ESTIMATES OF GENOTYPIC AND PHENOTYPIC VARIABILITY IN SRI LANKAN WINGED BEAN (Psophocarpus tetragonolobus (L) DC) Germplasm

I.P. WICKREMASINGHE

Department of Agricultural Biology
Faculty of Agriculture
University of Peradeniya

and

D.T. MATHES

Coconut Research Institute, Lunuwila.

SUMMARY

The improvement and effectiveness of selection of crops is dependant upon the magnitude of the variability present in the material and the extent to which the desirable characters are heritable. Hence a knowledge of the estimates of phenotypic and genotypic variability, heritability and genetic advance would help a breeder in selecting suitable methods for breeding. Selection for yield alone may not be very effective. It is suggested that the heritability estimates together with genetic advance would give a better picture of the amount of advance to be expected from selection (johnson et. al, 1955).

INTRODUCTION

Little or no attention has been given to study the range of variability found in local winged bean germplasm of winged bean. Thus one the objectives of the present investigation was to estimate genotypic and phenotypic variabilities, heritability and genetic advance in locally collected winged bean material for the future improvement of the crop.

Table 1: Details of the Collection of the Local Winged Bean Accessions

Accession Number	Source of Collection Distict	Village
SLS 1	Puttalam	Thabbowa
SLS 3	Jaffna	Tholpuram
SLS 6	Kegalle	Warakapola
SLS 7	Colombo	Colombo
SLS 8	Nuwara-Eliya	Karaliyadda
SLS 11	Kandy	Peradeniya
SLS 18	Polonnaruwa	Minneriya
SLS 20	Kandy	Kandy city
SLS 23	Nuwara-Eliya	Rikillagaskada
SLS 29	Galle	Waragoda
SLS 37	Colombo	Mirigama
SLS 40	galle	Waragoda
SLS 41	Kandy	Ratemulla
SLS 44	Kandy	Lewella
SLS 47	Kandy	Hataraliyadda
SLS 52	Colombo	Maharagama
SLS 55	Colombo	Maharagama
SLS 56	Galle	Kattiyagoda
SLS 57	Galle	Weligama
SLS 58	Galle	Kalahe
SLS 59	Galle	Kalahe
SLS 60	Galle	Kalahe
SLS 61	Galle	Kalahe
SLS 62	Galle	Kallhe
SLS 63	Galle	Kalahe
SLS 64	Galle	Maharambe
SLS 65	Galle	Maharambe
SLS 66	Matara	Sulthanagoda
SLS 67	Matara	Piladuwa
SLS 68	Hambantota	Thangalla
SLS 69	Matale	Thompawela
SLS 70	Matale	Ratalawewa
SLS 71	Matale	Welagedara
SLS 72	Matale	Bambewa
SLS 73	Matale	Galewela
SLS 74	Anuradhapura	Katukulam

SLS 75	Jaffna	Malape
SLS 76	Jaffna	Chunnakam
SLS 77	Jaffna	Chunnakam
SLS 78	Jaffna	Alaeddy West
SLS 79	Tricomalee	Urathauram
SLS 80	Vavuniya	Vavuniya
SLS 81	Puttalam	Sirigampola
SLS 82	Puttalam	Dumkannawa
SLS 83	Gampaha	Devuldeniya
SLS 84	Kurunegala	Giriulla
SLS 85	Kurunegala	Athuruwela
SLS 86	Gampha	Nittambuwa
SLS 87	Kurunegala	Kuliyapitiya
SLS 88	Kandy	Kandekumbura
SLS 89	Kandy	Barigama
SLS 90	Kegalle	Yatiyantota
SLS 91	Kegalle	Karawanella
SLS 92	Kegalle	Dehiowita
SLS 93	Ratnapura	Eheliyagoda
SLS 94	Kegalle	Ruwanwella
SLS 95	Kegalle	Atala
SLS 96	Kegalle	Galigamuwa
SLS 98	Gampaha	Watupitimulla
SLS 99	Gampaha	Ja-Ela
SLS 100	Matale	Ukuwela
SLS 101	Matale	Mahawela
SLS 102	Kandy	Bokkawela
SLS 103	Gampaha	Kotugoda
SLS 104	Trincomalee	Akbopura
SLS 105	Trincomalee	Kantale
SLS 106	Trincomalee	Pankulam
SLS 107	Trincomalee	Morawewa North
SLS 109	Anuradhapura	Horowpatana
SLS 111	Trincomalee	Kantale
SLS 112	Trincomalee	Kantale
SLS 113	Trincomalee	Kantale
SLS 114	Anuradhapura	Tibbotuwewa
SLS 115	Polonnaruwa	Minneriya
SLS 116	Polonnaruwa	Giritale
SLS 117	Polonnaruwa	Jayanthipura
SLS 118	Polonnaruwa	Jayanthipura
SLS 119	Polonnaruwa	Jayanthipura
SLS 120	Polonnaruwa	Jayanthipura

