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1) Evaluation of soybean germplasm for stress tolerance and biological efficiency.

(1980 Soybean Regional Report on RR-3 Project)

OBJECTIVES:

1. To evaluate soybean germplasm and cultivars for stress tolerance toward:

a. Soil Acidity
(Tiwari, C. C., Igbokwe, P. E., Edung, S., and Russel, L. Alcorn State College, Mississippi)

Field experiments conducted on a silt loam soil with six cultivars under four pH ranges (5.9-6.7, 5.7-6.5, 5.3-6.0 and 5.0-5.6) indicated significant tolerance of 'Bedford' and 'Forrest' under acid soil pH ranges. The two cultivars were superior to 'Bragg', 'Braxton', 'Co-237', and 'Tracy M' in 1981 and 1982 trials. However, lowering of pH to 4.6-5.4, 4.5-5.4, 4.1-5.1, and 3.8-4.5 resulted in nullified seed formation in all the cultivars. All cultivars showed good foliage and growth, but only Bedford and Forrest showed indication of seed formation but never matured, in spite of delayed harvesting.

Results of greenhouse studies at soil pH 4.5 and 5 indicated that Bedford and Forrest contained more P, a contributing factor to superior resistance under acid conditions, compared with other cultivars (Table 1). It also seemed impractical to test for the resistance of soybean germplasm at soil pH below 5.

Findings from both the field and greenhouse, as well as laboratory trials have indicated two things that may be useful in future studies:

1) Acid tolerance of soybean germplasms should be evaluated at pH 5;
2) The P content of soybean plants harvested 38 days after germination may be helpful to the screening process of soybean germplasm.

b. Moisture Stress
(Singh, B. T., Fort Valley State College, Georgia)

Soybean genotypes were screened for water-stress tolerance in a split-plot experimental design with four replications. Irrigated and stress treatments were assigned main plots and the genotypes were assigned subplots. The stress water condition was induced by covering the plots with plastic. In two genotypes, FC 31649 and FC 31732, yields under irrigation and stress conditions were similar. Maximum yield reduction (57.1%) due to stress was observed in FC 31921. A summary of the results is given in Tables 2 and 3.

Table 1. P content in the different cultivars of soybean plants on two different soil pH of Memphis silt loam soil

Cultivars	P content in ppm	
	4.5 pH	5 pH
1. Bedford	1,300	1,300
2. Bragg	1,000	1,050
3. Braxton	1,050	1,250
4. Co-237	1,200	1,150
5. Forrest	1,300	1,300
6. Tracy M.	1,250	1,200

N.B. Bedford and Forrest, which showed the better resistance in the field, may have the ability to absorb P more efficiently, which may help in screening the soybean germplasm.

Table 2. Yield of 18 soybean genotypes under water stress and irrigation

Genotypes	Yield (kg/ha)		Genotypes	Yield (kg/ha)	
	Water stress	Irrigation		Water stress	Irrigation
Georgian	1,278	1,470	FC 31,921	1,119	2,033
FC 31,927	1,282	1,876	FC 31,707	1,463	1,943
Volstate	1,219	1,456	FC 30,967	1,479	2,063
FC 30,282	1,554	1,653	PI 79,861	1,145	2,028
FC 33,123	1,638	1,966	FC 31,732	1,893	1,901
PI 84,642	1,214	1,746	PI 71,570	944	1,393
FC 31,649	1,674	1,708	Creole	1,003	1,825
FC 31,622	1,441	2,260	PI 192,874	728	1,326
PI 84,967	1,138	1,709	Ransom	1,531	1,554

Table 3. ANOV for the yield of 18 genotypes under water stress and irrigation

Source of variation	D.F.	M.S.	F
Replication	3	1,642,709	15.50*
Water level	1	7,891,005	74.60**
Error a	3	105,766	
Genotypes	17	437,019	2.36**
Genotypes x water level	17	151,862	.82
Error b	102	185,152	

c. Pest and Diseases

(Rangappa, M., and Benepal, P. S., Virginia State University, Virginia)

A total of 1,273 soybean germplasm lines and 39 commercial varieties were screened for natural resistance to Mexican bean beetle (MBB) under field conditions. There were 421, 314, 266, 136, and 136 germplasm and varieties from maturity groups VI, VII, VIII, IX, and X, respectively.

