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Genetic variability in Indian spinach (*Basella alba* L.)

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ABSTRACT

Evaluation of eleven germplasm lines of the Indian spinach (basella) revealed maximum leaf weight/plant in IIHR-1 (160.5g), followed by IIHR-18 (111.6g) and IIHR-3 (98.3g). Results of genetic studies revealed that phenotypic coefficient of variation was higher than genotypic coefficient of variation for all the traits studied, indicating environmental influence on expression of these characters. Moderate heritability along with high genetic advance was recorded for leaf weight and total plant weight, indicating the presence of additive gene effects. Hence, selection can be employed for improvement of these characters in basella. Higher plant weight was found to be significantly and positively associated with branch number, leaf number, leaf weight and stem weight. Leaf number had the maximum direct positive effect on total plant weight, followed by leaf length. Indirect effects of other characters through these characters were also seen to be positive. Thus, for yield improvement in basella, emphasis may be laid on indirect selection through leaf characters like leaf number, leaf length and leaf weight.

Key words: *Basella alba*, Indian spinach, genetic variability, heritability, path analysis

INTRODUCTION

Basella (Indian Spinach) is an important leafy vegetable grown for its fleshy stem and leaves. The nutritive value of young shoots and leaves is very high in terms of minerals (Ca, Fe) and vitamins (A, B, C). Fresh tender leaves and stems are consumed as leafy vegetable upon cooking. Owing to the mucilaginous nature of its leaves and stems, it is also used as a poultice. The juice of leaves is prescribed as remedy for constipation, especially in children and pregnant women (Burkill, 1935). In spite of its nutritional significance, very little effort has been made to improve yield in this leafy vegetable.

Further, the local cultivars available are poor yielders. Therefore, for improvement of basella, IIHR, Bangalore collected germplasm from different districts of Karnataka under the Network Project on 'Improvement of Under Utilized Vegetable Crops' and used it in the present investigation.

Yield is a complex trait influenced by genetic factors interacting with environment. Success in any breeding programme for improvement depends on existing genetic variability in the base-population and on efficiency of selection. For successful selection, it is necessary to study the nature of association of the trait of interest with other relevant traits and, also the genetic variability available for these. Path coefficient provides a better index for selection than mere correlation coefficient, thereby separating the correlation coefficient of yield and its components into direct and indirect effects. Therefore, the present study was undertaken to understand the nature and magnitude of variability, heritability and correlation coefficients for different quantitative parameters in Indian Spinach. The information on such aspects can be of great help in formulating an appropriate breeding strategy for genetic upgradation of this under-utilized vegetable crop.

MATERIAL AND METHODS

The experiments were carried out at the Vegetable Farm, Indian Institute of Horticultural Research, Bangalore during summer of 2005 and 2006. Experiments were laid out in Randomized Block Design with eleven germplasm lines in three replications during both the years. The plot size of 2.0 m x 3.0 m consisted of 40 plants per replication. Four week old seedlings were planted at 50 cm x 30 cm

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spacing. Recommended agronomical practices were followed to raise the crop. Observations on various quantitative characters and on yield were recorded on ten randomly-selected plants from each replication viz., branch number, leaf number, leaf weight (g), stem weight (g), plant height (cm) and total yield per plant (g). Leaf characters like petiole length (cm), leaf length (cm) and leaf width (cm) were recorded in 10 leaves from the randomly selected plants under each replication.

Pooled data of two years were analyzed as per Panse and Sukhatme (1984) for analysis of variance. Phenotypic and genotypic coefficients of variation (PCV and GCV), heritability in broad-sense and genetic advance as percent of mean were calculated as per procedures given by Burton and De Vane (1953) and Johnson *et al* (1955). Correlation coefficient was worked out as per Al-Jibouri *et al* (1958) and path coefficient analysis done as per Dewey and Lu (1959).

RESULTS AND DISCUSSION

Means for various characters of these eleven germplasm lines of basella are presented in Table 1. Analysis of variance revealed significant difference among germplasm lines for all the traits studied. These differences indicated presence of a wide variability and considerable scope for improvement in basella. Maximum leaf weight was recorded in IIHR-1(160.55 g), followed by IIHR-18(111.66 g) and IIHR-3(98.33 g). Upon assessing yield stability through multi-location trials, these genotypes may be used for large-scale cultivation if found suiyable.

