Environment & Ecology 29 (4) : 1860—1865, 2011
© Copyright by MKK Publication 2011 *ISSN 0970-0420*

Performance of Narrow Leaflet Genotypes and Genetic Variability in Segregating Generation of Soybean (*Glycine max* (L.) Merrill.)

B. SUJATA* AND G. T. BASAVARAJA

Department of Genetics & Plant Breeding, University of Agricultural Sciences
Dharwad, India
E-mail : suji_4140@yahoo.co.in
**Correspondence*

Abstract

The field experiments were conducted during *kharif* of 2006 to evaluate the performance of narrow leaflet genotypes for yield and its component traits and to analyze the extent of variability in F_3 segregating generation of cross JS-93-05 × JS-335 of soybean. In the experiment I, among the four narrow leaflet genotypes evaluated, Acc. No. 18A (DSb-12) recorded highest seed yield and exhibited significant superiority with respect to traits viz., pod length, days to maturity, number of seeds per plant and harvest index compared to best check JA-335. The analysis of variance and other genetic parameters indicated considerable genetic variability for different characters among the genotypes. In the experiment II, the population was classified based on leaflet shape viz., oval, ovate, lanceolate and linear leaflets. It was observed that considerable range of variation exhibited by all the four leaflet types. The characters viz., plant height, days to flowering, days to maturity, specific leaf weight, number of pods per plant, harvest index and 100 seed weight showed very narrow differences between phenotypic and genotypic coefficient of variation in all the four leaflet types. High heritability coupled with high genetic advance as percent of mean was observed for traits viz., number of pods per plant, specific leaf weight in oval, ovate and lanceolate leaflet types.

Key words : Soybean, Leaflet shape, Genetic variability, Segregating generation, Yield.

Soybean (*Glycine max* (L.) Merrill) is known as golden bean and miracle crop of 20th century. It is a versatile and fascinating crop with innumerable possibilities of not only improving agriculture but also supporting industries. Soybean besides having high yielding potential (40—45 q/ha) also provides high quality protein (40%) and cholesterol free oil (20%). The important states growing soybean are Madhya Pradesh, Maharashtra, Rajasthan, Karnataka and Andhra Pradesh. In India soybean has experienced a phenomenal growth in the area and production during the last two decades. Most soybean cultivars have broad or ovate leaflets. A few genotypes with distincty narrow leaflet shape have been identified. Leaflet shape is among the most diverse morphological traits of soybean (1). The two loci are reported to affect leaflet shape in soybean, Ln/In for ovate leaflet and narrow leaflet respectively (2). Leaflet shape has thus far been attributed to a single gene, it is considered as a qualitative trait and is not influenced by environment. In general association of a higher number of four-seeded pods with narrow leaflet is usually assumed to be a pleiotropic effect (3). Thus association and the altered canopy architecture, encouraged several plant breeders to introduce this trait into commercial cultivars. In addition, a number of studies have been conducted to more fully evaluate the effects of the narrow leaflet gene on agronomic traits. Importance of genetic variability in any breeding material is a pre-requisite as it provides not only a basis for selection but also some valuable information regarding selection of diverse parents for use in hybridization program. Thus improvement in any crop is based on the extent of genetic variation and the degree of improvement depends upon the magnitude of useful genetic variability. Hence, the present experiments were undertaken to evaluate the performance of narrow leaflet genotypes in respect of traits contributing yield and to evolve a classification system for leaflet shape and analyze the extent of variability present in

Table 1. Salient features of the parents used in study.

	Variety	Pedigree	Duration (days)	Yield potential (q/ha)	Salient features
1	JS-335	JS 78—77 × JS 71—05	85—90	25—35	Purple flowers, pubescence sparse or almost absent on stem, leaves and pods, yellow seed coat, semi determinate, tolerant to pod shattering up to 8—10 days after maturity, resistant to bacterial pustule and oval leaf shape
2	JS 93—05	Selection from PS 73—22	80—85	25—30	Purple flowers, absence of pubescence on stem leaves and pods, determinate, yellow seed coat, black hilum and lanceolate leaf shape

F_3 segregating generation of cross JS-93-05 × JS-335 of soybean.