An average of 1,000 laboratory-reared adult MBB per day were released uniformly over all the field throughout the growing season from May until September to create an adequate MBB infestation. However, due to the prolonged drought with high temperatures and humidity in 1983, the MBB population pressure did not develop as high as compared with 1982. Nevertheless, the population was adequate to separate the test plants into tolerant and susceptible lines. Selected tolerant lines are listed in Table 4 along with the lines that will be evaluated further during 1984 growing season.

In addition to the 1,273 germplasm lines and 39 commercial varieties screened, seven cultivars from USDA, Beltsville, and 89 lines of maturity group V were selected out of 1,352 screened in 1982. Among the 89 accessions selected in 1982, fifteen accessions were observed to have less than 20% overall leaf damage over two consecutive seasons of field evaluations (Table 5). Out of seven cultivars received from USDA, Beltsville, two were observed to be the best lines (Table 5). A total of 17 resistant lines tested will be evaluated further in the greenhouse during the winter months (Table 5).

(Pacumbaba, R. P. and Sapra, V. T., Alabama A&M University, AL)

Approximately 242 improved soybean lines were screened in the greenhouse and in the field for resistance to soybean cyst nematode (SCN) races 3 & 5 during the 1983 growing season. Of this group, 21 were identified resistant and 28 were identified tolerant. Ten resistant and 12 tolerant lines were rescreened and 9 lines (AM 1074-5,

Table 4. Soybean accessions tolerant to Mexican bean beetle that had less than 20% leaf damage in 1983 season

Code	Accession	Origin
	MATURITY GROUP VI	
164	388038	Taiwan
295	416781	Japan
323	417164	Japan
	MATURITY GROUP VII	
82	171451	Japan
199	299358	Japan
	MATURITY GROUP VIII	
13	Mamotan	Delta Branch Miss., Agr. Exp. Sta.
19	Yelnanda	Pedigreed Seed Co.
25	148259	Hawaii
58	200526	Japan
64	203400	Brazil
90	206258	Philippines
102	209837	India
119	240666	Philippines
128	259539	Brazil
151	397881	India
169	324068	Rhodesia
174	341252	Brazil
207	374185	India
230	417125	Japan
	COMMERCIAL VARIETIES	
4	Cocker-237	Cocker Seed Co.
18	Ransom	VPI
26	Shore	VPI
33	Late Giant Black Seeded	Japan

Table 5. Soybean accessions of Maturity Group VI tolerant to Mexican bean beetle that had less than 20% leaf damage in both 1982 and 1983 seasons

Code	Accession	Origin
35	81042	Japan
55	86078	Japan
80	96089	Korea
88	123440	Burma
108	159319	Korea
112	170899	South Africa
115	172902	Turkey
119	181554	Coffman Agr. Div. SCAP San Francisco
155	229339	Ministry of Agr. Tokyo
176	324924	Rhodesia
240	381670	Uganda
244	381675	Uganda
645	399095	Korea
1082	416981	Japan
1193	417419	Japan
	L-76-0132	Beltsville
	L-76-0049	Beltsville

AM 1081-3, D77-5169, D77-4809, D77-5161, ARD-18, D77-18, 'Centennial', and 'Foster') were identified resistant and 1 line (AM 1081-1) was tolerant to SCN races 3 & 5. Additional lines PI 90763 and Foster were identified resistant while 'Peking' and AM 1974-5 were tolerant to both Pms races 2 & 11 (phytophthora root rot of soybean) and to *Pseudomonas syringae* pv. *glycinea* (bacterial blight of soybean) (Table 6).

One hundred and ten new improved soybean germplasm also have been screened for resistance to SCN races 3 & 5 in the field. The results indicated that 11 and 22 lines were identified resistant and tolerant, repectively (Table 7). Screening of the first 48 lines of the 110 improved soybean lines in the greenhouse indicated that 3 lines (AM X-1026 P_{1a} 14-1, AM X-1026 P_{3a} 14-3, and AM X-1065 P_{21a} 15-1) were tolerant to SCN races 3 & 5. Forty-three lines initially were identifed resistant to Pms 2 & 11 (Table 8). Seven and 3 lines were resistant and tolerant, respectively, to *Pseudomonas syringae* pv. *glycinea*.

