

Variability of Growth, Yield and Nutrient Concentration in Moth Bean (*Vigna aconitifolia* (Jacq) Marechal) on Arid Lands

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Abstract: Study on thirty diverse genotypes of moth bean [*Vigna aconitifolia* (Jacq) Marechal], conducted under arid conditions, revealed enormous genetic variability for grain yield and the concentration of P, K, Fe, Mg and Mn nutrients in above-ground plant parts at flowering. High estimates of broad sense heritability and genetic advance observed for P, K and Fe concentrations and grain yield suggested that these traits would respond to simple selection. Significant negative correlations of grain yield with flowering and maturity periods revealed the importance of short seasoned strains for arid lands. Significant positive association of Zn concentration with grain yield was mainly due to its maximum direct positive effect (2.415), whereas the significant positive correlation between P concentration and grain yield was possibly due to indirect effect via Zn concentration. Thus, concentrations of P and Zn appear crucial for moth bean in abrupt arid conditions.

Key words: Nutrients selection, heritability, genetic gain, direct effects.

Concentration of certain macro and micro-nutrients in crops at flowering greatly varies amongst the genotypes. Moreover, high nutrient concentration, particularly in drought-prone situations, reflects the relative uptake efficiency of a genotype with reference to particular nutrient (Jolley *et al.*, 1986; Yau and Thurling, 1987). Nutrient concentration/uptake in a genotype is a genetically controlled trait (Horst, 1987). Therefore, information on nature and extent of variability for nutrients concentrations, along with morphological traits, is important in base population before finalization of breeding programme.

A few but sketchy reports on the extent of variability, character associations and the cause and effect relations of their associations with yield are available on moth bean (Kharb *et al.*, 1987; Bhandari, 1990;

Kumar, 1996). However, published reports on the nutrient concentration in any of the arid legumes is not available. Hence, assessment of the nature and extent of variability, correlation coefficients and path coefficient analysis in respect of growth, yield and nutrient concentrations in 30 genotypes of moth bean in arid conditions was undertaken.

Materials and Methods

Thirty diversified genotypes of moth bean, consisting of stable mutants (M6 generation), viz., CMZ 18E, -32E, -38E, -99E (early and erect); -170, -225A (erect, unbranched and late), -95A, -65-B (ornamental type); -62, -66, -79, -199 (semi-spreading and medium maturity), other variable mutants, commercial cv. (Maru Moth-1, Jawala, Jadia and RMO-40), very late and bushy

strains from Gujarat (GMO-9102, -903, -9118) constituted the population for this study. The crop was planted on 24.7.95, under rainfed conditions without additional fertilizer application, in a randomized block design with three replications. Inter and intra-row spacings of 60 x 10 cm were adopted for each of the genotype so as to maintain equal plant density in each of the plots of 9.6 sq. m area. At flowering, 3 plants from each of the treatment plots were uprooted for dry matter and nutrients concentration (above-ground plant part) studies. The N and P contents were determined following Jackson (1967). Potassium and Ca concentrations were determined by flame photometer, whereas those of Mg, Mn, Cu, Fe and Zn by atomic absorption spectroscopy.

Data on days to flowering, maturity and grain yield, and on dry matter yield were assessed on whole plot and single plant basis, respectively. Data on all the thirteen traits were statistically analyzed and the estimates of genotypic (gcv) and phenotypic coefficient of variability (pcv), heritability in broad sense (h^2B) and genetic advance were computed following Burton (1952), Burton and De Vane (1953) and Johnson *et al.* (1955), respectively. Direct and indirect effects of the correlation coefficients were estimated following Dewey and Lu (1959).

Results and Discussion

Variability

Significant differences were recorded in all the traits (barring dry matter yield), revealing, thereby, existence of discrete vari-

ations among the genotypes for growth, yield and the concentration of all the nutrients studied (Table 1). Ratio on maximum: minimum range values were highest for P, followed by Mg and K concentration, and grain yield revealing, therefore, skewed distribution of range for these traits, whereas the same was almost uniformly distributed in both sides for Ca concentration and days to maturity. PCV estimates were, in general, higher than the corresponding GCV estimates, suggesting, therefore, environmental influence on the expression of GCV estimates. The latter were, however, higher for grain yield, and the concentration of P, K, Fe and Mg in plant body at flowering, therefore suggesting huge large genetic variability for these traits. Variability was limited for days to maturity and Ca concentration; and was moderate for rest of the traits. Higher GCV estimates are, however, reliable only if substantiated by higher estimates of heritability and genetic advance which also provide the measure of genetic variation (Johnson *et al.*, 1955).