SLS 121	Polonnaruwa	Giridamana
SLS 122	Batticaloa	Periyapillumale
SLS 124	Ampara	Kekirihena
SLS 125	Ampara	Padiyatalawa
SLS 126	Badulla	Wewatta
SLS 127	Badulla	Dambana
SLS 129	Badulla	Mahiyanganaya
SLS 130	Badulla	Mahiyanganaya
SLS 131	Badulla	Peragasyaya
SLS 132	Badulla	Uduwewa
SLS 133	Hambantota	Magama
SLS 134	Hambantota	Tissamaharamaya
SLS 135	Hambantota	Lunugamwehehera
SLS 136	Moneragala	Wellawaya
SLS 137	Moneragala	Anapallama
SLS 138	Moneragala	Buttala
SLS 139	Moneragala	Karandagolla
SLS 140	Nuwara-Eliya	Walapane
SLS 142	Nuwara-Eliya	Padiyapalella
SLS 144	Kandy	Talatuoya
SLS 145	Kalutara	Pinwatta
SLS 146	Kalutara	Nagada

MATERIALS AND METHODS

Series of germplasm evaluation experiments were carried out at three different locations and for two seasons at each location. The locations were Mahaillupallama, Dodangolla and Gannoruwa. The two seasons were Yala and Maha, the two major cropping seasons in Sri Lanka. The evaluation of the varieties x locations was presented elsewhere (Wickramasinghe et.al, 1988). Due to the similarity of the estimates for each of the six experiments, only results obtained from the experiment at Mahaillupallama for the Maha season were used in this study. The experimental material consisted of 101 accessions of winged bean. These were grown in a randomized block design with 3 replicates (Table 1).

The following observations were used for the purpose of the present evaluation; seed yield, total dry matter production, leaf dry weight, stem dry weights, leaf area, 100 seed weight, length of pods and number of seeds/pod. Two samples were taken at intervals of 30 and 70 days after planting stem dry weights and leaf area.

STATISTICAL PROCEDURE

A variance analysis for each variable and the estimates of mean squares take the form as shown in table 2.

Table 2. Analysis of Variance and Estimates of Mean Squares

Source of Variation	d.f	M.S.	Expectation of M.S.
Replicates	(r-1)	M1	
Accessions	(r-1)	M2	$\sigma_e^2+r\sigma_g^2$
Error	(r-1)(v-1)	M3	σ_e^2

Where, σ_e^2 and σ_g^2 are the environmental and genotypic variances respectively of Number of genotypes and r number of replicates.

On the basis of table (2). Phenotypic(σ_p^2), genotypic (σ_g^2) variances, heritability (H) and genetic advance (GA) are calculated as follows,

Genotypic variance $(\sigma_g^2) = (M2-M3)/r$

Phenotypic variance $(\sigma_p^2) = \sigma_g^2+\sigma_e^2$ where $\sigma_e^2=M3$

Phenotypic coefficient of variation $(PCV) = (\sqrt{\sigma_p^2}/\overline{X}) x100$

Genotypic coefficient of variation $(GCV) = (\sqrt{\sigma_g^2}/\overline{X}) x100$

Heritability (H) = σ_g^2/σ_p^2

Genetic advance as suggested by Johnson et.al. (1955) is calculated using:

Genetic advance $GA = \frac{\sigma_g^2 K \sigma_p}{\sigma_p^2} = H.K.\sigma_p$

Genetic advance as a percentage of the mean $= \frac{GA}{\bar{x}} \times 100$

Where $\bar{x}$ is the general mean of a character and k the selection differential expressed in standard deviation units for the purpose of this paper, k was given value 2.06, as expected when the fraction selected was set at 5%.