Table 6. Improved soybean lines screened and selected for multiple resistance against SCN Races 3 & 5, Phytophthora root rot, and bacterial blight in the greenhouse

Soybean cyst nematode		Phytophthora root rot		Bacterial blight	
Resistant lines	Tolerant lines	Resistant lines	Tolerant lines	Resistant lines	Tolerant lines
AM 1074-5	AM 1081-1	PI 90763	Peking	PI 90763	Peking
AM 1081-3	--	Foster	AM 1074-5	Foster	AM 1074-5
D77-5169					
D77-4809	Total - 1	Total - 2	Total - 2	Total - 2	Total - 2
D77-5161					
ARD 77 - 18					
D77 - 18					
Centennial					
Foster					

Table 7. Improved soybean lines screened and selected for resistance to soybean cyst nematode, Races 3 and 5

Soybean cyst nematode	
Resistant lines	Tolerant lines
AMX-1026 P_{2a} 14-2	AMX-1026 P_{1a} 14-1
AMX-1026 P_{3a} 14-3	AMX-1026 P_{4a} 14-4
AMX-1026 P_{9a} 14-9	AMX-1026 P_{5a} 14-5
AMX-1026 P_{15a} 14-15	AMX-1026 P_{8a} 14-8
AMX-1026 P_{18a} 14-18	AMX-1026 P_{12a} 14-12
AMX-1065 P_{27a} 15-F	AMX-1026 P_{13a} 14-13
AMS - 1002	AMX-1026 P_{16a} 14-16
AMS - 1003	AMX-1065 P_{24a} 15-4
AMS - 1004	AMX-1065 P_{26a} 15-6
AM5549-1012-3-1	AMX-1065 P_{28a} 15-8
P1040	AMX-1065 P_{29a} 15-9
Total - 11	AMX-1065 P_{32a} 15-12
	AMX-1066 P_{45a} 16-7
	AMS - 1001
	AMS - 1002
	AMS - 1003
	AMS - 1013
	AM50 PL006-3
	AM51 PL 00 6-4
	AM53 PL 060
	AM54 Puniform 119
	AM(49 x 1069 - 2 - 1)
	Total - 22

Table 8. Improved soybean lines screened and selected for resistance to SCN Races 3 and 5 Phytophthora root rot, and bacterial blight in the greenhouse

Soybean cyst nematode		Phytophthora root rot		Bacterial blight	
Resistant lines	Tolerant lines	Resistant lines	Tolerant lines	Resistant lines	Tolerant lines
None	AM X-1026 P_{1a} 14-1	AM X-1026 P_{1a} 14-1	None	AM X-1026 P_{1a} 14-1	AM X-1026 P_{6a} 14-6
	AM X-1026 P_{3a} 14-3	AM X-1026 P_{1a} 14-2		AM X-1026 P_{1a} 14-2	AM X-1066 P_{14} 16-6
	AM X-1026 P_{21a} 15-1	AM X-1026 P_{1a} 14-3		AM X-1026 P_{1a} 14-3	AM X-1065 P_{22a} 15-2
		AM X-1026 P_{1a} 14-4		AM X-1026 P_{1a} 14-4	
	Total 3	AM X-1026 P_{1a} 14-5		AM X-1066 P_{45a} 16-7	Total 3
		AM X-1026 P_{1a} 14-6		AM X-1066 P_{45a} 16-8	
		AM X-1026 P_{1a} 14-7		AM X-1066 P_{45a} 16-9	
		AM X-1026 P_{1a} 14-8			
		AM X-1026 P_{1a} 14-9		Total 7	
		AM X-1026 P_{1a} 14-10			
		AM X-1026 P_{1a} 14-11			
		AM X-1026 P_{1a} 14-12			
		AM X-1026 P_{1a} 14-13			
		AM X-1026 P_{1a} 14-14			
		AM X-1026 P_{1a} 14-15			
		AM X-1026 P_{1a} 14-17			
		AM X-1026 P_{1a} 14-19			
		AM X-1065 P_{21a} 15-1			
		AM X-1065 P_{21a} 15-3			
		AM X-1065 P_{21a} 15-4			
		AM X-1065 P_{21a} 15-5			

