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VARIABILITY AND TRAIT RELATION BETWEEN YIELD AND YIELD RELATED TRAITS IN FRENCH BEAN (*PHASEOLUS VULGARIS* L.)

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ABSTRACT

Seventeen genotypes of French bean were evaluated to study the genetic variability component and correlation. The research was conducted at Horticultural Research Centre, Chauras Campus, H.N.B. Garhwal University, Srinagar (Garhwal), Uttarakhand (India) during zaid season, 2018. The experiment was laid out in randomized block design with three replications. The genotypic and phenotypic coefficient of variation values were high for fresh weight of nodules & dry weight of nodules per plant, number of pods per plant, pod diameter, yield of green pods per plant, per plot & per hectare and number of picking. The high heritability was found for almost all the traits studied. The yield of green pods per plot had significant positive association both at genotypic and phenotypic levels for number of pods per plant, pod weight, pod length, pod diameter, yield of green pods per plant, number of picking and yield of green pod per hectare. The selection of high yielding genotypes should be given emphasis to number of pod per plant, pod weight, pod length, pod diameter and number of pickings.

Keywords: Bean, Correlation, Genotypic, Heritability, Phenotypic and Variability

INTRODUCTION

Leguminosae family is one of the most important group among the vegetable due to their economic as well as their nutritional values. This family represents the wide range of vegetables like pea, French bean, cow pea, Indian bean, board bean, cluster bean, lima bean, jack bean etc. Among the family, French bean (*Phaseolus vulgaris* L. 2n=2x=22) is most popular, highly cultivated specie and short duration crop in the hills of Uttarakhand. It is known by several names like, snap bean, kidney bean, haricot bean (George, 1985) and also called "Raj mash" in Hindi. French bean had introduced to India during 17th century form Europe. It is originated from Central America and Peruvian Andes in South America (Vavilov, 1950). There are four cultivated species of *Phaseolus, viz. P. vulgaris, P. coccineus, P. lunatus and P. acutifolius* var *latifolius*. All the species are self-pollinated, except *P. coccineus* which is generally cross pollinated. French bean possess medicinal properties which is useful in controlling diabetes and certain cardiac problems and it is a good natural cure for bladder burn. It has both carminative and reparative properties against constipation and diarrhoea respectively (Duke, 1981).

For any kind of trait improvement, the variation and selection is a very critical points. The estimation of available variability in crop species is very crucial for initiating effective breeding planning to create new cultivars and improve the present cultivars in different areas (Patil *et al.,* 2012 and Belaj *et al.,* 2002). Traits having a high genotypic coefficient of variation indicate high potential for effective selection (Burton and De Vane, 1953). For starting a crop breeding programme, genetic variability along with heritability should be considered for assessing the maximum and accurate effect of selection because the degree to which variability of a character is transmitted to progeny is of utmost importance. Heritability is transmissibility of characteristics from parent to offspring (Falconer, 1981) and heritability also showed heritable portion of phenotypic variance. Heritability provides the real knowledge on the magnitude of inheritance of traits from parents to off spring. The genetic advance is very useful in finding the real gain expected under selection (Larik *et al.,* 2000, Nwangburuka & Denton, 2012 and Ogunniyan & Olakojo, 2015). The information on heritability alone may not very helpful in indentifying traits for enforcing selection; therefore, heritability estimates incorporation with genetic advance is more reliable than alone (Johnson *et al.,* 1955). Correlation studies help to find the degree of interrelationship among various characters and to evolve selection criteria for improvement. Yield related traits is one of the most critical points for creating the improved cultivars; while yield is one of the most complex trait which is related to many traits directly and indirectly, which are simply inherited (Rao *et al.,* 1990). From all the above mention facts the study was conducted to assess the component of genetic variability and correlation in seventeen genotypes of French bean in valley condition of Srinagar Garhwal.

