

## Variability Studies in Induced Mutants of Moth Bean on Rainfed Arid Lands

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**Abstract :** In genetically diverse and stabilized mutant lines of moth bean (*Vigna aconitifolia* (Jacq.) Marechal), irrespective of the year, number of pods plant<sup>-1</sup> had the maximum estimates of GCV (49%), broad sense heritability (69%) and the genetic gain (78-85%). Heritability for the grain yield during dry year was moderate (46%), but was quite high for days to 50% flowering (74.20%). During dry season, plant height and number of pods plant<sup>-1</sup> had significant positive association. The days taken to 50% flowering and the number of pods plant<sup>-1</sup> were most important traits for yield improvement through selection, during dry and the wet seasons, respectively.

**Key words :** *Vigna aconitifolia*, moth bean, mutants, heritability.

In view of high drought tolerance potential and adaptation to the arid areas, moth bean (*Vigna aconitifolia* (Jacq.) Marechal) is considered to be one of the most important arid legumes. However, its primitive growth habit and poor yield potential warrant its genetic improvement. For this purpose, basic information on the nature and magnitude of genetic variability for important traits, their associations with yield, and the cause and effect underlying the relationships are required. Such informations, though preliminary, are very poorly documented. A few reports in respect of local germplasm and varieties are available (Tikka *et al.*, 1980; Kharb *et al.*, 1987; Bhandari, 1990). No efforts have been undertaken on induced stabilized mutant lines in advanced generations. The present study was, therefore, undertaken on 50 induced mutant lines of moth bean over two years (1993 and 1994) corresponding to M<sub>4</sub> and M<sub>5</sub> generations, respectively.

### Material and Methods

Seeds of moth bean (cv. Jadia, JMS-1 and JMS-3) having 4.5 and 14.0% moisture content

were exposed to 10, 20 and 30 KR doses of CO<sup>60</sup> gamma-rays during 1990. Mutants isolated in M<sub>2</sub> generation (1991) were stabilized in M<sub>3</sub> generation. Fifty genetically diverse mutant lines (30 from Jadia, 15 from JMS-3 and 5 from JMS-1) were evaluated in 5-m-long paired row plots in a randomized block design in M<sub>4</sub> (sowing, 1 July 1993) and M<sub>5</sub> generations (sowing, 5 July 1994). The experiments were conducted under rainfed conditions at the CAZRI experimental farm. Fixed plant stands with 50 x 10 cm inter- and intra-row spacings were maintained in all the plots during both the years. At maturity, 10 plants were selected randomly from each of the treatments for recording observations on plant height, number of primary branches plant<sup>-1</sup> and number of pods plant<sup>-1</sup>. Observations on days taken to 50% flowering, maturity and grain yield were made on whole plot basis.

Data were statistically analysed following standard procedures and the estimates of genetic (GCV) and phenotypic coefficient of variation (PCV), heritability in broad sense (h<sup>2</sup>B) and genetic advance were computed

Table 1. Mean values, CV, GCV, PCV, heritability in broad sense ( $h^2_B$ ) and genetic advance (GA) as % of mean in moth bean, during 1993 (upper values) and 1994 (lower values)

Traits	Mean values	CV	Range	Ratio of the range values	GCV (%)	PCV (%)	$h^2_B$ (%)	GA as % of mean
Plant height (cm)	29.85	10.90	20.73-34.87	1.68	8.79	14.01	39.40	11.35
	78.46	10.60	65.90-102.10	1.54	7.27	12.86	32.00	8.47
No. of primary branches plant <sup>-1</sup>	3.34	24.18	2.17-4.73	2.17	14.85	28.38	27.40	16.13
	13.71	13.28	9.70-17.80	1.83	14.45	19.62	54.20	21.88
No. of pods plant <sup>-1</sup>	20.40	39.29	6.03-43.33	7.18	49.02	62.83	68.90	78.81
	53.50	33.41	20.30-115.90	5.70	49.81	59.98	69.00	85.12
Days to 50% flowering	46.10	4.99	36.67-51.33	1.39	8.47	9.84	74.20	15.02
	64.34	5.62	55.67-70.33	1.26	4.61	7.27	40.20	6.01
Days to maturity	86.52	3.02	75.33-94.00	1.24	4.92	5.78	76.60	8.64
	104.87	2.50	97.33-110.67	1.13	3.56	4.35	66.80	5.98
Grain yield per plot	355.27	32.87	81.67-580.00	7.10	36.12	53.07	46.30	50.65
	395.85	19.73	250.00-613.33	2.45	18.23	26.87	46.00	25.47

following Burton (1952), Burton and De Vane (1953) and Johnson *et al.* (1955), respectively. Direct and indirect effects of correlation coefficients were estimated following Dewey and Lu (1959).

## Results and Discussion

### Weather conditions

The cropping seasons of 1993 and 1994 were different in terms of total rainfall and the number of rainy days. During 1993, total rainfall was 292.2 mm, and the total rainy days were only 17 during June-October. There were 23, 29 and 27 dry days in July, August and September, respectively. Thus, it was a dry season, which considerably curtailed the crop maturity period. During 1994, higher rainfall of 543 mm was received, with 30 rainy days from 1 July to 23 September. Moreover, higher relative humidity (>90%), in association with poor sunshine (Ca 2.4 h per day) for a longer period (13 to 23 August), appeared to be more congenial for extension of vegetative growth period and the curtailment of the reproductive phase considerably. The 1994

season was, therefore, treated as wet, which is rare in arid climate.

### Variability

Compared with the wet year, the plants in dry year were smaller and flowered and matured earlier. However, the number of pods per plant and grain yield per plant were higher in the wet year. Although the range was narrow in the dry year, but the ratio of maximum to minimum value was higher than that in the wet year (Table 1).

