number of pods per inflorescence (83.91), pod length (82.22), plant height (78.82), pod yield per hectare (78.66) indicating that these characters are less influenced by environment. High heritability coupled with high genetic advance as per cent of mean was recorded for most of the characters, highest in pod yield per plant followed by number of pods per plant, average leaf area, yield in t/ha, pod width, number of pods per inflorescence. These characters had also high GCV which indicated that these characters were least influenced by environmental effects and were governed by additive genes and selection on the phenotypic performance will be rewarding for improvement of such traits. Therefore, characters with high heritability, GCV, PCV and genetic advance is considered as predominant characters in selecting dolichos bean genotypes for future breeding programmes. Categorically breeders should consider the effect of additive and non-additive gene actions in selecting the genotypes.

References

1. Afsan N and Roy AK. 2020. Genetic Variability, Heritability and Genetic Advance of some yield contributing characters in Lablab bean (*lablab purpureus* l. sweet), *Journal of Bio-Science*, **28** : 13-20.
2. Allard, R.W. (1960) *Principles of Plant Breeding*. John Willey and Sons Inc., New York.
3. Burton, G.N. and Devane, E.M. 1953 Estimating Heritability in Fall Fescue (*Festuca arundiancea* L.) from Replicated Clonal Materials. *Agronomy Journal*, 45, 478-481. <http://dx.doi.org/10.2134/agronj1953.00021962004500100005x>.
4. Chaitanya V, Reddy RVSK, and Kumar AP. 2014. Variability, Heritability and Genetic Advance in Indigenous Dolichos Bean (*Dolichos Lab Lab L. Var Typicus*) Genotypes, *Plant Archives*, **14**(1): 503-506.
5. Chaitanya V, Reddy RVSK, Pandravada SR, Sujata M and Kumar PA. 2014. Correlation and Path Coefficient Analysis in Dolichos Bean (*Dolichos Lablab L. Typicus Prain*) Genotypes, *Plant Archives*, **14**(1): 537-540.
6. Chowdary J , Kushwah SS, Singh OP, Naruka IS. 2016. Studies on genetic variability and character association in Indian bean (*Lablab purpureus* L.) *Legume Research*.39(3):336-342
7. Dewangan R, Bahadur V, Choyal P, Ramesh, Xaxa S, Singh VP, Sachan S and Kerketta A. 2017. Study on Genetic Variability, Heritability and Genetic Advance in Dolichos Bean (*Lablab purpureus* L.) Genotypes, *International Journal of Current Microbiology and Applied Sciences*, **6**(8): 2319-7706.
8. Dewangan R, Choyal P, Ramesh ND, Kerketta A and Godara A. 2018. Path coefficient analysis study in dolichos bean (*Lablab purpureus* L.), *International Journal of Chemical Studies*, **6**(4): 2494-2496.

9. Dewangan R, Choyal P, Ramesh ND, Kerketta A and Mathew AM. 2018. Correlation coefficient analysis study in Dolichos bean (*Lablab purpureus* L.), *The Pharma Innovation Journal*, **7**(7): 721-723.
10. Gamit UC, Jivani LL, Ponkia HP, Balas A and Vadavi AT. 2020. Study of genetic variability and heritability in Indian bean (*Lablab purpureus* L.), *Electronic Journal of Plant Breeding*, **11**(1): 328-330.
11. Jyoti RK, Genetic divergence for pod quality, yield and yield attribute characters in dolichos bean (*Dolichos lablab* L. Var. *typicus*) germplasm. *M.Sc. (Horti.)* Thesis submitted to Sri Konda Laxman Telangana state horticulture university, Rajendranagar, 2017
12. Jyothireddy K, Prabhakar BN, Saidaiah P and Pandravada SR. 2018. Genetic divergence, variability, heritability and genetic advance for growth, pod quality and yield characters in dolichos bean (*Dolichos lablab* L.var. *typicus* Prain) germplasm, *Legume Research*, **41**(6): 804-809.
13. Lahari V, Ashok P, Ramesh Babu B and Sasikala K. 2022. Genetic variability, heritability and genetic advance of yield and yield attributing characters of Dolochos bean (*Dolichos lablab* L), *The Pharma Innovation*, **11**(8): 1205-1208.
14. Noorjahan AM, Deshmukh JD, Wankhade MP and Kalpande HV. 2019. Genetic variability, heritability and genetic advance studies in dolichos bean (*Lablab purpureus* L.). *International Journal of Chemical Studies*. **7**(3): 479-482.
15. Noorjahan AM, Deshmukh JD, Wankhade MP and Kalpande HV and Reddy V. 2019. Correlation studies in dolichos bean (*Lablab purpureus* L.), *International Journal of Chemical Studies*. **7**(2): 47-49.
16. Noorjahan AM, Deshmukh JD, Wankhade MP, Kalpande HV and Reddy V. 2019. Path analysis studies in dolichos bean (*Lablab purpureus* L.), *Journal of Pharmacognosy and Phytochemistry*, **8**(2): 41-42.
17. Parmar K, Sen R and Prakash R. 2013. Study of genetic variability on yield and yield attributing characters. *Journal of Horticultural Science*, **7**: 402-405.
18. Parmar AM, Singh AP, Dhillon NSP and Jamwal M. 2013. Genetic Variability Studies for Morphological and Yield Traits in Dolichos Bean (*Lablab purpureus* L.). *World Journal of Agricultural Sciences* .**9**(1): 24-28.
19. Parmar AM, Singh AP, Dhillon NPS and Jamwal M. 2013. Genetic variability of morphological and yield traits in Dolichos bean (*Lablab purpureus* L.), *African Journal of Agricultural Research*, **8**(12): 1022-1027.
20. Poehlman and Borthakur, 1972. *Breeding Asian Field crops: with special reference to crops of India*. Publisher: New Delhi, Oxford & IBH Publishing co.
21. Ramesh, S. and Byregowda, M. 2016. Dolichos bean [*Lablab purpureus* (L.) Sweet, Var. *Lignosus*] genetics and breeding present status and future prospects. *Mysore Journal of Agricultural Sciences*. **50**(3): 481-500
22. Sahu S and Bahadur V. 2018. Genetic analysis of dolichos bean (*Lablab purpureus* L.) genotypes for horticultural traits, *Journal of Pharmacognosy and Phytochemistry*, **7**(4): 3112-3116.
23. Singh S, Singh PK, Singh DR, Pandey VB and Srivastava RC. 2015. Genetic variability and character association study in dolichos bean, *Indian Journal of Horticulture*, **72**(3): 343-346.
24. Verma AK, Jyothi KU and Rao AVD. 2014. Genetic variability, heritability and genetic advance studies in Dolichos bean (*Lablab purpureus* L.) genotypes, *Electronic Journal of Plant Breeding*, **5**(2): 272-276.

25. Verma AK, Jyothi KU and Rao AVD. 2015. Variability and character association studies in dolichos bean (*Lablab purpureus* L.) genotypes, *Indian Journal of Agricultural Research*, **49**(1): 46-52.

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