Methods

The present investigations were carried out at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad during *kharif* of 2006. The experiment I, comprised of four narrow leaflet genotypes developed at AICRP on Soybean, University of Agricultural Sciences, Dharwad along with the three checks viz., JS-335, DSb-1 and JS 93-05. The experiment was laid out in a randomized complete block design with three replications. The entries were sown in 12 rows each of 5.0 m length with spacing of 30 cm between rows and 10 cm between the plants. The crop was raised as per the recommended package of practices. Observations were recorded on ten randomly selected plants for different characters. The parameters considered for the study were plant height (cm), number of branches, days to maturity, specific leaf weight (mg/cm^2), number of pods per plant, number of seeds per plant, pod length (cm), harvest index and seed yield (kg/ha). The genotypic and phenotypic coefficients of variation were computed as per (4) while the genetic advance was calculated as per (5). The experiment II, comprised of F_3 segregating generation of cross JS-93-05 × JS-335. The seeds of F_3 population was obtained from AICRP on Soybean, Main Agricultural Research Station, Dharwad and laid out in an unreplicated trial along with the parental lines. The population was sown in eleven rows of 5 m

Table 2. Performance of narrow leaflet genotypes for eleven traits in soybean. *Significant at 5% level and compared with best check JS-335. **Advanced breeding lines derived from JS-335 × PS 73-7.

	Genotypes	Plant height (cm)	No. of branches	Days to maturity	Specific leaf weight (mg/cm^2)	Pod length (cm)	No. of pods per plant	No. of seeds per plant	Oil (%)	100 seed weight (g)	Harvest index (%)	Seed yield (kg/ha)	Percent increase JS-335
1	Acc. No. 18A (DSb-12)**	51.33*	3.66	83.00*	4.28	4.55*	36.33	71.61*	18.03	13.43	60.02*	2578	12.70
2	Acc. No. 32A**	53.46*	3.06	89.00	3.58	4.66*	29.66	57.66	18.73	14.63	53.63	2335	2.10
3	Acc. No. 32**	51.70*	2.93	87.00	3.48	4.37	27.60	41.66	18.76	14.23	40.13	1888	0.20
4	Acc. No. 8**	58.20*	2.83	88.00	3.88	4.08	30.00	65.33	18.86	15.20	50.20	2483	8.60
5	JA 93-05 (C)	43.03	3.60	84.00	3.87	4.42	33.00	55.00	18.10	13.86	48.20	2199	–
6	DSb-1 (C)	68.53	3.66	92.00	2.79	2.78	38.00	61.60	19.16	13.60	52.03	2268	–
7	JS-335 (C)	46.66	3.26	87.00	3.52	3.77	35.00	63.30	18.43	14.46	53.56	2287	–
CV (%)		4.27	9.60	1.44	8.64	7.25	6.34	5.14	5.80	9.43	3.69	8.23	–
CD at 5%		4.03	0.99	2.24	1.42	0.61	3.70	5.44	1.76	2.36	3.39	336	–

