academicJournals

Vol.8(12), pp. 1022-1027, 4 April, 2013
DOI: 10.5897/AJAR2012.0033
ISSN 1991-637X ©2013 Academic Journals
http://www.academicjournals.org/AJAR

African Journal of Agricultural Research

Full Length Research Paper

Genetic variability of morphological and yield traits in Dolichos bean (*Lablab purpureus* L.)

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Accepted 4 April, 2013

Thirty genotypes of Dolichos bean (*Lablab purpureus*) were evaluated to study the genetic variability on yield, yield-contributing and related characters. The highest and lowest coefficient of variation was observed for single podded clusters per plant and protein content respectively. Little or no difference between the phenotypic and genotypic coefficients of variability in the expression of various horticultural traits studied for protein content, days to 50% flowering, days to first pod set, pod length, pod weight, weight of 10 green pods and days to maturity. Phenotypic coefficient of variation was high for the single podded clusters per plant. Days to 50% flowering, pod length, width of pod, weight of 10 green pods accounted for the higher heritability and higher genetic advance. Significant positive phenotypic correlations were observed between yield other yield components including days to first pod set, days to 50% flowering, number of pods per plant, weight of 10 green pods and length of pod. The genotypes used in the study are of diverse nature and can be used in the breeding programme for development of superior genotypes in Dolichos bean.

Key words: Dolichos bean, correlation, genetic advance, genetic variability, heritability.

INTRODUCTION

Dolichos bean (*Lablab purpureus*L.) 2n=2x=22, 24 is an important leguminous vegetable crop grown throughout India and is commonly known as Sem. It is potentially a herbaceous perennial but cultivated as an annual with bushy, erect or climbing races. Sem is primarily grown for green pods and is rich in protein (3.8%, green pod basis). The dry seeds are also used for various vegetable preparations and foliage of the crop provides hay, silage and green manures (Bose et al., 1993). It is photo-sensitive and both short day and long day types areavailable (Anonymous, 1961).India is the centre of diversity of Dolichos and large numbers 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 exists for the plant and pod characters amongst the accessions grown all over the country. The 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. Since, many of the plant characters are governed by polygenes and greatly influenced by environmental conditions; the progress of breeding is, however, conditioned by the magnitude, nature and interrelationship of genotypic and non-genotypic variation.

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This suggests a redundancy need to partition the overall variability into heritable and non-heritable components. For the success of the crop improvement programme, the characters for which variability is present, it should be highly heritable as progress due to selection depends on heritability, selection intensity and genetic advance of the character. Heritability and genetic advance estimates for different targeted traits help the breeder to apply appropriate breeding methodology in the crop improvement programme. One of the main thrust in any crop improvement programme is to enhance yield. Yield is a complex trait and is dependent on many other ancillary characters which are mostly inherited quantitatively. Meager information is available for genetic variability in dolichos bean addressing the morphological and yield traits. Hence, an attempt was made with specific objective to examine the genetic parameters of variability to identify major characters for achieving higher yield.

MATERIALS AND METHODS

The experimental material for the present investigation comprised 30 dolichos bean genotypes viz. PD 1, PD 2, PD 3, PD 4, PD 5, PD 6, PD 7, PD 8, PD 9, PD 10, PD 11, PD 12, PD 13, PD 14, PD 15, PD 16, PD 17, Pushpa, PD 19, Pusa Sem 2, PD 21, PD 22, PD 23, PD 24, Pusa Sem 3, PD 26, PD 27, PD 28, PD 29 and PD 30. These were evaluated in randomized complete block design with three replications during (*kharif)* seasons of two consecutive years 2002 to 2003 at the Vegetable Experimental Area, Punjab Agricultural University, Ludhiana. The sowing was done on ridges with spacing of 1.25 m and 45 cm, ridge to ridge and plant to plant respectively. The recommended package of practices was followed to raise a good crop. Observations were recorded on five randomly taken competitive plants for eleven characters, viz. days to 50% flowering, days to first pod set, days to maturity, number of pods per cluster, pod length, width of pod, weight of 10 green pods, yield per plant, number of single podded clusters per plant, number of pods per plant and protein content.