Estimates on a broad sense heritability were, in general, high for the concentration of all the nutrients ($h^2B > 86\%$) and also days to maturity, flowering and grain yield (96.1, 93.3 and 77.9%, respectively). Heritability was, however, lowest for dry matter yield. Tikka *et al.* (1977) also reported high heritability for days to flowering, maturity and grain yield in moth bean. The concentration of P (89.8, 109.7%), K (92.1, 95.7%) and Fe (86.0, 70.8%) and the grain yield (77.9, 81.8%) had appreciable estimates of heritability and genetic advance. These traits were also characterized by higher estimates of GCV. Hence, these traits, due probably to depicting additive gene

Table 1. Parameters of genetic variations of growth traits, grain yield and the concentration of certain nutrients at flowering in moth bean

Traits/ elements	Mean	Range	Significance	CV (%)	Ratio of range	GCV (%)	PCV (%)	h ² B (%)	GA as % of mean
Days to flowering	39.74	26-55	**	2.29	2.11	17.50	17.69	93.3	38.8
Days to maturity	74.07	65-96	**	1.92	1.47	9.50	9.72	96.1	19.2
Grain yield (kg ha ⁻¹)	425.53	156.3-857.0	**	23.96	5.48	45.00	50.99	77.9	81.8
Dry matter yield (g plant ⁻¹)	16.38	8.3-30.0	NS	39.57	3.61	15.78	43.70	13.70	83.6
N (mg g ⁻¹)	20.06	14.3-39.0	**	2.27	2.72	24.01	24.16	99.1	49.7
P (mg g ⁻¹)	1.13	0.2-1.6	**	18.83	8.00	56.00	59.09	89.8	109.7
K (mg g ⁻¹)	21.39	11.6-52.8	**	14.21	4.55	48.45	50.49	92.1	95.7
Ca (mg g ⁻¹)	12.54	9.7-15.8	**	2.22	1.62	13.92	14.08	97.5	28.3
Mg (mg g ⁻¹)	5.91	2.7-12.4	**	6.35	4.59	36.31	36.89	97.0	43.9
Cu (µg g ⁻¹)	20.93	11.1-28.5	**	3.42	2.56	27.42	27.63	98.5	56.0
Fe (µg g ⁻¹)	659.58	242.3-1352.0	**	14.96	5.57	37.11	40.01	86.0	70.8
Mn (µg g ⁻¹)	78.43	63.0-181.3	**	6.52	2.87	26.92	27.75	94.5	54.0
Zn (µg g ⁻¹)	75.29	52.9-152.1	**	8.07	2.87	23.80	25.19	89.7	45.6

** Significant at 0.01.

effects for their expression, offer the possibility of improvement through simple selection. Concentration of P, with poor availability in arid soils, has ample opportunity for its genetic improvement.

Correlation coefficients

Associations between the traits pertaining to nutrient concentration were, however, of almost the similar magnitude at genotypic and phenotypic levels, suggesting therefore, less masking effects of environment on their expression (Table 2).

Grain yield exhibited significant negative association with days taken to flowering and maturity, therefore, suggesting that genotypes with short duration could give high yields under arid conditions, confirm-

ing findings of Kumar (1996). Grain yield also had significant positive association with P and Zn concentrations. However, significant positive association between days to flowering and maturity suggested that selecting an early flowering genotype could lead to the selection of early maturing strains. Mn concentration showed significant positive association with other nutrients, viz., P, Cu and Fe. Similarly, Zn concentration was found to have high degree of significant positive associations with the concentrations of Cu, Fe and Mn. Correlation studies, therefore, lead us to conclude that supply of P and Zn are essential for moth bean as their high concentration not only ensure higher yield but also the higher concentration of other nutrients like Fe, Mn and Cu in plant body.

Table 2. Genotypic (upper) and phenotypic (lower values) correlation coefficients between growth traits, grain yield and the concentration of certain nutrients at flowering in moth bean