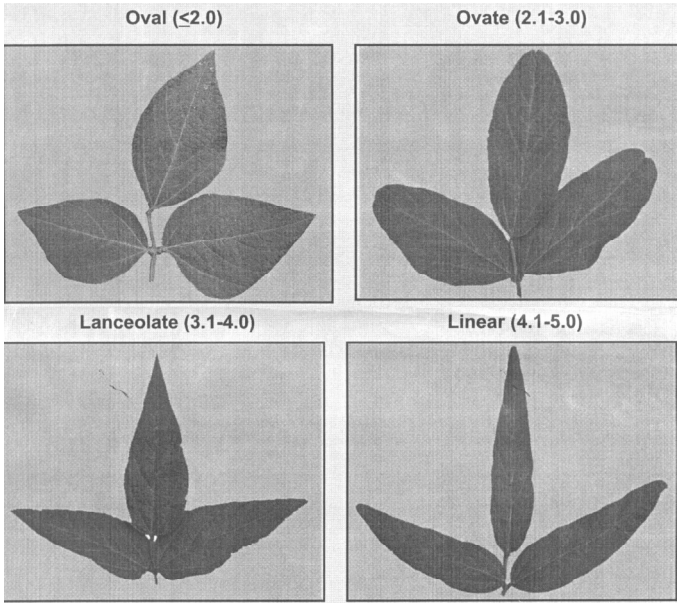

Figure 1. Classification of leaflet shape in soybean.

length, with a spacing of 30 cm between the rows and 10 cm between the plants. The salient features of the parents are given in Table 1 and within F_3 population, plants were classified based on their leaf shape. Observations were recorded on 150 plants of cross JS-93-05 × JS-335 and 20 plants of each parental lines.

Results and Discussion

Experiment I

The mean values for yield and its component traits for narrow leaflet genotypes along with checks are presented in Table 2. Among the four narrow leaflet genotypes evaluated, Acc. No. 18A (DSb-12) recorded highest seed yield (2578 kg/ha) followed by Acc. No. 8 (2483 kg/ha) and Acc. 32A (2335 kg/ha) compared to best check JS-335 (2287 kg/ha). Acc. No. 18A (DSb-12) recorded significant superiority with respect to traits viz., days to maturity (83.00 days), pod length (4.55 cm), number of seeds per plant (71.61) and harvest index (60.02%) compared to best check JS-335 (87.00 days, 3.77 cm, 63.30 and 53.56%, respectively). From the present study, it can be concluded that these characters might have contributed to the higher yield in narrow leflet genotype, Acc. No. 18A, (DSb-12).

The mean sum of squares due to various sources in narrow leaflet genotypes along with checks as depicted in Table 3 indicated highly significant variation among genotypes for all the characters except for number of branches.

The estimates depicting the genetic variability including mean, range, phenotypic coefficient of variation (PCV), genotypic coefficient of variation

Table 3. ANNOVA for nine traits in narrow leaflet genotypes of soybean.

	Characters	Sources of variation (df) Replication (02)	Genotypes (06)	SE ±	CD 5%
1	Plant height (cm)	2.66	211.22**	1.30	4.03
2	No. of branches	0.18	0.31*	0.20	0.99
3	Days to maturity	0.14	24.76**	0.72	2.24
4	Specific leaf weight (mg/cm^2)	0.28	0.64**	0.24	1.42
5	No. of pods per plant	5.33	45.52**	1.20	3.70
6	Pod length (cm)	0.94	1.27**	0.49	0.61
7	No. of seeds per plant	4.62	271.54**	1.76	5.44
8	Harvest index (%)	9.56	141.94**	1.10	3.39
9	Seed yield (kg/ha)	441.1	1576.51**	95.94	336.00

Table 4. Estimates of genetic variability parameters in narrow leaflet genotypes of soybean.

	Character	Range	Mean	PCV	GCV	h^2	GA	GAM
1	Plant height (cm)	43.00-68.00	53.13	16.17	15.59	93.03	30.98	30.98
2	No. of branches	2.80-3.60	3.24	12.75	8.38	43.20	11.41	11.41
3	Days to maturity	83.00-92.00	87.50	5.68	5.50	93.57	10.96	10.96
4	Specific leaf weight (mg/cm^2)	2.79-4.11	3.60	14.58	11.74	65.00	19.50	19.50
5	No. of pods per plant	27.60-38.00	32.76	29.58	28.89	95.39	58.13	58.13
6	Pod length (cm)	2.78-4.66	4.09	16.99	15.36	82.00	28.60	28.60
7	No. of seeds per plant	41.66-71.61	59.47	16.54	15.71	90.29	30.76	30.76
8	Harvest index (%)	40.00-63.00	51.75	13.62	13.11	92.68	26.01	26.01
9	Seed yield (kg/ha)	1888-2578	2291.42	11.62	9.08	61.08	14.60	14.60