Table 8. *Continued*

Soybean cyst nematode		Phytophthora root rot		Bacterial blight	
Resistant	Tolerant	Resistant	Tolerant	Resistant	Tolerant
		AM X-1065 P_{21a} 15-6			
		AM X-1065 P_{21a} 15-7			
		AM X-1065 P_{21a} 15-8			
		AM X-1065 P_{21a} 15-9			
		AM X-1065 P_{21a} 15-10			
		AM X-1065 P_{21a} 15-11			
		AM X-1065 P_{21a} 15-12			
		AM X-1065 P_{21a} 15-13			
		AM X-1065 P_{21a} 15-14			
		AM X-1065 P_{21a} 15-15			
		AM X-1065 P_{21a} 15-16			
		AM X-1065 P_{21a} 15-17			
		AM X-1065 P_{21a} 15-18			
		AM X-1066 P_{39a} 16-1			
		AM X-1066 P_{39a} 16-3			
		AM X-1066 P_{39a} 16-4			
		AM X-1066 P_{39a} 16-5			
		AM X-1066 P_{39a} 16-6			
		AM X-1066 P_{39a} 16-7			
		AM X-1066 P_{39a} 16-8			
		AM X-1066 P_{39a} 18-9			
		AM X-1066 P_{39a} 18-10			
		Total 43			

II. To evaluate soybean germplasm for biological efficiency in:

a. Harvest Index
(Dadson, R. B., J. Joshi, and L. Murphy, University of Maryland, Eastern Shore, Maryland)

Two hundred soybean plant introductions and cultivars in each of maturity groups III, IV, and V were evaluated during the 1983 planting season. Data collection consisted of days from emergence to maturity, final plant height, and oven-dried weights of stems and pod walls and seeds from four plants removed from each plot. Seed yield was determined by clipping off the end 30 cm of each plot and harvesting the remaining 1 m of the three rows. This report is limited to data on seed yield efficiency (SYE) values only.

A wide range of SYE was found in each maturity group (Tables 9, 10, and 11). SYE in MG III ranged from 0.43 to 1.39 with a mean of 0.88. About 60 entries had a higher mean SYE than 'Williams 79' which was used as a standard. In comparison, SYE in MG IV ranged between 0.44 and 1.27 with a mean of 0.83. Ninety-eight PIs in MG IV had SYEs higher than 'Clark' or 'Columbus', the standards. MG V had the widest range in SYE values from 0.25 to 1.56 and the highest mean, 0.97. Both 'Essex' and 'York', standard varieties on the eastern shore, had similarly high SYE, 1.22 and 1.21, respectively. Only 20 PIs had higher SYE than those two cultivars. Correlations between SYE, yield and plant height will be determined in each group and reported in the future.

b. Photosynthetic activity and translocation of photosynthates
(Bhagsari, D. S., Fort Valley State College, Georgia)

Sixteen soybean genotypes comprising the parentage of cultivar Forrest were grown in pots in the greenhouse and under field conditions to determine whole-plant and single-leaf net photosynthesis (Pn), leaf-area index, dry-matter accumulation, photosynthate partitioning, leaf conductance, and yield. Under field conditions, the range in pN was 47.9 to 29.6 mg $CO_2 dm^{-2} hr^{-1}$ for 'Illini' and 'Haberlandt', respectively (Tables 12 and 15). Illini also had higher photosynthesis (whole-plant basis) than all other genotypes grown in pots (Table 13). The range in leaf area index was 5.8 to 3.4. 'Volstate' accumulated more dry matter (505.0 g/m^2) than all the other genotypes during the vegetative stage of growth (Table 14). At pre-flowering stage, about 46.0% of the dry matter was partitioned to leaves (Table 15). Lower leaf surface showed more leaf conductance than upper leaf surface (1.0 and 0.30, respectively) in mid-September (night temperature 70°F). During the fall (night temperature 47°F), the leaf conductance was reduced to one third for both leaf surfaces on 23 September.

The yield data are not yet available.