Analysis of variance was performed following the standard procedures. The phenotypic and genotypic coefficients of variation (PCV, GCV) were computed as described by Burton and Devane (1953). Heritability in broad sense and genetic advance (% of mean) were calculated according to Allard (1960). Estimates of genotypic and phenotypic correlation were obtained using the formulae given by Al-Jibouri et al. (1958).

RESULTS AND DISCUSSION

The 30 genotypes involved in the study varied significantly among themselves for all the horticultural traits studied (Table 1) as revealed by analysis of variance over the years. The minimum number of days to 50% flowering was found in Pushpa (39.33) and the maximum number of days to 50% flowering was taken by genotype PD 21 (147.30). Genotype PD 1 and PD-17 had taken 91.66 days to first pod set whereas PD 21 and PD 22 had taken 140.33 and 108 days to first pod set respectively. The minimum number of days taken to first maturity was found in the cultivar Pushpa (57.33) and the maximum number of days to maturity of pods among genotypes was recorded in PD-21 (155.66). The genotypes PD-24 (497.66) and PD-12 (487.00) followed by Pusa Sem-2 (460.66) gave higher number of pods per plant and the lower number was obtained from PD-21 (46.00) followed by Pushpa (63.33) and PD-28 (105.00). Pods of genotype PD-21 had maximum pod width (30.03 mm) and the lowest width was observed in PD-9 (14.96). The highest mean value for 10 pod weight was recorded for PD-2 (64.33 g) and the lowest mean value for the 10 pod weight was recorded in PD-29 (27.66 g). Yield/plant is the most important horticultural trait of a crop. The genotype PD-10 out yielded all the cultivars for marketable fruit where production of 2.03 kg pods per plant was recorded. The lowest marketable yield was recorded from PD-21 (0.260 kg). Similar pattern of variability in germplasm evaluation of different sizes for various horticultural traits in dolichos bean have earlier been reported by Borah and Shadeque (1992).

The highest coefficient of variation was observed for single podded clusters per plant (33.78), suggesting the highest variability in the material which can be exploited for further improvement (Table 2). The lowest coefficient of variation was observed in the protein content (2.62) followed by days to maturity (3.91), days to 50% flowering (4.01) and days to first pod set (4.83). The experimental material exhibited a wide range of phenotypic variability ranged from 7.30 to 89.98 (Table 2). Phenotypic coefficient of variation was high for the single podded clusters per plant (89.98) and the lowest phenotypic coefficient of variation was observed in protein content (7.30). In case of genotypic variability, the experimental material exhibited wide ranging from 7.12 (protein content) to 83.40 (single podded clusters per plant). A close proximity in the phenotypic and genotypic coefficients of variability (Table 2) was observed indicating a little influence of environment in the expression of various horticultural traits studied for protein content, days to 50% flowering, days to first pod set, pod length, pod weight, weight of 10 green pods and days to maturity. This suggests that selection for improvement of these characters is possible and effective on the phenotypic basis. Similar findings pertaining to different traits including weight of 10 green pods and days to maturity in dolichos bean is found Borah and Shadeque (1992) and Ali et al. (2005).

Heritability is the transmissibility of characteristics from parents to offsprings. It is of fundamental importance in practicability of selection, because it acts as predictive instrument in expressing the reliability of phenotypic value as guide to breeding value. Heritability is a useful indicator of the progress that can be expected as a result of exercising selection on the pertinent population. In the present investigation, heritability (%) ranged from 59.02 to 95.09 (Table 2). High heritability estimates were obtained for protein content (95.09), days to 50%

Table 1. Mean values for pod yield and related horticultural traits of 30 dolichos bean genotypes.