MATERIALS AND METHODS

The present investigation was carried out at Horticultural Research Centre, Chauras Campus, H.N.B. Garhwal University, Srinagar (Garhwal), Uttarakhand (India)

during *zaid* season, 2018. The Horticultural Research Centre is situated in Alaknanda valley which lies between 78°47'30" E longitude and 30°13'0" N latitude, at an elevation 540 meter above MSL, in the lesser Himalayan region. Seventeen strains *viz.,* Aishwarya, Anupam, Arka Komal, Contender, Dun-10, Dun-11, Dun-12, L-1, L-2, Pant Anupama, Pauri Local, P-29, Sangalakoti-1, Sangalakoti-2, SK-1, SM-1 and SM-9 of French bean were collected from different location of Uttarakhand and India. The experiment was laid out in randomized block design with three replications. The entire experimental field was divided into three blocks each block consist of seventeen beds of equal size of 2 x 2 m size with 45cm x 15cm spacing. All the intercultural operation and plant protection measures recommended for the successful crop growth were followed and irrigation were given according to crop requirement for better growth and development of the plants. During the experiment eighteen different growth, yield and quality parameters were recorded. Ten plants from each treatment per replication were randomly selected and tagged for recording the observations. The statistical analysis was carried out for each observed traits under the study using OPSTAT software. The treatments were tested at the 5% and 1% probability level. Analysis of variance was carried out as per the procedure given by Panse and Sukhatme (1985). Estimation of parameters of variability, genotypic and phenotypic coefficient of variation was done following Burton and De Vane (1953). Heritability and expected genetic advance was calculated according to Burton (1952) and Johnson *et al.* (1955). Correlations of various biometrical characters were undertaken as per the procedure suggested by Al-Jibouri *et al.* (1958).

RESULT AND DISCUSSION

Estimation of genetic variances and their component is presented in Table 1. The phenotypic coefficient of variation (PCV) was higher than the genotypic coefficient of variation (GCV) for all the traits studied in this research work, the results of study indicating that, the present variation was not only genetic but also influenced by environmental factors of growing conditions. In general view, the quantitative traits very quickly influenced by growing environmental conditions, while the qualitative traits is very less influenced by climatic factors. The PCV and GCV values were a bit lower ranging from 3.41% to 38.39% and 3.37% to 38.38% respectively. According to Deshmukh *et al.* (1986), the PCV and GCV values more than 20% are considered to be higher, values between 10%-20% to be moderate, while value less than 10% are considered to be low. The GCV and PCV values were higher for fresh weight of nodules/plant (23.11 and 23.11%), dry weight of nodules/plant (38.38% and 38.39%), number of pods per plant (23.58 and 23.65), pod diameter (28.31 and 29.64), yield of green pods per plant (29.94 and 29.94), yield of green pods per plot (30.72 and 30.76), number of picking (23.49 and 23.90) and yield of green pod per hectare (26.26 and 29.70). The high values of PCV and GCV suggested that there is a possibility of improvement through direct selection for these traits. Similar results were also obtained by Kumar *et al.* (2014), Singh *et al.* (2014b) and Verma *et al.* (2014a) in French bean.

The moderate GCV and PCV were recorded for the traits *viz.,* days taken to first germination (14.62% and 14.79%), plant height (12.62% and 12.64%), number of primary branches/plant (19.18% and 19.63%), number of nodules per plant (13.13% and 13.35%), pod weight (19.06% and 19.15%), pod length (12.77% and 12.86%) and total soluble solids (10.13% and 10.79%). It implies equal importance of additive and non additive gene action and substantial amount of variability for these traits. Kumar *et al.* (2014), Singh *et al.* (2014b) and Verma *et al.* (2014a) also observed similar results in French bean. The GCV and PCV for days taken to first flowering (5.94% and 5.99%), days taken to first pod set (6.60% and 6.64%) and days taken to first pod picking (3.37% and 3.41%) were low.

The heritability values is one of the key factors in the assumption to be achieved through the selection process; the joint view of high heritability and high genetic advance is a key marker of higher proportion of additive genetic variance and consequently a high genetic gain is expected from selection (Singh and Rai, 1981). In the present research work, the heritability ranged from 78.16% to 100% (Table 1). According to classification of Singh (2000), the heritability values higher than 80% are high, values 60% to 79% are moderately high, values from 40% to 59% are medium and values less than 40% are low. The high heritability was found for almost all the character studied except yield of green pod per hectare (78.16%) which was found to be moderately high.