Table 9. Ranking of seed yield efficiency (SYE) in soybean cultivars and plant introductions in Maturity Group III

Cultivar or PI #	SYE	Cultivar or PI #	SYE	Cultivar or PI #	SYE	Cultivar or PI #	SYE
Hobbit	1.39	FC31.678	0.96	84.657	0.88	84.631	0.73
FC02.109	1.38	79.874	0.96	FC02.108	0.87	68.479-1	0.77
79.726	1.23	Ford	0.95	68.806	0.87	70.202	0.77
68.731	1.22	68.560	0.95	70.469-1	0.87	81.031-1	0.77
79.587	1.19	68.756	0.95	79.874-1	0.87	81.761A	0.77
70.188	1.18	70.253	0.95	80.844-2	0.87	84.656	0.77
68.535	1.17	70.528	0.95	54.591	0.86	57.334	0.76
Fayette	1.14	81.037-3	0.95	54.618	0.86	84.957-1	0.76
80.461	1.14	81.041-1	0.95	55.089-1	0.86	70.541	0.75
84.987	1.14	84.987-A	0.95	61.940	0.86	83.945-1	0.75
FC04.002B	1.13	65.379	0.94	68.692-2	0.86	84.581	0.75
68.701	1.12	70.466-4	0.94	68.761-3	0.86	84.644	0.75
70.566	1.12	71.461	0.94	84.646	0.86	80.844-3	0.74
69.993	1.10	79.583	0.94	68.479	0.85	81.766	0.74
54.613	1.09	68.533-2	0.93	70.023	0.85	84.979	0.74
79.620	1.09	71.845	0.93	79.848-1	0.85	79.835	0.73
54.608-5	1.08	72.232	0.93	84.957	0.85	81.044-1	0.73
69.515	1.08	85.009-2	0.93	62.483	0.84	82.246-1	0.73
79.628	1.08	Williams 79	0.92	70.469	0.84	84.682	0.73
84.976-1	1.08	FC29.333	0.92	70.501	0.84	84.908-2	0.72
79.645	1.07	FC31.572	0.92	79.691	0.84	FC19.979-2	0.60
79.710	1.07	54.610-1	0.92	79.693	0.84	54.620	0.69
82.302	1.07	60.272	0.92	82.308	0.84	60.296-2	0.69
68.732-1	1.05	68.748-1	0.92	84.579	0.84	80.459	0.69
70.213	1.05	70.247	0.92	68.523	0.83	81.031-2	0.68
70.519	1.05	70.473	0.92	68.599	0.83	85.019	0.68
68.533-1	1.04	84.976	0.92	81.030-1	0.83	84.611	0.67
70.019	1.07	68.423	0.91	84.757	0.83	84.662	0.67
70.500	1.03	70.212	0.91	54.620-2	0.82	84.914	0.67
79.627	1.02	68.470	0.90	68.398	0.82	68.621	0.65
84.509	1.02	68.494	0.90	70.001	0.82	68.648	0.65
79.797	1.02	68.528	0.90	70.462	0.82	81.667	0.64
79.872	1.02	69.995	0.90	70.199	0.81	80.480	0.63
68.710	1.02	70.080	0.90	81.044	0.81	81.780	0.63
70.014	1.02	70.470	0.90	83.940	0.81	70.201	0.63
54.615	1.01	79.692	0.90	68.521-1	0.80	81.041	0.62
54.615-1	0.99	80.825	0.90	70.192	0.80	82.235	0.62
79.616	0.99	80.841	0.90	80.831	0.80	85.292	0.60
79.691-4	0.99	84.666	0.90	80.481	0.80	84.619	0.59
70.076	0.98	68.609-1	0.88	84.610	0.80	80.845-1	0.59
70.189	0.98	68.648	0.88	84.680	0.80	62.202	0.57
70.515	0.98	70.469-1	0.88	84.973	0.80	84.578	0.56
54.608-2	0.98	70.471	0.88	68.530-2	0.79	80.847-1	0.53
79.760	0.98	70.471	0.88	FC03.654N	0.78	80.845-2	0.52
79.870-2	0.98	71.850-1	0.88	54.583	0.78	82.232	0.46
FC31.571	0.97	80.822	0.88	68.759	0.78	81.037-2	0.43
FC31.684	0.97	81.038	0.88	80.471-1	0.78	Mean	.88
						S.D.	.16
						Variance	.03

Table 10. Ranking of seed yield efficiency (SYE) of soybean cultivars and plant introductions in Maturity Group IV