Estimates for various genetic parameters are presented in Table 2. Wide range of variation was observed in most of the characters like branch number (2.30-5.36), leaf number (15.33-40.56), leaf weight (34.16-160.55 g), stem weight (22.50-78.33 g) and total plant weight (68.50-260.43 g). Presence of this high variability for the above parameters can form basis for effective selection of superior

Table 1. Mean values of 11 genotypes for some quantitative parameters in *Basella*

Sl. No	Genotype	Branch number	Leaf number	Leaf weight (g)	Stem weight (g)	Plant height (cm)	Petiole length (cm)	Leaf length (cm)	Leaf breadth (cm)	Total plant weight (g)
1	IIHR- 1	5.36	36.76	160.50	78.33	23.17	1.53	10.64	8.16	260.43
2	IIHR- 2	4.46	30.80	83.34	63.00	40.36	2.79	11.22	6.76	162.50
3	IIHR- 3	4.62	29.56	98.30	56.94	19.67	2.21	11.70	8.28	177.33
4	IIHR- 4	5.00	33.76	95.83	69.16	40.63	2.64	11.50	6.84	214.16
5	IIHR- 7	2.30	17.38	45.50	36.36	26.66	1.92	9.91	7.16	101.16
6	IIHR- 8	3.83	21.00	70.83	39.58	19.33	1.97	10.28	7.97	160.83
7	IIHR- 9	3.73	28.76	54.30	40.33	34.90	2.25	10.25	6.55	124.16
8	IIHR- 10	3.01	15.33	57.39	23.83	21.95	1.85	10.74	7.24	106.33
9	IIHR- 11	3.91	18.25	34.16	22.50	21.16	2.50	8.89	5.50	68.50
10	IIHR- 13	4.00	25.26	58.33	33.30	40.81	2.34	11.10	7.75	91.66
11	IIHR- 18	4.56	40.56	111.67	70.83	29.26	1.46	10.18	7.70	185.00
	Mean	4.07	27.04	79.11	48.56	28.90	2.13	10.58	7.26	150.19
	Significance	**	**	**	**	**	**	**	**	**
	CD *(P=0.01)*	1.28	9.28	37.04	27.03	8.95	0.39	1.43	1.17	62.20
	C.V (%)	11.12	12.09	16.48	19.60	10.91	6.47	4.77	5.67	14.58

** Significant at $P=0.01$

Table 2. Means, coefficient of variation, heritability and genetic advance for some traits in *Basella*

Sl.No	Trait	Mean	Genotypic Variance (GV)	Phenotypic Variance (PV)	Genotypic Coefficient of Variation (GCV)	Phenotypic Coefficient of Variation (PCV)	Herita-bility(h^2)	Genetic Advance (GA)	G.A.as % mean
1	Branch number	4.07	0.56	1.79	18.45	32.86	31.53	0.87	21.34
2	Leaf number	27.04	58.66	122.75	28.32	40.97	47.78	10.91	40.33
3	Leaf weight (g)	79.11	1139.50	2159.84	42.66	58.74	52.76	50.51	63.84
4	Stem weight (g)	48.56	299.95	843.33	35.66	59.79	35.57	21.28	43.81
5	Plant height (cm)	28.90	67.04	126.71	28.32	38.94	52.91	12.27	42.44
6	Petiole length (cm)	2.13	0.16	0.28	19.07	24.80	59.18	0.65	30.23
7	Leaf length (cm)	10.58	0.39	1.91	5.92	13.08	20.54	0.59	5.53
8	Leaf breadth (cm)	7.26	0.51	1.53	9.88	17.03	33.65	0.86	11.80
9	Total plant weight (g)	150.19	2876.81	5753.09	35.71	50.50	50.00	78.12	52.02

Table 3. Genotypic (r_g) and phenotypic (r_p) correlation coefficient among various characters in *Basella*