RESULTS

Analysis of variance showed significant differences among the variance for 10 characters. No significant difference was indicated for no. of seeds per pod. The range, the general mean, standard error of the mean and the coefficient of variation are shown in Table 3. Comparatively low levels of variability was shown for all the characters except for stem dry weight (sample 1). The variability ranged from 9.4% to 35.6%. The value 35.6% being for stem dry weight (sample 1).

Table (4) show the phenotypic and genotypic components of variance, the coefficients of phenotypic and genotypic variability, heritability and genetic advance. In general phenotypic variation was higher than the genotypic variation for all the characters.

Total dry matter production and seed yield showed comparatively higher genotypic and phenotypic coefficients of variation than the other characters. The genotypic C of V for these two characters were 40.1% and 43.5% while phenotypic values were 41.2% and 45.0% respectively.

Heritability values were very high for total dry matter production and seed yield, having values 0.95

and 0.93 respectively. The other characters showing lower values.

A very high magnitude of genetic advance, expressed as a percentage of the mean was shown for total dry matter production (80.4%) and seed yield (86.6). Rest of the characters showed very low values. The two characters showed high genetic coefficient of variation too. This pattern was not true for leaf area (sample 1), leaf dry weight (sample 2), and stem dry weight, though the heritability values respectively were 0.72, 0.62 and 0.73, their genetic advance as a % of the mean were very low.

DISCUSSION

In a germplasm evaluation a number of characters are considered. The effectiveness of the evaluation will depend on the magnitude and variability in the material and the extent to which the characters are heritable. The aim of the present investigation was to obtain information on the heritability of various characters, genetic coefficient of variation and expected genetic advance of the Sri Lankan winged bean germplasm.

Though the characters such as leaf area (sample 2), leaf dry weight (sample 2) and stem dry weight (sample 2) showed high heritabilities, their values for genetic advances as a % of means were low. This indicate that there characters were conditioned by non additive gene effects hence they are not important to consider in a selection procedure.

In the present study very high heritability values were obtained for total dry matter production and seed yield (Table 4). The values were respectively 0.95 and 0.93. Comparatively higher but lower values were shown for leaf area (sample 2) . The values were 0.72, 0.62 and 0.73 respectively. All the other characters showed very low values for heritability.

Coupled with high heritability, total dry matter production and seed yield showed high values for genetic advances as a % of the mean. (Table 4) Thus as suggested by Johnson et. al. (1955) the two characters, total dry matter production and seed yield should be effective in plant selection and improvement.

Also it could be reasonably stated that the magnitude of heritability estimates is influenced by the variability between the populations, influence of the prevailing environmental conditions on a particular character and the method used in the estimation. Thus the estimate of the heritability obtained in a particular experiment, will be valid under the conditions of that experiment.

Thus a question might arise as to its wide application. However, if a number of estimates for a certain character were made under different environmental conditions, a general idea could be formulated as to the range and its magnitude for the character. Such evaluations were carried out for all the six experiments under this study. (Table 5) shows the values for PCV, GCV, H and GA as a % of mean for the two characters, total dry matter production and seed yield. For these two characters the heritability and the genetic advance as a % of the mean were very high for all the experiments, carried out under different environmental conditions. The consistencies of these values for the six experiments clearly indicate the effectiveness of using the total dry matter production and the seed yield in a programme of selection for improvement of the crop.