(GCV), heritability (h^2), genetic advance and genetic advance as per cent of mean are presented in Table 4. It was observed that considerable range of variation was exhibited by the genotypes for all the traits. The maximum range of variation was observed for plant height, number of pods per plant, harvest index and seed yield. The results indicate that there is a scope for further improvement of these characters. Number of pods per plant exhibited high PCV and GCV. Moderate estimates of PCV and GCV were noticed for characters viz., plant height, specific leaf weight, pod length, number of seeds per plant and harvest index. The narrow differences between PCV and GCV indicated lesser sensitivity of these parameters to environmental influence. The expression of these attributes is more dependent on genetic factors and hence selection for these characters would be more effective. Similar results have been obtained for harvest index (6) and for plant height (7).

The heritability estimates ranged from 43.20% for number of branches to 95.00% for number of pods per plant. Heritability estimates in respect of plant height, days to maturity, specific leaf weight, pod length and harvest index were high ranging from 64.00 to 95.00%. High heritability is an indication of presence of higher proportion of fixable additive variance in the population. Heritability value is of much use to breeder, as it indicates the accuracy with which a genotype can be evaluated by its phenotypic expression.

The estimates of heritability when accompanied by genetic advance are more meaningful from the point of expected gain and type of selection method to be followed. High heritability coupled with high genetic advance was observed for number of pods per plant. Similar results were reported for number of pods per plant (8). The character number of branches showed moderate heritability with low genetic advance, there by indicating the expression of this character may be under non-additive gene action.

Experiment II

Sawada (9) proposed the leaflet shape index (ratio of leaflet length to width) to indicate leaflet shape. Later Chen and Nelson (10) reported five clusters generated by FASTCLUS procedure using length/width ratio. In the present study evolved a classification system based on FASTCLUS procedure (Table 5) and four leaflet types were identified presented in Figure 1.

The estimates depicting the genotypic variabil-

Table 5. Classification of leaflet shape based on cluster centroid by FASTCLUS procedure.

Parameter	Cross	Defined range	Class	Cluster centroid by FASTCLUS	No. of segregants observed
Length/width ratio	JS-93-05 × JS-335	a) < 2.0	Oval	1.6	59
		b) 2.1-3.0	Ovate	2.1	45
		c) 3.1-4.0	Lanceolate	3.2	40
		d) 4.1-5.0	Linear	4.2	06

Table 6. Genetic variability parameters in four leaflet types of cross JS 93-05 × JS-335.