Character		Branch number	Leaf number	Leaf weight	Stem weight	Plant height	Petiole length	Leaf length	Leaf breadth	Total plant weight
Branch	(r_g)	1.000	0.933**	0.877**	0.910**	0.146	0.013	0.468	0.269	0.843**
number	(r_p)	1.000	0.626*	0.627*	0.588	0.302	0.196	0.383	0.236	0.663*
Leaf	(r_g)		1.000	0.815**	0.963**	0.316	-0.277	0.394	0.319	0.790**
number	(r_p)		1.000	0.783**	0.827**	0.485	0.136	0.415	0.362	0.773*
Leaf	(r_g)			1.000	0.915**	-0.135	-0.541	0.505	0.710*	0.958**
weight	(r_p)			1.000	0.876**	0.207	-0.130	0.345	0.413	0.911**
Stem	(r_g)				1.000	0.174	-0.281	0.572	0.511	0.957**
weight	(r_p)				1.000	0.399	0.062	0.364	0.270	0.869**
Plant	(r_g)					1.000	0.558	0.464	-0.326	-0.075
height	(r_p)					1.000	0.480	0.315	-0.019	0.271
Petiole	(r_g)						1.000	0.198	-0.766*	-0.390-
length	(r_p)						1.000	0.309	-0.147	0.004
Leaf	(r_g)							1.000	0.440	0.524
length	(r_p)							1.000	0.689*	0.466
Leaf	(r_g)								1.000	0.564
breadth	(r_p)								1.000	0.486
Total plant	(r_g)									1.000
weight	(r_p)									1.000

** Significant at $P=0.01$, * Significant at $P=0.05$

lines in basella. The degree of variability shown by different parameters can be judged by the magnitude of GCV and PCV. GCV showed that the extent of genetic variability in the population ranged from 5.92 (leaf length) to 42.66 (leaf weight). Perusal of data in Table 2 shows a considerable difference between PCV and GCV values for all the characters studied. This indicates presence of greater environmental influence on expression of all these characters and selection may not be effective in improvement of basella. Further, GCV values were low in magnitude compared to PCV values for all the characters studied. This also indicates that direct selection is not effective in these characters and that heterosis breeding can be resorted to for further improvement. Similar observations were made by Rastogi *et al* (1995) in Chinese cabbage, which is a leafy vegetable.

With the help of GCV alone, it is not possible to determine the extent of heritable variation. Thus the estimates for heritability indicate effectiveness with which selection may be expected to exploit existing genetic variability. Broad-sense heritability was moderate for petiole length (59.91%), leaf weight (52.76%), plant height (52.91%) and total plant weight (50%) (Table 2). Similarly, moderate heritability for petiole length was reported earlier by Varalakshmi and Pratap Reddy (1997) in vegetable amaranth. Johnson *et al* (1955) reported heritability along with genetic advance to be more useful than heritability alone for predicting the resultant effect of selecting the best individual genotype, as, it suggests the presence of additive gene-effects. Moderate heritability along with high genetic advance was recorded by leaf weight and total plant weight, indicating presence of additive gene-effects. Selection can therefore be employed for improvement of these parameters in basella. Branch number, leaf number, stem weight, plant height, petiole length, leaf length and leaf breadth recorded moderate to low heritability and genetic advance. This suggests that environmental effects constitute a major part of total phenotypic variation and, hence, direct selection for these characters is likely to be less effective.

All possible correlation coefficients between total plant weight and its component characters were estimated at phenotypic (P) and genotypic (G) levels and are presented in Table 3. From these associations, it is seen that higher plant weight was significantly and positively associated with branch number, leaf number, leaf weight and stem weight. In the present investigation, interrelations among these parameters were also positive and significant. Leaf breadth exhibited positive and significant association with leaf weight, leaf length and negative, significant association with petiole length. This signifies that indirect selection for increased leaf breadth, leaf length and reduced petiole length is likely to improve leaf weight in basella. Similar positive and significant association of plant weight with leaf weight and stem weight was reported by Kader Mohideen and Muthukrishnan (1979) and Varalakshmi and Pratap Reddy (1997) in vegetable amaranth.