The genetic advance as percent of mean (GAM) was ranging from 6.86% to 79.04%. Johnson *et al.* (1955) classified genetic advance as a percentage of mean as value between 0 to 10% are low, 10 to 20% are moderate and above 20% are high. The high genetic advance over mean (Table 1) was observed for almost all the traits studied. The traits days taken to first flowering (12.15%) and days taken to first pod set (13.54%) were recorded moderate GAM while, days taken to first pod picking (6.86%) was found low GAM. Based on this measure, the traits under study have high heritability value coupled with high-to-moderate genetic advance as a percentage of the mean (ranging from 12.15% to 79.04%). Rai *et al.,* 2010; Kumar *et al.,* 2014; Prakash and Ram (2014) and Jayprakash *et al.,* 2015 also recorded similar results in French bean.

Correlation coefficient measures the degree of association (genetic and non-genetic) between two or more traits. The knowledge of the nature and magnitude of genetic

Table 1: Estimation of component of variance, heritability, genetic advance and genetic advance over mean for growth, yield and quality characters in French bean genotypes

Characters	Range	Variance		Coefficients of variance (%)		Heritability h^2 (%)	Genetic advance (GA)	Genetic advance over mean GAM (%)
		GV	PV	GGV	PCV			
Days taken to first germination	7.47-13.46	2.98	3.05	14.62	14.79	97.60	3.51	29.74
Plant height (cm)	38.29-64.64	36.19	36.27	12.62	12.64	99.79	12.38	25.98
Number of primary branches/plant	3.65-7.41	1.37	1.43	19.18	19.63	95.44	2.35	38.60
Days taken to first flowering	34.48-42.69	5.34	5.42	5.94	5.99	98.53	4.73	12.15
Number of nodules per plant	7.60-14.55	2.38	2.46	13.13	13.35	96.69	3.13	26.59
Fresh weight of nodules/ plant (mg)	75.15-150.39	678.51	678.61	23.11	23.11	99.99	53.66	47.60
Dry weight of nodules/ plant (mg)	13.55-44.49	124.88	124.95	38.38	38.39	99.94	23.01	79.04
Days taken to first pod set	41.49-48.57	8.78	8.87	6.60	6.64	98.99	6.07	13.54
Days taken to first pod picking	55.58-62.56	3.86	3.95	3.37	3.41	97.80	4.00	6.86
Number of pods per plant	10.33-22.35	12.38	12.45	23.58	23.65	99.46	7.23	48.45
Pod weight (g)	7.40-13.58	3.69	3.73	19.06	19.15	99.04	3.94	39.06
Pod length (cm)	10.39-15.63	3.07	3.11	12.77	12.86	98.66	3.58	26.13
Pod diameter (cm)	0.69-1.75	0.10	0.11	28.31	29.64	91.23	0.63	55.69
Yield of green pods per plant (g)	91.55-250.11	2097.22	2097.28	29.94	29.94	100.00	94.34	61.67
Yield of green pods per plot (kg)	7.80-20.28	14.61	14.65	30.72	30.76	99.72	7.86	63.19
Number of picking	2.24-5.24	0.59	0.61	23.49	23.90	96.56	1.55	47.55
Yield of green pod per hectare (q/ha)	183.30-416.53	6318.97	8084.45	26.26	29.70	78.16	144.77	47.82
TS S (°Brix)	5.08-7.53	0.36	0.40	10.33	10.79	91.67	1.19	20.37

association among components of economic importance can help in improving the efficiency of selection by making possible use of suitable combination of characters. In the present study the correlation coefficients were estimated for 18 characters with yield of green pods per plot and among the characters themselves both at genotypic and phenotypic levels which is presented in Table 2. The magnitude of genotypic correlation coefficients was higher than phenotypic correlation coefficients in the present investigation. Similar results were also reported by Jayprakash *et al.* (2015), Panchbhaiya *et al.* (2017) and Aklade *et al.* (2018) in French bean**.** This could be explained on the basis that there was strong inherent genotypic relation between the characters under studied. The environmental factor has not played much role in expression of phenotypic correlation.

The results (Table 2) in the present investigation revealed that yield of green pods per plot had significant positive association both at genotypic and phenotypic levels for number of pods per plant (0.882, 0.879), pod weight (0.562, 0.559), pod length (0.332 , 0.332), pod diameter (0.595, 0.565), yield of green pods per plant (0.971, 0.969), number of picking (0.645, 0.631) and yield of green pod per hectare (1.007, 0.888), while significant negative association between genotypic and phenotypic levels was observed in days taken to first germination (-0.502, -0.495) and days taken to first pod picking (-0.698, -0.692). Aklade *et al.* (2018) and Devi *et al.* (2015) also reported similar results in French bean.