Character	Oval leaflets Mean	PCV	GCV	h^2 (%)	GAM	Ovate leaflets Mean	PCV	GCV	h^2 (%)	GAM
1. Plant height (cm)	52.32 (30.10-68.0)	17.90	17.65	96.82	35.81	53.74 (37.00-74.00)	20.84	20.60	97.76	24.58
2. No. of branches	3.35 (2.00-4.00)	20.35	11.25	30.60	12.83	3.00 (2.00-4.00)	25.06	16.37	42.72	54.39
3. Days to flowering	38.69 (39.00-41.00)	3.33	02.62	61.81	4.23	38.40 (38.00-40.00)	3.32	3.12	61.02	6.58
4. Days to maturity	87.86 (88.00-90.00)	1.24	0.56	20.54	0.52	87.82 (86.00-90.00)	1.32	0.72	29.79	2.02
5. Leaf area index	2.42 (1.50-3.50)	22.00	19.58	79.17	35.95	2.67 (1.79-3.50)	17.01	14.37	71.33	71.90
6. Specific leaf weight (mg/cm^2)	4.13 (2.31-5.00)	20.87	19.39	86.31	37.04	3.80 (2.70-5.70)	23.29	21.73	87.07	70.38
7. No. of pods per plant	41.32 (20.00-67.00)	42.07	40.83	94.18	81.64	49.00 (25.00-74.00)	39.63	38.21	92.97	75.89
8. Pod length (cm)	3.92 (3.40-4.10)	6.25	2.35	14.17	1.81	3.68 (3.50-4.30)	6.28	1.15	3.36	0.44
9. Harvest index (%)	64.52 (36.00-72.00)	22.51	22.17	95.61	44.98	59.64 (43.00-71.00)	16.14	15.57	93.08	30.95
10. 100 seed weight (g)	15.51 (13.30-17.0)	11.74	10.47	79.54	19.25	16.47 (13.60-22.50)	16.91	16.15	91.25	31.79
11. Seed yield per plant (g)	11.68 (5.12-14.00)	50.41	46.21	84.04	87.27	12.90 (5.30-20.60)	33.38	25.11	56.58	38.91
	Lanceolateleaflets					**Linear leaflets**				
1. Plant height (cm)	55.94 (40.00-65.00)	18.19	17.95	97.29	21.78	49.68 (30.5-60.00)	17.79	19.50	97.10	23.81
2. No. of branches	3.50 (2.00-4.00)	17.84	7.36	17.03	27.87	2.83 (2.00-4.00)	24.25	13.59	31.44	47.11
3. Days to flowering	38.27 (37.00-40.00)	3.10	2.30	54.91	6.06	38.83 (37.00-40.00)	3.46	2.78	64.69	6.89
4. Days to maturity	87.75 (87.00-90.00)	1.20	0.44	13.94	1.52	88.00 (86.00-90.00)	1.46	0.95	42.70	2.46
5. Leaf area index	1.95 (1.50-2.80)	16.96	11.47	45.77	65.24	2.30 (1.63-2.98)	20.46	17.52	78.88	85.95
6. Specific leaf weight (mg/cm^2)	4.80 (3.90-5.70)	9.01	8.75	94.30	50.45	3.88 (2.41-5.00)	21.86	20.26	85.92	67.38
7. No. of pods per plant	40.50 (16.00-65.00)	39.46	38.23	93.85	76.31	23.50 (15.00-32.00)	20.34	11.98	34.71	14.54
8. Pod length (cm)	4.42 (4.32-5.10)	5.71	2.55	19.71	14.92	4.64 (4.20-5.30)	7.86	6.15	61.15	35.01
9. Harvest index (%)	56.57 (38.00-72.00)	18.57	17.49	88.75	33.95	55.00 (42.00-65.00)	14.12	12.58	79.43	23.10
10. 100 seed weight (g)	14.13 (8.17-20.10)	15.33	14.41	88.30	27.89	15.24 (12.00-18.48)	15.06	14.04	87.16	27.05
11. Seed yield per plant (g)	13.19 (3.98-22.40)	37.18	30.65	67.95	52.04	6.95 (4.40-9.50)	25.67	14.00	29.77	15.74

ity including mean, range, phenotypic coefficient of variation (PCV) genotypic coefficient of variation (GCV), heritability (h^2) and genetic advance as percent of mean in F_3 population of cross JS-93-05 × JS-335 of each leaflet types are presented in Table 6. All the leaflet types of cross JAS-93-05 × JS-335 exhibited wide range of variation for the traits viz., plant height, number of branches, days to flowering, days to maturity, leaf area index, specific leaf weight, number of pods per plant, pod length, harvest index, 100 seed weight and seed yield per plant. The results indicate that there is a scope for further improvement of

those characters.

In the present study oval leaflet types exhibited high PCV and GCV estimates for traits viz., number of pods per plant, harvest index and physiological parameters viz., leaf area index and specific leaf weight. Where as in both ovate and lanceolate leaflet types, characters viz., number of pods per plant and seed yield per plant recorded high estimated high estimates of PCV and GCV. This indicates the greater scope for selection to improve these characters. Similar findings were reported by Basavaraja (8) for number of pods per plant, Nirmala Kumari and Balasubramanian (11), for harvest index and Basavaraja (8) for seed yield per plant. Specific leaf weight indicates the leaf thickness which plays an important role in increasing photosynthetic efficiency. A wide variation in specific leaf weight over different growth phases of a plant was reported by Lugg and Sinclair (12).