Cultivar or PI #	SYE	Cultivar or PI #	SYE	Cultivar or PI #	SYE
83.858	1.27	19.986	0.89	19.979-3	0.74
80.498-1	1.20	79.743	0.89	82.218	0.74
83.891	1.17	80.847-2	0.89	82.246	0.73
80.834-1	1.15	81.023	0.89	54.606-1	0.72
70.013	1.14	81.042-2	0.89	62.248	0.72
83.889	1.14	82-263.1	0.89	84.646-2	0.72
64.747	1.13	79.870-4	0.88	54.617	0.71
80.837	1.12	83.893	0.88	70.825-1	0.71
82.264	1.12	83.944	0.88	80.030	0.71
62.199	1.10	84.671	0.87	84.633	0.71
62.202-2	1.09	84.724	0.87	84.660	0.71
79.696	1.08	63.945	0.86	19.979-5	0.70
83.881	1.08	82.555	0.86	60.269-2	0.70
80.466-2	1.07	83.868	0.86	79.732-4	0.70
83.923	1.05	83.892	0.86	81.764	0.70
68.768	1.03	68.449	0.85	82.326	0.70
82.307	1.02	69.507-1	0.85	Clark	0.69
83.853	1.01	82.210	0.85	54.610-4	0.69
80.828-2	0.99	70.467	0.84	58.955	0.69
80.777	0.97	80.473	0.84	81.042-1	0.69
54.615-2	0.95	84.628	0.84	83.946	0.69
84.713	0.95	FC31.630	0.83	Columbus	0.68
54.600	0.94	54.614	0.83	70.243	0.68
70.229	0.94	56.563	0.83	81.037-5	0.68
70.242-2	0.94	70.208	0.83	82.325	0.68
82.558	0.94	82.259	0.83	FC31.946	0.67
79.732-3	0.93	19.979-1	0.82	59.849	0.67
82.312N	0.93	63.468	0.82	64.698	0.67
84.639	0.93	79.870.6	0.82	83.945-4	0.67
70.490	0.92	84.664	0.82	55.887	0.66
82.509	0.92	80.834-1	0.81	68.011	0.66
82.527	0.92	19.976-2	0.80	Douglas	0.61
80.479	0.91	71.444	0.80	19.979-7	0.61
80.828-1	0.91	83.881A	0.80	54.608-4	0.58
19.976-1	0.91	19.979-6	0.79	82.295	0.57
FC31.685	0.90	81.029-1	0.78	83.925	0.55
72.227	0.90	FC33.243	0.77	FC31-715	0.54
80.488	0.90	71.506	0.76	82.534	0.52
81.037	0.90	80.034-1	0.76	54.606-2	0.49
83.915	0.90	84.594	0.76	Cutler	0.46
84.679	0.90	84.669N	0.75	82.296	0.44
				Mean	0.83
				SD	0.16
				Variance	0.03

Table 11. Ranking of seed yield efficiency (SYE) of soybean cultivars and plant introductions in Maturity Group V