CONCLUSION

Table 2: Genotypic and phenotypic correlation coefficients for 18 characters of French bean genotypes

Character	Days taken to first germination	Plant height (cm)	Number of primary branches/plant	Days taken to first flowering	Number of nodules per plant	Fresh wt. of nodules/ plant (mg)	Dry wt. of nodules/ plant (mg)	Days taken to first pod set	Days taken to first pod picking	Number of pods per plant	Pod weight (g)	Pod length (cm)	Pod diameter (cm)	Yield of green pods per plant(g)	Number of picking	yield of green pod per hectare(q/ ha)	TSS (°Brix)	Yield of green pods per plot (kg)
Days taken to first germination	*	-0.447**	-0.286*	0.709**	-0.138	-0.126	-0.172	0.678**	0.542**	-0.429**	-0.672**	-0.253	-0.683**	-0.496**	-0.436**	-0.435**	-0.397**	-0.502**
		-0.442**	-0.275*	0.698**	-0.145	-0.124	-0.170	0.663**	0.530**	-0.425**	-0.663**	-0.248	-0.648**	-0.490**	-0.423**	-0.358**	-0.362**	-0.495**
Plant height (cm)		*	0.823**	-0.485**	0.644**	0.454**	0.483**	-0.418**	0.253	-0.077	0.509**	0.132	0.216	-0.132	0.011	-0.166	0.577**	-0.172
			0.801**	-0.480**	0.634**	0.453**	0.483**	-0.415**	0.249	-0.077	0.507**	0.131	0.210	-0.132	0.012	-0.144	0.552**	-0.171
Number of primary branches/plant			*	-0.276*	0.622**	0.410**	0.416**	-0.338*	0.070	0.068	0.413**	0.319*	0.009	-0.079	0.101	-0.038	0.578**	-0.094
				-0.271*	0.603**	0.401**	0.408**	-0.331*	0.072	0.069	0.406**	0.311*	-0.003	-0.077	0.088	-0.053	0.545**	-0.092
Days taken to first flowering				*	-0.227	-0.116	-0.189	0.940**	0.360**	-0.100	-0.597**	-0.364**	-0.464**	-0.188	-0.296*	-0.103	-0.647**	-0.128
					-0.226	-0.115	-0.188	0.928**	0.355**	-0.100	-0.589**	-0.352**	-0.443**	-0.187	-0.282*	-0.084	-0.608**	-0.127
Number of nodules per plant					*	0.779**	0.795**	-0.250	0.157	0.230	0.430**	0.499**	0.066	0.033	0.341*	0.018	0.518**	0.024
						0.766**	0.782**	-0.237	0.154	0.224	0.421**	0.486**	0.067	0.033	0.329*	0.013	0.479**	0.021
Fresh wt. of nodules/plant (mg)						*	0.990**	-0.048	0.133	0.243	0.098	0.189	-0.009	0.040	0.010	0.138	0.504**	0.081
							0.990**	-0.048	0.132	0.243	0.097	0.187	-0.009	0.039	0.010	0.122	0.483**	0.080

Table 2: continued...

Character	Days taken to first germination	Plant height (cm)	Number of primary branches/plant	Days taken to first flowering	Number of nodules per plant	Fresh wt. of nodules/ plant (mg)	Dry wt. of nodules/ plant (mg)	Days taken to first pod set	Days taken to first pod picking	Number of pods per plant	Pod weight (g)	Pod length (cm)	Pod diameter (cm)	Yield of green pods per plant(g)	Number of picking	Yield of green pod per hectare(q/ ha)	TSS (°Brix)	Yield of green pods per plot (kg)
Dry wt. of nodules/ plant (mg)							*	-0.113 -0.113	0.119 0.118	0.245 0.244	0.159 0.158	0.220 0.219	0.025 0.025	0.051 0.051	0.041 0.040	0.138 0.122	0.531** 0.509**	0.077 0.077
Days taken to first pod set								*	0.523** 0.514**	-0.154 -0.154	-0.597** -0.591**	-0.433** -0.430**	-0.478** -0.452**	-0.258 -0.257	-0.467** -0.451**	-0.177 -0.160	-0.648** -0.623**	-0.204 -0.203
Days taken to first pod picking									*	-0.655** -0.646**	-0.377** -0.368**	-0.356** -0.350*	-0.382** -0.355**	-0.682** -0.674**	-0.518** -0.506**	-0.698** -0.627**	-0.313* -0.287*	-0.698** -0.692**
Number of pods per plant										*	0.538** 0.536**	0.494** 0.490**	0.313* 0.301*	0.909** 0.906**	0.558** 0.548**	0.923** 0.806**	0.297* 0.286*	0.882** 0.879**
Pod weight (g)											*	0.572** 0.567**	0.690** 0.655**	0.611** 0.608**	0.624** 0.610**	0.557** 0.473**	0.575** 0.547**	0.562** 0.559**
Pod length (cm)												*	0.135 0.126	0.368** 0.365**	0.700** 0.689**	0.325* 0.287*	0.479** 0.452**	0.332* 0.332*

