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Evaluation of Soybean Genotypes at Coimbatore*

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Thirty one soybean cultivars were evaluated for eight agronomic characters at two locations for 6 seasons in Coimbatore. The genotype mean square in the pooled analysis significantly exceeded the mean squares for interaction of genotype x location and genotype x season for all the traits. On black loam soil the seed yield, number of pods, seeds and nodes and height were greater than on red sandy loam soil. Sowing done in May has resulted in maximum production of nodes, pods, seeds and seed yield under red sandy loam soil and has produced maximum seed yield, besides taking maximum number of days to mature under block loam soil. All the varieties holding the top 10 ranks on overall mean seed yield basis were of tropical origin. EC 7034 produced the highest seed yield/plant, number or seeds and pods and had the maximum height at maturity.

The availability of well-adapted cultivars with high yield potential for the successful cultivation needs no emphasis, especially for a new crop. The variations in yield level evidence in soybean types under different environments are mostly due to photoperiodic requirements (Weber, 1962). The photoperiodic sensitivity determines to a considerable degree, the area of adaptation and time of maturity of each cultivar. Hartwin (1970) has stressed the need for developing cultivars adapted for production under low-latitude areas. The present study on soybeans was, therefore, formulated for defining possibilities of adaptation to specific areas and planting dates of this photosensitive crop under Coimbatore (11° N latitude) conditions.

MATERIAL AND METHODS

Field experiments were conducted at the Central Farm (L 1) and Millets Breeding Station (L 2) of the Tamil Nadu Agricultural University, Coimbatore 31 ecogeographically and phenotypically diverse soybean (*Glycine max* (L.) Merrill) varieties were evaluated at the above two locations under 6 biomonthly sowings. Sowings were undertaken on 15 of September and November 1970. January, March, May and July 1971. Sowing dates were chosen to represent the range of environmental site at the Millets Breeding Station (L 2) had a red sandy loam soil of poor fertility with low sub-soil moisture supply and a critical level (ECe 1 8 mhos/cm) of soluble salt content of irrigation water. In con-

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trast, the soil at the experimental site in the Central Farm (L 1) was a black loam good native fertility having high available sub-soil moisture. The irrigation water had a negligible salt concentration (ECe 0.8 mhos/cm).

A randomized block design with two replications was used for each test. The varietal plot contained a single row of 25 plants spaced 20 cms. Rows were 60 cm apart. The plots were over planted and thinned in the seedling stage. A starter dose of 20 kg of N, 80 kg of P_2O_5 and 60 kg of k_2O/ha was placed in rows at the time of planting. The seeds were treated with peat-based commercial inoculum Nitragin before sowing.

Except for the character days to 50 per cent flowering, which was recorded on a plot basis, measurements for all other characters were taken on 10 random plants per plot in each test and the 10-plant mean was used as the plot value for the characters seed yield (g). number of seeds, pods and nodes, height (cm), days to first flowering and days to maturity.

RESULTS AND DISCUSSION

The pooled analysis of variance for 31 genotypes evaluated under six dates of sowing and two locations constituting 12 environments for eight agronomic characters is presented in Table I. Highly significant variances due to genotypes for all the characters under study indicated that the average performance of the genotypes in all tests were significantly different. Mean squares for genotype x location were also highly significant for all traits except days to 50 per cent flowering. Genotype x season interactions were significant for only four characters viz., days to first flowering, 50 per cent flowering and maturity and height at maturity, and genotype x season x location interactions for six of the eight characters evaluated exception of seed yield/plant and days taken to first flowering.

Mean yield of seed and seven other agronomic characteristics for each variety over seasons and locations are presented in Table II and the salient observations are summarised below:

Seed yield/plant : A range in variation from 22.68 g to 8.71 g was noticed with respect to seed yield. The highest seed yield was produced by the variety EC 7034 (CNS, Australia) which was statistically equalled by EC 39824 (Thailand), EC 39506 (Ringgit, Indonesia) and EC 14437 (Australia). Besides, EC 39822 (8-2, Thailand) also recorded significantly superior yield to the general mean. An overall average yield of 20.80 g was recorded on black loam soil (L1) compared to 7.03 g on red sandy loam soil (L2). The highest average yield of 25.99 g was produced under May planting, followed by 25.84 g in July and 22.62 g in September in L1 location (Table III). In L2 location also the highest yield of 9.22 g was recorded in May planting, followed by 8.60 g in January and 8.49 g in March.

Number of seeds/plant : The number of seeds/plant produced under the two locations was significantly different averaging 145.8 seeds in L1

TABLE I. Pooled analysis of variance for agronomic characters in soybean.