Cultivar or PI #	SYE	Cultivar or PI #	SYE	Cultivar or PI #	SYE	Cultivar or PI #	SYE
416.803	1.56	423.726	1.14	417.379	0.97	417.099	0.84
423.720	1.47	423.773	1.14	423.732	0.97	417.309	0.84
417.259	1.38	416.849	1.13	417.420	0.96	417.404	0.84
416.820	1.37	416.899	1.12	417.350	0.96	416.804	0.83
423.723	1.37	417.048	1.12	416.860	0.95	416.977	0.83
417.402	1.35	417.494	1.12	423.782	0.95	417.253	0.83
423.724	1.33	417.419	1.11	416.861	0.94	417.360	0.83
423.775	1.31	423.758	1.11	416.957	0.94	417.372	0.83
423.799C	1.31	423.764	1.09	417.031	0.94	417.026	0.81
417.332	1.29	416.799	1.08	417.373	0.94	417.068	0.81
417.423	1.29	416.844	1.08	417.430	0.94	417.073	0.81
423.742	1.29	417.284	1.07	416.808	0.93	423.727	0.81
417.392	1.28	417.308	1.07	923.759	0.93	416.909	0.80
417.263	1.27	417.390	1.07	416.843	0.92	417.159	0.79
423.762	1.26	417.486	1.07	416.960	0.92	417.383	0.78
417.037	1.25	423.785	1.07	416.979	0.92	417.157	0.76
423.751	1.25	416.797	1.06	417.069	0.92	417.158	0.76
417.581	1.24	417.090	1.06	417.074	0.92	417.474	0.76
416.877	1.23	417.341	1.06	423.745	0.92	416.827	0.74
417.440	1.23	417.411	1.06	417.055	0.91	417.346	0.74
Essex	1.22	416.982	1.05	417.414	0.91	417.329	0.72
417.493	1.22	417.280	1.05	416.847	0.90	416.927	0.70
417.247	1.22	417.098	1.04	416.901	0.90	417.275	0.70
York	1.21	423.774	1.04	417.081	0.90	416.815	0.68
416.962	1.21	416.821	1.03	417.264	0.90	416.931	0.68
417.251	1.21	417.352	1.03	423.781B	0.90	417.250	0.68
417.475	1.21	417.418	1.02	417.049	0.89	416.908	0.66
423.761	1.21	417.041	1.01	417.169	0.89	417.394	0.66
417.387	1.20	417.348	1.01	417.188	0.89	416.944	0.65
417.465	1.20	417.366	1.01	417.399	0.89	417.093	0.65
417.472	1.20	417.491	1.01	416.973	0.89	417.567	0.65
417.335	1.19	417.351	1.00	423.738	0.89	417.166	0.64
423.801	1.19	417.395	1.00	416.975	0.88	417.108	0.63
417.441	1.18	417.088	0.99	417.105	0.88	417.359	0.63
423.772	1.18	417.104	0.99	417.356	0.88	417.058	0.62
423.781A	1.17	417.347	0.99	417.483	0.88	417.00	0.61
416.970	1.17	417.415	0.99	416.807	0.87	417.053	0.58
417.464	1.17	417.445	0.99	417.156	0.87	417.396	0.58
417.467	1.16	416.851	0.98	417.272	0.87	417.052	0.56
416.999	1.15	417.039	0.98	416.811	0.86	417.135	0.56
417.481	1.15	417.106	0.98	416.938	0.86	417.322	0.52
423.76	1.15	417.141	0.98	417.016	0.86	423.804	0.44
416.800	1.14	417.426	0.98	423.786	0.86	417.337	0.42
416.814	1.14	417.492	0.98	416.981	0.86	417.307	0.37
416.838	1.14	423.722	0.98	417.262	0.86	417.402	0.25
416.871	1.14	417.103	0.97	417.288	0.86		
417.363	1.14	417.273	0.97	416.85	0.84	Mean	0.97
						S.D.	0.21
						Variance	0.05

Table 12. Net photosynthesis and specific leaf weight for field grown soybean genotypes (1983)

Genotype	Net photosynthesis		Specific leaf wt
	$mgCO_2\ dm^{-2}hr^{-1}$	$mgCO_2$/hr/g dry wt	mg/cm^2
Illini	47.87	94.30	5.10
D49-2491	46.95	88.64	5.39
CNS	45.71	95.13	4.81
Peking	44.38	99.21	4.45
Bragg	44.38	94.14	4.71
Dyer	43.09	81.44	5.31
Palmetto	42.83	94.98	4.50
Hill	41.00	79.01	5.23
Volstate	40.86	85.06	4.78
Dunfield	40.39	72.21	5.60
Jackson	39.45	83.54	4.74
Lee	36.88	81.07	4.73
S-100	36.29	82.99	4.52
Forrest	34.73	71.97	4.82
Clemson	31.27	66.55	4.62
Haberlandt	29.57	74.51	3.98
Mean	40.35	84.05	4.83

Table 13. Leaf area index for soybean (1983)

Genotype	LAI
S-100	5.81
Haberlandt	5.73
CNS	5.69
Volstate	5.64
Jackson	5.17
Palmetto	4.72
Bragg	4.61
Peking	4.48
Lee	4.44
Clemson	4.25
Dyer	4.04
Hill	4.02
Forrest	4.00
Dunfield	3.90
D49-2491	3.83
Illini	3.42
Mean	4.58

Table 14. Dry matter accumulation and partitioning for soybean genotypes 1983

Genotype	Dry matter g/m^2	% in leaves
Volstate	505.0	43.8
Haberlandt	446.0	44.8
S-100	427.3	44.8
CNS	380.5	47.3
Jackson	376.2	42.5
Palmetto	364.4	43.8
Lee	346.6	47.5
Bragg	346.6	47.5
Dunfield	342.3	49.3
Hill	328.2	42.8
Dyer	309.9	48.8
Clemson	308.5	46.0
D49-2491	304.1	46.5
Illini	287.4	45.5
Peking	268.1	49.0
Forrest	251.7	45.8
Mean	349.5	46.0