Table 2: continued...

Character	Days taken to first germination	Plant height (cm)	Number of primary branches/plant	Days taken to first flowering	Number of nodules per plant	Fresh wt. of nodules/ plant (mg)	Dry wt. of nodules/ plant (mg)	Days taken to first pod set	Days taken to first pod picking	Number of pods per plant	Pod weight (g)	Pod length (cm)	Pod diameter (cm)	Yield of green pods per plant(g)	Number of picking	Yield of green pod per hectare(q/ ha)	TSS (°Brix)	Yield of green pods per plot (kg)
Pod diameter (cm)													*	0.577**	0.512**	0.520**	0.334*	0.595**
														0.551**	0.496**	0.462**	0.320*	0.565**
Yield of green pods per plant (g)														*	0.638**	1.000**	0.280*	0.971**
															0.627**	0.884**	0.268	0.969**
Number of picking															*	0.547**	0.243	0.645**
																0.472**	0.233	0.631**
Yield of green pod per hectare (q/ha)																*	0.376**	1.007**
																	0.302*	0.888**
TS S (°Brix)																	*	0.265
																		0.250
Yield of green pods per plot (kg)																		*

* Significant at 5% level

** Significant at 1% level

On the basis of results obtained from the present experiment, it can be concluded that the French bean genotypes used has vast genetic variability with narrow differences between genotypic coefficients of variation and phenotypic coefficients of variation, high to moderate heritability and genetic advance over mean for most of the characters, so the selection would be more feasible for these traits. Correlation studies indicated that selection for number of pod per plant, pod weight, pod length, pod diameter, yield per plant and number of picking could be criteria for simultaneously increasing yield in French bean.

REFERENCES

AI-Jibouri, H.A., Millar, P.A. and Robinson, H.P. (1958). Genotypic and environmental variances and co-variances in an upland cotton cross of inter-specific origin. *Agronomy Journal,* 50: 633-636.

Aklade, S.A., Patil, H.E., Sarkar, M. and Patel, B.K. (2018). Genetic variability, correlation and path analysis for yield and yield related traits in vegetable type French bean (*Phaseolus vulgaris* L.). *International Journal of Pure and Applied Bioscience*, 6(6): 25-32.

Belaj, A., Satovic, Z., Rallo, L. and Trujillo, I. (2002). Genetic diversity and relationship in olive (*Olea europea* L.) germplasm collection as determined by RAPD. *Theoretical Applied Genetics,* 105: 638-644.

Burton, G.W. (1952). Quantitave inheritance in grasses. *Proceedings on 6th Inter. Grassland Cong. J.,* 1: 277-283.

Burton, G.W. and De Vane, E.H. (1953). Estimating heritability in tall fescue (*Festuca arundinacea*) from replicated clonal material. *Agronomy Journal*, 45: 478-481.

Deshmukh, S.N., Basu, M.S. and Reddy, P.S. (1986). Genetic variability, character association and path coefficient analysis of quantitative traits in Virginia bunch varieties of groundnut. *Indian Journal of Agricultural Science*, 56: 816-821.

Devi J., Sharma, A., Singh, Y., Katoch, V. and Sharma, K.C. (2015). Genetic variability and character association studies in French bean (*Phaseolus vulgaris* L.) under North-Western Himalayas. *Legume Research*, 38(2): 149-156.