Moderate estimates of PCV and GCV were noticed for characters viz., plant height and number of branches in oval leaflet types. In addition to these traits leaf area index and specific leaf weight showed moderate estimates of PCV and GCV in ovate leaflet types. The PCV and GCV estimates were moderate for traits viz., leaf area index and plant height in lanceolate leaflet types, whereas plant height, number of pods per plant harvest index and 100 seed weight in linear leaflet types. Similar results were reported for plant height and for 100 seed weight and harvest index (8). The narrow differences between PCV and GCV, indicating lesser sensitivity of these parameters to environmental influence.

The characters viz., days to flowering, days to maturity, 100 seed weight showed low PCV and GCV in all the four types of leaflet shapes. Similar results were obtained by Nirmala Kumari (11) for days to flowering, Agarwal et al. (13) for days to maturity and Basavaraja (8) for 100 seed weight. This suggests that there is a scope to enrich the variation for these characters.

The heritability estimates ranged from 3.36 percent for pod length in ovate leaflet types to 96.82% for plant height in oval leaflet types. High heritability is an indication of presence of higher proportion of fixable additive variance in the population. The estimates of heritability when accompanied by genetic advance as per cent of mean are more meaningful from the point of expected gain and types of selection method to be followed. High heritability coupled with high genetic advance as per cent of mean was observed for traits viz. number of pods per plant, specific leaf weight in oval, ovate and lanceolate leaflet types.

References

1. Dong Y. S., H. Sun, B. Zhuang and M. He. 1999. The genetic diversity in annual wild soybean. Pp. 147—155. *In Proc. World Soybean Res. Conf. IV,* Chicago, IL.
2. Bernard R. L. and M. G. Weiss. 1973. Quantitative genetics *In* B. E. Caldwell, (ed.) *Soybeans : Improvement, production and uses.*Am. Soc. Agron. Madison, WI. 117—154 pp.
3. Weiss M. G. 1970. Genetic linkage in soybeans. Linkage group IV. *Crop Sci.* 10 : 368—370.
4. Burton C. W. and E. H. Devane. 1953. Estimating heritability in tall Festuca (*Restuca arundinacae*) from replicated clonal material. *Agron. J.* 45 : 1476—1481.
5. Johnson H. W., H. P. Robinson and R. E. Comstock. 1955. Estimates of genetic and environmental variability in soybean. *Agron. J.* 47 : 314—318.
6. Perraju P., Y. Mishra, S. M. Sharma and M. L. Tawar. 1982. Correlated response in soybean. *Jawaharlal Nehru Krishi Vishwa Vidyalaya Res J.* 16 : 105—111.
7. Bangar N. D., G. R. Kukhekar, D. B. Lad and D. G. Mukhekar. 2003. Genetic variability, correlation and regression study in soybean. *J. Mah. Agric. Univ.* 28 : 320—321.
8. Basavaraja G. T. 2002. *Studies on induced mutagenesis in soybean (Glycine max*(L.) Merrill.). Ph.D. thesis. Univ. Agric. Sci., Dharwad, India.
9. Sawada S. 1988. Inheritance of leaflet shape in soybean Genet. *Newsl.* 15 : 61—65.
10. Chen Y. and R. L. Nelson. 2004. Evaluation and classification of leaflet shape and size in wild soybean. *Crop Sci.* 44 : 671—677.
11. Nirmala Kumari A. and M. Balasubramanian. 1993. Genetic variability in soybean. *Madras Agric. J.* 80 : 429–433.
12. Lugg D. G. and T. R. Sinclair. 1979. A survey of soybean cultivars for variability in specific leaf weight. *Crop Sci.* 19 : 882—897.
13. Agarwal A. P., S. A. Patil and P. M. Salimath. 2000. Identification of potential soybean genotypes for pod shattering resistance and seed yield. *Crop Improv.* 27 : 236—239.