S/N	Genotype	Days to 50% flowering	Days to first pod set	Days to maturity	No. of pods per cluster	Pod length (cm)	Width of pod (mm)	Wt. of 10 green pods (g)	Yield per plant (kg)	No. of single podded clusters per plant	No. of pods per plant	Protein content (%)
1	PD 1	103.00	91.66	106.00	8.07	9.82	26.00	61.33	1.10	2.33	168.33	18.23
2	PD 2	120.00	103.00	119.33	5.13	9.39	28.53	64.33	0.63	4.33	116.00	21.00
3	PD 3	93.67	95.00	107.00	5.07	9.21	23.23	43.67	0.80	1.33	178.67	20.60
4	PD 4	101.00	98.00	110.33	7.20	9.90	21.30	41.00	0.89	0.00	220.67	21.90
5	PD 5	106.00	101.00	113.33	6.70	5.18	18.33	35.00	0.66	2.00	188.00	21.50
6	PD 6	95.33	95.67	109.67	8.70	6.57	21.93	59.00	1.26	0.00	220.33	19.73
7	PD 7	94.67	95.33	107.00	7.40	9.33	25.43	55.67	1.83	3.00	362.00	17.70
8	PD 8	95.00	94.67	106.33	5.53	8.70	25.33	48.00	1.26	3.67	253.33	18.10
9	PD 9	91.00	95.67	106.33	6.40	8.23	14.96	38.00	0.88	4.66	237.67	18.77
10	PD 10	105.00	106.00	118.00	5.63	10.48	22.07	53.00	2.03	1.00	382.67	18.43
11	PD 11	110.30	106.00	112.67	3.66	8.66	22.13	55.67	0.91	3.00	166.00	22.03
12	PD 12	93.67	95.33	106.33	8.27	9.11	17.80	29.33	1.38	3.67	487.00	20.30
13	PD 13	95.67	96.67	110.00	7.10	9.71	22.67	52.67	1.37	0.33	267.33	19.73
14	PD 14	106.67	101.67	116.33	6.25	10.17	19.63	56.67	0.76	0.33	136.00	21.17
15	PD 15	95.00	102.00	108.00	8.43	8.16	18.16	40.00	1.03	0.00	302.00	18.60
16	PD 16	103.67	102.00	105.67	6.63	7.13	18.40	37.67	0.58	0.00	160.00	20.60
17	PD 17	93.33	91.66	101.33	7.33	8.50	15.03	30.00	0.76	4.00	249.00	19.70
18	Pushpa	39.33	49.00	57.33	6.97	6.57	16.50	34.67	0.26	0.00	63.33	19.10
19	PD 19	100.33	97.33	112.67	8.30	9.52	20.13	58.00	0.88	1.00	164.00	20.10
20	Pusa Sem 2	101.33	101.33	110.67	12.93	10.00	19.70	40.33	1.79	2.33	460.66	20.10
21	PD 21	147.33	140.33	155.66	5.40	5.43	30.03	56.00	0.26	7.33	46.67	22.13
22	PD 22	105.00	108.00	117.33	5.90	10.23	21.42	49.33	1.78	2.67	357.33	19.16
23	PD 23	96.33	99.00	111.33	6.80	9.03	18.43	42.33	0.76	0.00	185.00	20.60
24	PD 24	98.00	100.67	106.67	11.23	6.57	23.78	31.67	1.60	2.00	497.66	16.26
25	Pusa Sem 3	93.67	97.00	106.00	11.26	8.30	22.57	49.00	1.70	4.33	371.67	20.30
26	PD 26	91.67	92.00	102.33	6.00	9.94	17.63	32.00	0.42	2.00	143.00	18.57
27	PD 27	94.33	93.00	106.33	6.07	7.68	15.05	52.67	1.33	0.00	250.00	19.43
28	PD 28	102.67	102.67	114.33	5.10	9.40	20.57	53.00	0.52	3.67	105.00	18.47
29	PD 29	99.33	99.67	111.33	7.27	5.70	15.13	27.66	0.54	4.33	177.33	21.83
30	PD 30	88.00	92.33	105.00	5.70	9.31	15.17	33.33	0.43	2.33	131.67	20.50
	CD (*P*=0.05)	6.47	7.72	6.99	2.35	0.90	2.45	6.68	0.53	1.20	117.33	0.52

Table 2. Range, mean, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability, expected genetic gain and genetic advances (GA) in dolichos bean.