Though correlation analysis can quantify the degree of association between two characters, it does not provide reasons for such as association. Simple linear correlation

Table 4. Direct and indirect effects of various characters on total plant weight at the genotypic level in *Basella*

Character	Branch number	Leaf number	Leaf weight	Stem weight	Plant height	Petiole length	Leaf length	Leaf breadth	Genotypic correlation
Branch number	**-0.197**	1.880	-0.714	-0.473	-0.210	-0.008	0.823	-0.257	0.843**
Leaf number	-0.184	**2.015**	-0.664	-0.501	-0.455	0.192	0.693	-0.305	0.790**
Leaf weight	-0.173	1.642	**-0.815**	-0.476	0.195	0.375	0.889	-0.679	0.958**
Stem weight	-0.179	1.940	-0.745	**-0.520**	-0.251	0.194	1.007	-0.489	0.957**
Plant height	-0.028	0.636	0.110	-0.090	**-1.443**	-0.386	0.816	0.312	-0.075
Petiole length	-0.002	-0.558	0.441	0.146	-0.805	**-0.692**	0.347	0.733	-0.390
Leaf length	-0.092	0.793	-0.411	-0.297	-0.669	-0.136	**1.760**	-0.421	0.524
Leaf breadth	-0.053	0.643	-0.578	-0.265	0.470	0.530	0.774	**-0.957**	0.564

** Significant at $P=0.01$
Direct effects are shown in bold figures on the main diagonal

coefficient is designed to detect presence of linear association between two variables. It cannot be assumed to imply absence of functional relationship between the two variables. Path coefficient analysis resolves this mystery by breaking total correlation into components of direct and indirect effects. Therefore, path analysis was performed to assess direct and indirect effects of different characters on total plant weight (Table 4).

Leaf number had the maximum direct positive effect (2.015) on total plant weight, followed by leaf length (1.760). Indirect effects of other parameters through these parameters were also positive. Rest of the parameters, like, branch number, leaf weight, stem weight, plant height, petiole length and leaf breadth exhibited negative, direct effect on total plant weight and the indirect effects seen via these parameters were also negative. Thus, the positive direct and indirect effects of leaf number and leaf length led to significant and positive correlation with total plant weight. This indicates that positive selection for these parameters could contribute to higher leaf yields in basella.

In conclusion, it may be stated that for yield improvement in basella, emphasis may be laid on indirect selection through leaf parameters like leaf number, leaf length and leaf weight.

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REFERENCES

Al-Jibouri, H.H., Miller, P.A. and Robinson, H.F. 1958. Genotypic and environmental variances and covariances in upland cotton crosses of interspecific origin. *Agron. J.*, **50:**633-37

Burkill, I.H. 1935. A Dictionary of the Economic Products of the Malay Peninsula, Crown Agents, London

Burton, G.W. and De Vane, E.W. 1953. Estimating heritability in tall fescue (*Festuca arundinacea*) from replicated clonal material. *Agron. J.*, **45:**478-81

Dewey, D.R. and Lu, K.H. 1959. A correlation and path coefficient analysis of components of crested wheat grass seed production. *Agron. J.,* **51:**515-18

Johnson, H.W., Robinson, H.F. and Comstock, R.E. 1955. Estimates of genetic and environmental variability in soybean. *Agron. J.,* **47:**314-18

Kader Mohideen, M. and Muthukrishnan, C.R. 1979. Studies on correlation, multiple regression and path analysis as related to yields of vegetable amaranth (*Amaranthus tricolor*). Proc. 2nd Amaranth Conf. pp: 74-90. Rodale Press, Pennsylvania

Panse, V.G. and Sukhatme, P.V. 1984. Statistical Methods for Agricultural Workers. Indian Council of Agricultural Research, New Delhi

Rastogi, K.B., Korla, B.N., Joshi, A.K. and Thakar, M.C., 1995. Variability studies in Chinese cabbage (*Brassica chinensis* L.). *Adv. Hort. Forest*., **4:**101-107

Varalakshmi, B. and Pratap Reddy, V.V. 1997. Variability, heritability and correlation studies in vegetable amaranth. *Ind. J. Hort*., **54:**167-170

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