The estimates of PCV for all the characters were, in general, higher than the corresponding estimates of GCV. This reflects a greater environmental influence on the expression of these characters. The estimates of GCV and PCV were lower in the wet year, which may be linked to higher magnitude of rainfall and relative humidity and the poor sunshine, which probably masked the expression of variability in this drought adapted crop. The GCV estimates were higher for number of pods plant<sup>-1</sup> and moderate for grain yield during both the seasons. Higher estimates of GCV are, how-

Table 2. Direct (bold) and indirect effects and correlation coefficients of component characters with grain yield in moth bean during 1993 (upper values) and 1994 (lower values)

Traits	Plant height	No. of primary branches/plant	No. of pods/plant	Days to 50% flowering	Days to maturity	Correlations with grain yield		
						Genotypic	Phenotypic	Error
Plant height	<b>-0.033</b>	0.316	-0.127	0.730	0.080	0.966	0.580*	0.294
	<b>-0.885</b>	0.170	-0.067	-0.038	0.163	0.544	-0.085	0.205
No. of primary branches/plant	-0.025	<b>0.412</b>	-0.169	0.695	0.069	0.983	0.301	-0.078
	-0.329	<b>0.458</b>	-0.077	0.078	-0.225	-0.178	-0.039	0.101
No. of pods/plant	-0.024	0.396	<b>-0.176</b>	0.406	0.046	0.649	0.393	0.106
	-0.141	0.323	<b>0.409</b>	0.163	0.013	0.904	0.038	0.223
Days to 50% flowering	-0.031	0.379	-0.092	<b>0.774</b>	0.095	0.928	0.625**	-0.080
	-0.074	-0.079	-0.039	<b>-0.454</b>	-0.005	-0.537	-0.423	-0.338
Days to maturity	-0.026	0.285	-0.081	0.736	<b>0.100</b>	0.820	0.622**	0.088
	0.312	0.222	0.003	-0.004	<b>-0.463</b>	-0.128	0.008	0.188

Residual effect, 1993; 0.4447 and 1994; 0.7378, respectively.

\*, \*\* Significant at 5% and 1% level of significance, respectively.

ever, reliable only if substantiated by higher estimates of heritability, which also provides a measure of genetic variation.

The broad sense heritability was higher for days to maturity (76%), days to flowering (74%) and number of pods plant<sup>-1</sup> (68%), during the dry year of 1993. Heritability for grain yield was low (46%) and high for number of pods plant<sup>-1</sup> (69%) over two years. A high genetic advance, expressed as per cent of control, coupled with high estimates of heritability, offers the most effective opportunity for selection. Number of pods plant<sup>-1</sup> had higher estimates of heritability and genetic advance over the years. This trait also had higher GCV estimates, hence due to presence of additive gene effects, it may be improved through direct selection. Tikka *et al.* (1977 and 1980) also reported higher estimates of heritability and genetic advance for number of pods plant<sup>-1</sup> in moth bean. Bhavsar and Birani (1989) also observed that pods plant<sup>-1</sup> was the most important yield component for selection and improvement for grain yield in moth bean. Estimates on heritability and genetic advance were lower for grain yield,

hence, its improvement through direct selection appears to be difficult.

#### Correlation coefficients

Grain yield showed significant positive association with plant height, days taken to 50% flowering and maturity, during dry season, at both genotypic and phenotypic levels. Thus, masking effect of environment on these associations was less. On the contrary, number of primary branches plant<sup>-1</sup>, and number of pods plants<sup>-1</sup>, with significant positive association with grain yield at the genotypic level only, represent high degree of masking effect of environment on these associations. Significant negative association of days taken to 50% flowering with grain yield during 1994, suggests that selection of early flowering strains of moth bean during favourable (wet) season would result in poor yield potential. Plant height and number of pods plant<sup>-1</sup> were characterized with stable significant positive association with grain yield over the seasons. Thus, selection of taller plants with higher number of pods plant<sup>-1</sup> may be effective in

selection of high yielding moth bean strains over the wet and dry seasons.

#### *Path coefficients*

Since, yield is influenced by many factors, selection based on single character, without taking into consideration the interaction between component characters, would be misleading. Therefore, genotypic correlations were partitioned into direct and indirect effects (Table 2). Significant correlation between plant height and grain yield during 1993, was mainly due to indirect effects via days to 50% flowering and number of primary branches plant<sup>-1</sup>. Thus, taller plants were early to flower and had more number of primary branches, leading to higher grain yield. During high rainfall year of 1994 also, the significant correlation of plant height with grain yield was indirectly through number of primary branches.

Significant positive association of primary branches with grain yield (0.983) was mainly due to indirect effect of days of 50% flowering and the direct effect of number of primary branches.

The significant positive association of number of pods plant<sup>-1</sup> with grain yield was principally due to indirect effects of almost equal magnitude of primary branches plant<sup>-1</sup> and days to 50% flowering during 1993. However, number of pods directly contributed to significant association with grain yield during 1994.

The cause of significant positive association of grain yield with days to 50% flowering and maturity was also mainly due to direct and indirect effects of the former during 1993.

Thus, induced variability, as represented by the mutant lines reflects high degree of heritability and expected genetic gain exploitable though selection for number of pods plant<sup>-1</sup>, irrespective of the dry or wet seasons.

Improvement of grain yield would, however, be more rewarding during dry season in comparison to that in wet season.

However, on the basis of correlation and path coefficient analysis, it appears that during soil moisture deficit situations as in 1993, number of days taken to 50% flowering or early partitioning, would be most vital component for yield improvement due to its maximum direct and indirect contribution through rest of the components. Under high soil moisture conditions of 1994, higher number of pods plant<sup>-1</sup> would seem to be an important trait for direct selection for yield acceleration programme in moth bean.

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