REFERENCES

Johnson, H.W. Robinson, H.F. and Comstock, R.F.(1955). Estimates of genetic and environmental variability in soybean. Agron. J. 47: 314-8

Wickremasinghe, I.P. & Mathes, D.T. (1988) Genotype-Environment Interactions in Winged bean (Phophocarpus tetragonolobus (L) DC). Sri Lanka journal of Agricultural Sciences. 25(1): 15-36.

Table 3. Phenotypic Variability for 11 Characters in 101 SLS Accessions of Winged Bean

Character	Range	General mean	S.E. of mean (+)	C.V. (%)	F values (var.ts)
Leaf area (Sample 1)	1861.2-5423.8	3356.5	465.2	19.3	2.84***
Leaf area (Sample 2)	4924.5-10760.5	7213.3	568.3	11.0	6.19***
Leaf dry wt. (Sample 1)	6.6 - 19.9	12.4	1.3	18.4	3.93***
Leaf dry wt. (Sample 2)	16.5 - 39.1	25.3	2.1	14.1	5.89***
Stem dry wt. (Sample 1)	8.5 - 39.2	14.8	3.1	35.6	1.43***
Stem dry wt. (Sample 2)	27.2 - 57.2	39.2	2.3	10.2	9.01***
Tot dry matter production	62.6 -1135.1	513.9	27.9	9.4	55.65***
Length of pods	14.7 - 24.2	19.7	1.5	13.5	1.11***
No. of seeds per pod	9.6 - 14.9	12.1	1.4	19.5	0.93
100 seed wt.	25.4 - 43.5	35.1	2.7	13.4	2.00
seed yield	31.9 - 556.6	234.2	15.5	11.5	44.07

**** Significant at p= 0.001

Table 4. Estimates of Phenotypic & Genotypic Variances, Phenotypic & Genotypic Coefficient of Variation Heritability (H) and Genetic Advance (G.A) for 11 Characters

Character	Variance		Phenotypic C.V.%	Genotypic C.V.%	H	G.A.	G. A. as % of mean
	Phenotypic	Genotypic					
Leaf area (sample1)	809126.3	388144.6	26.8	18.6	0.48	888.9	26.5
Leaf area (sample2)	2260500.1	1632132.8	20.8	17.7	0.72	2236.2	31.0
Leaf dry wt.(sample1)	10.3	5.1	25.9	18.2	0.49	3.3	26.4
Leaf dry wt.(sample2)	33.5	20.8	22.9	18.1	0.62	7.4	29.3
Stem dry wt.(sample1)	31.9	4.0	38.1	13.5	0.12	1.5	9.9
Stem dry wt.(sample2)	58.3	42.4	19.5	16.6	0.73	11.4	29.2
Total dry matter production	44743.9	42415.6	41.2	40.1	0.95	413.1	80.4
Length of pods	7.3	0.26	13.8	2.6	0.03	0.2	1.0
No.of seeds per pod	6.0	0.4	20.2	5.3	0.07	0.3	2.8
100 seed wt.	29.4	7.4	15.4	7.7	0.25	2.8	8.0
Seed yield	11103.1	10380.2	45.0	43.5	0.93	202.9	86.6

Table 5. Estimates of PCV, GCV, Heritability and Genetic Advance for Total Dry Matter Production and Seed Yield over the Six Experiments.

Character	Experiment	Phenotypic CV (%)	Genotypic CV (%)	Heritability	G.A. as a % of mean
Total dry matter production	1	41.2	40.1	0.95	80.4
	2	40.5	36.9	0.83	69.4
	3	44.9	44.3	0.97	90.0
	4	43.1	41.6	0.93	82.5
	5	48.3	47.7	0.97	97.2
	6	46.0	44.8	0.95	89.9
Seed yield	1	45.0	43.5	0.93	86.6
	2	44.4	39.8	0.80	73.4
	3	44.8	44.1	0.97	89.6
	4	43.0	40.5	0.88	78.4
	5	48.6	47.7	0.96	96.6
	6	46.4	45.1	0.94	90.3

Legend :

Exp. 1, 3, 5 - Maha Season
Exp. 2, 4, 6 - Yala Season
MI - Mahailluppallama
D - Dodangolla
G - Gannoruwwa