	Dry matter yield	Days to flowering	Days to maturity	N	P	K	Ca	Mg	Cu	Fe	Mn	Zn
	1	2	3	4	5	6	7	8	9	10	11	12
1	0.013 0.020	-0.606* -0.532*	-0.629* -0.538*	0.083 0.069	0.527* 0.595	-0.304 -0.230	0.140 0.117	0.213 0.198	-0.159 -0.135	0.144 0.137	-0.006 0.015	0.543* 0.613*
2	-	0.330 -0.104	-0.290 -0.080	0.133 0.078	-0.391 -0.075	0.090 0.074	-0.238 -0.096	-0.167 -0.049	-0.575* -0.207	-0.233 -0.095	-0.569* -0.196	-0.483 -0.167
3	-	-	0.718** 0.701	0.074 0.073	-0.297 -0.284	-0.055 -0.043	0.123 0.117	0.243 0.235	-0.047 -0.047	-0.016 -0.020	-0.023 -0.027	-0.314 -0.295
4	-	-	-	0.286 0.280	-0.158 -0.145	-0.243 -0.220	0.152 0.144	0.068 0.064	-0.012 -0.010	0.203 0.181	-0.006 0.004	-0.137 -0.118
5	-	-	-	-	0.139 0.134	-0.452 -0.435	0.164 0.159	0.086 0.086	0.187 -0.186	0.054 0.048	-0.042 -0.044	0.092 0.082
6	-	-	-	-	-	-0.093 -0.093	0.342 0.315	0.363 0.351	0.410 0.393	0.570* 0.501	0.767** 0.750**	0.912** 0.820**
7	-	-	-	-	-	-	-0.402 -0.381	-0.113 -0.109	0.174 0.170	-0.015 -0.156	0.078 0.075	-0.068 -0.061
8	-	-	-	-	-	-	-	-0.092 -0.084	0.197 0.194	0.282 0.281	0.179 0.176	0.420 0.410
9	-	-	-	-	-	-	-	-	-0.127 -0.117	0.241 0.225	0.218 0.217	0.149 0.149
10	-	-	-	-	-	-	-	-	-	0.474 0.441	0.703** 0.701**	0.506* 0.497
11	-	-	-	-	-	-	-	-	-	-	0.633** 0.596*	0.617** 0.577**
12	-	-	-	-	-	-	-	-	-	-	-	0.789** 0.791**

* P = 0.05, ** P = 0.01.

Path coefficients

Among the growth characters, dry matter yield had the maximum direct positive effect on grain yield. Significant positive association of grain yield with P concentration was due to direct effect of P (0.184) and also the indirect effects of Zn concentration (2.201) on yields. However, direct effect of Zn (2.415) was mainly responsible for its association with grain yield. Besides, maximum direct positive effect of Zn con-

centration on grain yield, other nutrients, viz., P (2.201), Mn (1.906), Fe (1.489), Cu (1.222) and Ca (1.014) also influenced it indirectly via Zn concentration (Table 3).

Nutrients concentration in plant body which may relate to their uptake, are known to depend on their needs by a genotype for its immediate adjustment, growth and finally the production potential under abrupt situations. Thus, desired concentration of

Table 3. Direct (underlined) and indirect effects of certain growth traits and the concentration of certain nutrients in moth bean

	Days to flowering	Days to maturity	Dry matter yield	N	P	K	Ca	Mg	Cu	Fe	Mn	Zn
Days to flowering	<u>0.948</u>	-0.311	-0.478	-0.044	0.054	0.012	-0.057	0.081	-0.036	0.009	0.025	-0.757
Days to maturity	0.680	<u>-0.433</u>	-0.419	-0.170	0.029	0.052	-0.070	0.023	-0.009	-0.114	0.005	-0.331
Dry matter yield	-0.313	0.125	<u>1.448</u>	-0.079	0.072	-0.19	0.109	-0.055	-0.440	0.131	0.470	-1.167
N	0.070	0.124	0.192	<u>-0.524</u>	-0.026	0.096	-0.075	0.028	0.143	-0.030	0.034	0.223
P	-0.282	0.068	-0.567	-0.083	<u>-0.184</u>	0.020	-0.120	0.120	0.313	-0.320	-0.633	2.202
K	-0.052	0.105	0.131	0.269	0.017	<u>-0.212</u>	0.184	-0.037	0.087	-0.064	-0.064	-0.163
Ca	0.117	-0.066	-0.345	-0.098	-0.063	0.085	<u>-0.458</u>	-0.031	0.150	-0.158	1.148	1.014
Mg	0.231	-0.030	-0.242	-0.051	-0.051	-0.067	0.024	<u>0.331</u>	-0.097	-0.135	-0.180	0.360
Cu	-0.044	0.005	-0.833	0.111	-0.075	-0.038	-0.090	-0.042	<u>0.764</u>	-0.266	-0.580	1.222
Fe	-0.015	-0.088	-0.338	-0.032	-0.105	0.033	-0.129	0.080	0.362	<u>-0.561</u>	-0.522	1.489
Mn	-0.029	0.003	-0.825	0.025	-0.141	-0.017	-0.082	0.072	0.537	-0.355	<u>-0.825</u>	1.906
Zn	-0.297	0.059	-0.700	-0.055	-0.167	0.014	-0.192	0.048	0.387	-0.346	-0.651	<u>2.415</u>

Residual effect, 0.6652.

P might have ensured the supply/uptake of other nutrients including P to the plants. In moth bean, therefore, association of P and Zn concentration with grain yield at the active growth stage (30-40 days of planting) may help isolate high yielding genotypes under abrupt drought conditions. Furthermore, grain yield and P concentrations showing additive gene effects for their expression, are likely to be improved through selection. Other nutrients, viz., K, Fe and Cu may also respond to simple selection under existing conditions.

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