Duke, J.A. (1981). Handbook of Legumes of World Economic Importance. New Work, USA/London, UK: *Plenum press*, pp: 195-200.

Falconer, D.S. (1981). *Introduction to Quantitative Genetics*, Ed. 2. Longmans Green, London, New York.

George, R.A.T. (1985). Vegetable Seed Production. *Longman*, London and New Work, pp: 193-207.

Jayprakash., Ram, R.B. and Meena, M.L. (2015). Genetic variation and characters interrelationship studies for quantitative and qualitative traits in French bean (*Phaseolus vulgaris* L.) under Lucknow conditions. *Legume Research,* 38(4): 425-433.

Johnson, H.W., Robinson, H.F. and Comstock, R.E. (1955). Estimates of genetic and environmental variability in soybeans. *Agronomy Journal,* 47: 314-318.

Kumar, A.P., Reddy, R.V.S.K., Pandravada, S., Durga, R.C.V. and Chaitanya, V. (2014). Genetic variability, heritability and genetic advance in pole type French bean (*Phaseolus vulgaris* L.). *Plant Archives*, 14(1): 569-573.

Larik, A.S., Malik, S.I., Kakar, A.A. and Naz, M.A. (2000). Assessment of heritability and genetic advance for yield and yield components in *Gossypium hirsutum* L. *Science Khyber* 13: 39-44.

Nwangburuka, C.C. and Denton, O.A. (2012). Heritability, character association and genetic advance in six agronomic and yield related characters in leaf *Corchorus olitorius*. *International Journal of Agricultural Research*, 7: 367-375.

Ogunniyan, D.J. and Olakojo, S.A. (2015). Genetic variation, heritability, genetic advance and agronomic character association of yellow elite inbred lines of maize (*Zea mays* L.). *Nigerian Journal of Genetics*, 28: 24-28.

Panchbhaiya, A., Singh, D.K. and Jain S.K. (2017). Inter-characters association studies for morphological, yield and yield attributes in the germplasm of French bean (*Phaseolus vulgaris* L.) in Tarai region of Uttarakhand, India. *Legume Research,* 40(1): 196-199.

Panse, V.G. and Sukhatme, P.V. (1985). Statistical Methods for Agricultural Research. ICAR, New Delhi, pp: 308-318.

Patil, P.R., Surve, V.H. and Mehta, H.D. (2012). Line x Tester analysis in rice (*Oryza sativa* L.). *Madras Agriculture. Journal,* 99: 210-213.

Prakash, J. and Ram, R.B. (2014). Genetic variability, correlation and path analysis for seed yield and yield related traits in French bean (*Phaseolus vulgaris* L.) under Lucknow conditions. *International Journal of Innovative Science, Engineering and Technology*, 1(6): 41-50.

Rai, N., Singh, P.K., Verma, A., Yadav, P.K. and Choubey, T. (2010). Hierarchical analysis for genetic variability in pole type French bean (*Phaseolus vulgaris* L.). *Indian Journal of Horticulture,* 67: 150-153.

Rao, D.S.R.M., Singh, H., Singh, B., Khola, O.P.S. and Faroda, A.S. (1990). Correlation and path coefficient analysis of seed yield and its components in sesame (*Sesamum indicum* L.). *Haryana Agricultural University Journal of Research,* 20: 273-276.

Singh, B.D., 2000. Plant Breeding-Principles and Methods, sixth ed. Kalyani Publishers, New Dehli, India.

Singh, B.K., Deka, B.C., Ramakrishna, Y. (2014b). Genetic variability, heritability and interrelationships in pole-type French Bean (*Phaseolus vulgaris* L.). *Proceedings of the National Academy of Sciences, India*, 84(3): 587–592.

Singh, R.P. and Rai, J.N. (1981). Note on the heritability and genetic advance in chilli. (*Capsicum annuum* L.). *Progressive Horticulture*, 13: 89-92.

Vavilov, N.I. (1950). The origin, variation, immunity and breeding of cultivated plants. *Chromosome Botany*, 13: 1-364.

Verma, K.A., Umajyothi, K. and Rao, D.A.V.D. (2014a). Genetic variability, heritability and genetic advance studies in dolichos bean (*Lablab purpureus* L.) genotypes. *Electronic Journal of Plant Breeding,* 5(2): 272-276.