Source	d f	Mean sum of squares							
		Seed yield/ plant	Number of seeds	Number of pods	Number of nodes	Height at maturity	Days to first flowering	Days to 50% flowering	Days to maturity
Seasons (S)	5	742.40	45286.34	14623.16**	140.67**	940.01	68.82	84.57	927.8
Locations (P)	1	35228.77**	1534220.44	376474.52**	1177.29**	21648.63**	1.84	4.37	5967.0
Season X Locations (SP)	5	868.46**	38385.56**	9842.63**	11.35**	364.18*	28.18**	39.13**	937.2**
Replications in S and P	12	167.77	5395.60	1097.62	2.32	99.66	1.23	1.14	13.4
Genotypes (G)	30	355.02**	71793.11	18135.43**	389.12**	8786.32**	617.72**	639.47**	914.3**
Genotypes X Seasons (GS)	150	19.76	1210.12	318.52	3.59	98.18**	5.56**	5.76*	34.2**
Genotype X Locations (GP)	30	80.46**	14073.52**	3636.69**	16 21**	722.42**	3.81**	4.38	43.1**
Genotypes X Locations X Seasons (GPS)	150	20.73	1429.20*	236.65**	2.57**	46.85**	1.82	8.77**	1.6*
Error (Ge)	360	56.26	940.36	136.71	0.83	23.09	1.34	0.39	7.7
Total	743								

Ge : Mean square for genotype x replication in seasons and locations

* Significant at 5% level

** Significant at 1% level

TABLE II. Mean performance of 31 varieties for 8 traits over 2 locations 6 sowing dates and 2 replications

(Varieties in order of decreasing mean yield)

Varieties	Yield/ plant (g)	Number of seeds	Number of pods	Number of nodes	Height at maturity (cm)	first flowering	50% flowering	maturity
EC 7034	22.68	234.53	114.85	19.63	67.75	40.37	43.45	97.23
EC 39824	20.19	209.71	104.52	18.52	56.55	41.79	44.79	97.11
EC 39506	19.34	209.76	104.56	17.62	67.54	39.50	42.00	93.16
EC 14437	19.20	220.92	108.89	18.34	65.10	37.08	40.08	92.64
EC 39822	18.29	163.74	78.75	16.49	48.21	34.42	37.25	91.34
EC 39821	17.58	153.84	75.36	16.30	47.37	35.04	37.50	90.62
EC 14477	17.56	96.75	48.97	14.61	46.22	38.00	40.37	89.03
Hernon-49	17.28	127.15	63.02	18.32	66.59	34.25	37.20	98.69
EC 14475	17.05	181.01	81.85	17.81	60.57	32.83	35.45	91.36
EC 39800	16.49	174.65	89.91	19.98	60.91	48.33	51.75	109.76
Imp. Pelican	16.47	159.80	74.63	16.87	51.15	32.91	36.54	30.62
EC 27500	15.63	111.32	49.28	16.10	43.30	33.62	36.08	90.94
EC 14450	14.55	87.07	41.98	12.68	29.95	33.66	36.29	90.62
Hardee	14.10	96.27	47.58	12.19	24.40	33.50	35.95	89.05
EC 16111	13.35	128.28	58.52	14.58	39.32	32.91	35.62	83.38
EC 36895	13.18	113.18	59.04	16.59	65.48	34.66	37.45	85.79
Davis	12.70	84.65	39.40	10.87	22.41	31.00	33.83	88.44
Wilis	12.01	75.37	32.17	8.92	19.05	28.20	30.91	85.64
Hampton	11.87	62.05	30.73	9.20	19.77	27.79	30.12	83.54
Monetta	11.78	110.82	54.90	14.70	49.27	31.25	33.83	84.45
Bragg	10.88	71.82	32.80	9.27	25.20	28.29	30.66	83.64
Hill	10.87	84.51	37.24	10.55	24.32	31.91	34.08	83.98
EC 9311	10.73	64.52	33.31	8.84	16.88	28.20	30.62	88.46
Semmes	10.31	68.84	30.51	9.65	19.01	29.20	31.54	83.56
Masterpiece	10.24	78.87	38.46	11.97	28.06	27.41	30.16	82.98
Lee	9.95	64.74	27.90	8.20	15.80	28.04	30.54	83.26
Fickett	9.68	60.85	27.60	8.20	15.80	28.04	30.54	83.51
Norchief	9.65	60.35	28.30	9.00	17.42	28.62	31.41	82.79
D 60.9647	9.62	59.55	27.97	9.14	18.47	27.04	29.58	82.62
D 60.7965	9.49	60.57	28.34	9.24	18.66	27.37	29.70	82.17
Punjab-1	8.71	69.04	32.52	8.30	16.87	28.41	31.70	84.04
LSD 5%	4.35	72.30	35.47	0.53	10.46	0.65	0.36	1.53
Grand mean	13.92	114.34	54.94	13.32	37.73	32.68	35.35	88.53