Characters	General mean	Range	GCV	PCV	CV	h^2 (%)	Expected genetic gain	GA % of mean
Days to 50% flowering	98.68	39.33-147.33	15.76	16.26	4.01	93.91	31.05	31.46
Days to first pod set	97.86	49.00-140.33	12.70	13.59	4.83	87.38	23.94	24.46
Days to maturity	109.34	57.33-155.66	12.32	12.92	3.91	90.83	196.15	24.18
Number of pods per cluster	7.01	3.66-12.93	24.60	32.02	20.50	59.02	2.73	38.93
Length of pod (cm)	8.53	5.18-10.48	17.23	18.79	7.50	84.06	20.13	32.54
Width of pod (mm)	20.57	14.96-30.03	19.08	20.43	7.29	87.27	7.55	36.72
Weight of 10 green pods (g)	45.36	27.66-64.33	23.31	24.99	9.02	86.98	20.31	44.79
Pod yield per plant (kg)	1.01	0.26-2.03	45.26	55.42	31.97	66.71	0.77	76.16
Number of single podded clusters per plant	2.19	0.00-7.33	83.40	89.98	33.78	85.91	3.49	159.24
Number of pods per plant	234.84	63.33-497.66	48.05	56.93	30.55	71.21	196.15	83.52
Protein content	19.84	16.26-22.13	7.12	7.30	2.62	95.09	2.84	25.32

flowering (93.91), days to maturity (90.83), days to first pod set (87.38), width of pod (87.27), weight of 10 green pods (86.98), single podded cluster per plant (85.91) and pod length (84.06). High heritability showed the possibility of effective selection based on the phenotypic expression. High heritability estimates of these characters were also recorded by Nayar (1982), Borah and Shadeque (1992), Basu et al. (1999), Rai et al. (2008) and Pandiyan et al. (2006). Low heritability for number of pods per cluster (59.02) was observed. The highest genetic advance as percentage of mean was observed in single podded clusters per plant (159.24), number of pods per plant (83.52), yield per plant (76.16) and weight of 10 green pods (44.78). These results are in conformity with Nayar (1982). Low genetic advance was observed for days to first pod set (24.46) and days to maturity (24.18) and was also reported by Das et al. (1987). Days to 50% flowering, pod length, width of pod, weight of 10 green pods accounted for the higher heritability and higher genetic advance which suggests the role of additive gene action in the expression of these characters. So, selection will be effective for the improvement of these characters. High heritability coupled with moderate genetic advance was expressed by days to first pod set and days to maturity. So, these characters can be partially improved by selection. Similar results have been reported by Singh et al. (2011), Ali et al. (2005) and Das *et al.* (1987) supports the results of the present investigations. Pod yield of a crop is a complex character and is the ultimate product of action and interaction of various component characters.

Correlation of yield with other characters should be studied because sometimes the selection on the basis of yield may not be effective due to low heritability. If high correlation between easily measurable characters and yield is established, it would facilitate selection work. The correlation coefficient among the nine characters estimated from the data recorded on 30 genotypes of dolichos bean is presented in Table 3. Phenotypic correlations reflect observed relationship between traits arising from the combined effects of genotypes and environment, whereas genotypic correlations estimate the association between traits resulting from linkage or pleiotropy as well as physiological/metabolic constraints. Significant positive phenotypic correlations were observed between yield and number of pods per plant (0.459), weight of 10 green pods (0.409) and length of pod (0.375) were also reported by Lal et al. (2005) and Singh et al. (2011). In contrast, the correlation between yield and protein content of pods (-0.332) was significantly negative. Therefore, selection for yield and its positively correlated characters should result in correlated response for increased yield, but protein content in pods would be reduced. This positive correlation between yield and its contributing characters show simple, indirect selection criteria in the development of high yielding cultivars. Genotypic correlations between yield and other traits were slightly larger in magnitude and similar in direction to their corresponding phenotypic correlations. These results indicated that superior

Table 3. Estimation of correlation coefficients at the phenotypic and genotypic levels.