TABLE III. Expersion of agronomic characters under different sowing dates and locations (Averaged over 2 replications and 31 varieties)

Characters/Locations		Sowing dates							
		Sep 70 I	Nov 70 II	Jan 71 III	Mar 71 IV	May 71 V	July 71 VI	C. D. 5%	Mean/ location
Seed yield /	L_1	22.62	18.27	16.53	15.44	25.99	25.84		20 80
plant (g)	L_2	6.70	3.99	8.60	8.49	9.22	5.21	2.72	7.03
Number of seeds/	L_1	158.31	130.72	145.98	132.77	157.23	202.05		145.78
plant	L_2	60.73	38.72	83.13	85.00	94.38	51.63	28.74	68.93
Number of pods	L_1	71.91	62.35	28.99	62.52	96.70	102.12		77.43
plant	L_2	29.60	19.45	36.08	37.92	45.75	25.85	15.27	32.44
Number of nodes/	L_1	14.41	12.79	13.68	14.95	15.42	16.22		14.58
plant	L_2	11.30	10.62	11.86	12.74	13.03	12.83	0.33	12.06
Height at maturity	L_1	44.68	38.43	42.65	41.09	45.37	46.55		43.12
(cm)	L_2	28.29	38.69	30.92	35.31	35.11	35.71	3.74	32.34
Days to first	L_1	32.32	33.90	31.83	31.33	33.50	33.46		32.72
flowering	L_2	32.51	33.70	33.14	31.74	32.35	32.30	0.41	32.62
Days to 50%	L_1	34.54	36.45	36.69	34.82	36.20	33.86		35.43
flowering	L_2	34.14	35.50	35.04	34.90	36.54	35.51	0.22	35.27
Days to maturity	L_1	89.98	88.16	83.93	93.66	97.72	94.72		91.36
	L_2	90.15	84.60	82.97	84.96	85.23	86.27	0.98	85.63

L_1 = Black loam soil of Central Farm

L_2 = Red sandy loam soil of Millets Breeding Station

location and 68.9 seeds in L2 location (Table III). July sowing produced the maximum of seeds (202.05) under L1 location and May sowing the highest (94.38) number of seeds under L2 location. The number of seeds in different varieties varied from 234.54 to 59.55 with EC 7034 producing the maximum number of seeds. This variety was statistically on a par with six varieties, EC 39800 (Dunfied, Nigeria) and EC 39822.

Number of pods/plant : On an average 77.4 pods were produced on black loam soil, compared to 32.4 pods on red sandy loam soil, under L1 location 102.1 pods were recorded in July, 96.7 in May and 71.9 in September sowing, while in L2 location 45.7 pods were produced in May sowing, 37.9 in March and 36.1 in January. A range in variation of 114.85 to 27.60 pods/plant was shown by the genotypes under study. EC 7034 which was statistically equalled by EC 14437, EC 39506, EC 39824, EC 39800 and EC 14475 (Sangalo, Australia) produced the highest number of pods/plant.

Number of nodes/plant: A range of 19.98 to 8.20 nodes was exhibited by the various types under study with EC 39800 and EC 7034 producing a high number of nodes. An average of 14.58 and 12.06 nodes/plant were produced in L1 and L2 locations, respectively,plants in black loam soil have recorded greater number of nodes under all the sowing dates.

Plant height at maturity : Plants from sowings made in black loam soil have averaged to a height of 43.1 cm, compared to 32.3 cm for those under red sandy loam soil (Table III). A wide variation of 67.75 cm to 15.80 cm was observed in respect of this attribute. EC 39800 and EC 14475 were not significantly different from the tallest variety EC 7034.

Days to first flowering: No significant difference between the two locations was revealed in September, November and March sowings. Under both L1 and L2 locations, sowings made in November have taken the longest duration of 33.9 and 33.7 days for first flowering, respectively. Variety D 60.9647 (USA) was the earliest to flower in 27.0 days and EC 39800 the latest in 48.3 days. In all, 13 varieties were later in duration for first flowering than the general mean, all of which with the exception of Hardee (USA) were of tropical or sub-tropical origin.