S/N	Characters	Path	Days to 50% flowering	Days to first pod set	No. of pods per cluster	Single podded clusters per plant	No. of pods per plant	Length of pod (cm)	Width of pod (mm)	Weight of 10 green pods (g)	Days to maturity	Pod yield per plant (kg)	Protein content
1	Days to 50% flowering	rp		0.915**	-0.156	-0.002	0.513**	0.101**	0.221	0.418*	-0.054	0.936**	0.359**
		rg		0.961	-0.209	-0.022	0.579	0.447	0.019	0.476	-0.075	0.979	0.379
2	Days to first pod set	rp			-0.070	-0.019	0.0419**	0.254	0.093	0.391**	0.065	0.964**	0.266*
		rg			-0.113	-0.072	0.0477	0.311	0.096	0.468	0.057	0.985	0.294
3	No. of pods per cluster	rp				-0.047	-0.034	-0.197	.0352**	-0.090	0.478**	-0.129	-0.267*
		rg				-0.061	-0.0833	-0.258	0.567	-0.0151	0.755	-0.214	-0.326
4	Single podded clusters per plant	rp					0.075	0.283*	0.327*	-0.170	0.193	0.009	-0.174
		rg					0.1060	0.307	0.364	-0.194	0.212	-0.020	-0.188
5	No. of pods per plant	rp						0.591**	0.192	0.296**	-0.003	0.459**	-0.047
		rg						0.712	0.260	0.325	-0.008	0.525	-0.050
6	Length of pod (cm)	rp							0.211	-0.002	-0.184	0.375	0.018
		rg							0.235	0.006	-0.235	0.421	0.031
7	Width of pod (mm)	rp								-0.025	0.883**	0.067	-0.386**
		rg								-0.081	0.861	0.045	-0.479
8	Weight of 10 green pods (g)	rp									-0.044	0.409**	-0.359**
		rg									-0.004	0.475	-0.128
9	Days to maturity	rp										-0.014	-0.379**
		rg										-0.048	-0.455
10	Pod yield per plant (kg)	rp											0.332**
		rg											0.360
11	Protein content	rp											
		rg											

*P=0.05.

yielding ability in dolichos bean was associated with enhanced expression for number of pods per plant and selection for them should result in a correlated response for increased yield. Similar results were obtained by Nandi et al. (1997) and Rai et al. (2008).

Among the genotypes evaluated, PD 10 was the highest yielder (2.06 kg) of pod per plant but recorded the second best due to unattractive pod characteristics (extra-large and white coloured pod). Pushpa produced earlier marketable yield and was bushy in nature, PD 21 and PD11 had maximum protein contents, while Pusa Sem 3, Pusa Sem 2 and PD-24 had medium sized green coloured pods. All these characters were not present in a single genotype, so attempts should be made to develop ideotype with all the desirable characters in a single plant through proper hybridization and selection. High heritability estimates were obtained for protein content, days to 50% flowering, days to maturity, days to first pod set, width of pod, weight of 10 green pods, single podded clusters per plant and pod length. High heritability showed that selection based on phenotype for these characters would be effective. The highest genetic advance as percentage of mean was observed in single podded clusters per plant, number of pods per plant, yield per plant and weight of 10 green pods.

Days to 50% flowering, pod length, width of pods and weight of 10 green pods accounted for the higher heritability and genetic advance which suggests the role of additive gene action. So, selection could be effective for the improvement of these characters. Significant positive phenotypic correlations were observed between yield and other yield components viz. days to first pod set, days to 50% flowering, number of pods per plant, weight of 10 green pods and length of pod. In contrast, the correlation between yield and protein content of pods was significantly negative; therefore, selection of positively correlated characters with yield would be easy to practice for obtaining high breeding types. Early selection based on days to 50% flowering will result in high marketable yield and is thus desirable character for early life cycle selection.

In summary, there was adequate genetic variability within the germplasm evaluated for the improvement of all the characters studied viz. pod yield, growth and related traits, which can be utilized for further improvement through selection.

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