Days to 50% flowering : Except for that in March sowings, all the other seasons produced differential effect under the two test locations. The range in variation expressed with regard to this character has been 29.45 days for the earliest variety Lee (USA) to 51.75 days for the latest variety EC 39800 (Nigeria). Fourteen varieties including Improved Pelican and Hardee from USA have taken greater number of days to 50 per cent flowering than the general mean. Rest of the varieties of U.S. origin were early in flowering.

Days to maturity : In black loam soil the number of days taken for maturity was more under all the six seasons tested. Except for September and January sowings,all the other sowings have shown differential responses under the two test locations. Under L1 location, May sowing has resulted in significant lateness in maturity (97.72 days)' where as under the L2 location maximum delay in maturity was recorded for the sowing done in September (90.15). A range of 109.76 days to 82.17 days was observed for this character. The varieties EC 39800 (Nigeria) and D 60.7965(USA) were the latest and the earliest to mature, respectively. D 60.7965 was on a par in maturity with 9 other varieties, D 60.9647, Norchief, Masterpiece Lee, EC 16111, Pickett, Hampton, Semmes and Bragg, all with the exception of EC 16111 (China) having their origin in America.

Effect of locations : Invariably more seed yield, number of pods, seeds and nodes and plant height were produced on black loam soil of Central Farm, besides taking more number of days to maturity, than on red sandy-loam soil of Millets Breeding Station. Cartter and Hartwig (1963) have reported that soybeans are better adapted for production on clay than either Corn or Cotton

soils. The other probable reasons for low seed yield at the Millets Breeding Station could be poor native fertility, low moisture retention capacity and high soluble salt content of irrigation water. Sanbuich ond Gotoh (1969) have suggested that adaptability to site is mainly due to response to soil fertility.

Effect of seasons : Sowing done in May has resulted in maximum production of nodes, pods seeds and seed yield under red sandy loam soil. Under black loam soil also maximum seed yield was obtained besides taking the maximum number of days to mature with the same sowing date. The seed yield of May planting in the later location was not, however, significantly different to July planting. Besides. planting in July has also produced more number of seeds, pods and nodes and greater height. According to Cartter and Hartwig (1963) no single cultural factor is more important to soybean production than planting date. The effect of planting date was observed by Mooers (1908) who recognized that under southern U.S.A. conditions late May or June plantings would often produce the best yields,

Garner and Allard (1930) discussed the significance of day length in the flowering behaviour of soybeans and explained these phenomena as changes in day length accompanying changes in planting date From their studies of photoperiodic response of four soybean varieties in green house experiments, they observed that under a daily light exposure of 12 hrs or less all varieties became early maturing ones and there was little difference in the time required by the four varieties to reach the blooming stage. In the present investigation a maximum of 12 hrs and 30 mts day length was available for sowing on 15 July with the progressive decrease with subsequent sowings, whereby all the varieties were observed to flower within 45 days and there was a less than three days difference for average first flowering under different sowing dates. The U,S.A. varieties of maturity groups VI, VII and VIII were found to be early flowering and maturing like their counterparts in early maturity groups (0,I and II). Similar behaviour was experienced earlier in respect of elite U.S. varieties when tested under Coimbatore (11° N) conditions (Kaw and Menon, 1971).

In most evaluation studies the performance of genotypes averaged over environments is an important consideration for wide adaptation and stability of performance. Table II reveals that the varieties EC 7034, EC 39824, EC 39506, EC 14437, EC 39822, EC 39821, EC 14477, Hernon 49, EC 14475 and EC 39800 proved to be the 10 most adaptable types across 12 environments. According to Allard and Bradshaw (1964), the varieties which could maintain productivity at a high level in response to predictable and unpredictable transient fluctuations in environments would lead to stability in productivity. All the types that proved to be adapted and high yielding under Coimbatore agro-climatic conditions presently, were of tropical or sub-tropical origin. In general, cultivars adapted for production in the United States of America have given unsatisfactory results.

EC 7034 (CNS, Australia), a medium maturing variety which produced the

highest seed yield/plant, also produced the highest number of seeds and pods and had the maximum height at maturity' besides being the second last to flower and mature. The varteties EC 7034. EC 39822, EC 39824 and EC 39821 were earlier identified as promising medium to early maturing types with good yield potential (Kaw and Menon, 1971).

Before making any final varietal recommendations, the above findings, however, need to be confirmed undar solid plantings, since the yield data in the present investigation were based on space planted individual plants.

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