Table 15. Canopy photosynthesis for soybeans grown in pots (1983)

Genotype	Photosynthetic rate ($mgCO_2/hr$)		
	per dm^2 leaf area	per g fresh wt	per g dry wt
Illini	16.56	11.52	35.46
Bragg	16.45	11.98	39.86
Dunfield	13.84	10.80	33.35
S-100	13.41	10.20	32.01
CNS	11.86	9.64	35.94
Peking	11.78	9.21	31.59
D49-2941	11.71	8.87	29.93
Lee	11.24	8.84	28.76
Hill	10.61	8.26	27.76
Haberlandt	10.52	7.17	24.62
Forrest	10.50	8.20	27.26
Jackson	10.16	9.43	32.77
Clemson	10.08	7.22	27.40
Dyer	8.68	6.83	22.25
Volstate	8.45	6.63	22.10
Palmetto	7.70	5.88	23.20
Mean	11.47	8.79	29.64

c. Nitrogen Fixation

(Sapra, V. T., Floyd, M., R. Garner and S. Mookherji, Alabama A&M University, Normal, AL)

Twenty commercial soybean cultivars from maturity groups IV through VIII were screened for nitrogen-fixation in a growth chamber using *Rhizobium* strains 3I1B 6,122 and combination of 6 and 122. The data on nodule number, nodule weight, shoot fresh weight, shoot dry weight, and acetylene reduction were recorded. Among twenty cultivars, 'Lee 74' (MG IV), 'Bay' (MG V), and 'Essex' (MG V) were identified as high N-fixers, based on more nodules and high acetylene reduction. The lower N-fixers showed low value of acetylene reduction for strains 6 and 122, as well as for 6+122 (Table 16). Several advance breeding germplasm lines are being screened in our laboratory for compatibility with these strains.

Table 16. Response of two rhizobia strains and their combination on nodule number in different maturity groups of soybean cultivars

Maturity Group and cultivar	Rhizobium strain		
	6	122	6+122
MG IV			
RA 480	8.3 c[a]	6.9 feg	7.0 dc
RA 401	11.0 cd	10.9 fbdecg	9.8 bdc
Stevens	5.0 c	5.4 g	8.3 bdc
MG V			
Bedford	6.3 c	9.4 fdecg	7.8 dc
Forrest	9.7 c	11.4 fbdecg	7.7 dc
Wilstar 550	10.6 cb	9.9 fdecg	7.1 dc
Essex	17.1 b	15.2 bac	18.2 a
Bay	24.8 a	20.7 a	18.7 a
MG VI			
Lee 74	17.1 b	17.1 ba	14.6 ba
Tracy	12.4 cd	14.8 bdac	11.9 bdc
Davis	10.5 cb	13.0 bdac	12.9 bac
Centennial	17.2 b	15.9 bac	14.4 ba
McNair 600	7.1 c	6.1 fg	7.2 dc
RA 680	10.8 cb	12.6 fbdec	7.7 dc
Greenseed 737	12.3 cb	9.9 fdecg	11.9 bdc
MG VII			
Bragg	5.1 c	7.6 feg	6.0 d
Braxton	5.5 c	7.7 feg	6.3 dc
Hutton	8.7 d	8.6 fdeg	7.0 dc
MG VIII			
Foster	9.4	11.2 fbdecg	10.5 bdc
Wright	6.8 c	9.3 fdecg	7.8 dc

[a]Means within a column with the same letter are not significantly different.

d. Micronutrient Uptake
(Reddy, M. R., North Carolina Agricultural and Technical University, N.C.)

An investigation was carried out to evaluate soybean germplasm response to (1) manganese deficiency and toxicity, (2) various rates of manganese application, and (3) to different soil pH levels on manganese accumulation by the germplasm lines and their yield. Manganese rates were 0, 10, and 20 kg/ha. The pH levels were 5.3, 6.3, and 7.0. The germplasm lines tested were PI 159319, PI 324924, PI 960895 and L-76-0132. Results indicated differences in seed yield among the germplasm lines tested due to manganese rates and pH level (Table 17). Germplasm lines PI 960895 gave the highest seed yield; L-76-0132 produced lowest yield. Seed yields for germplasm lines PI 159319 and PI 960895 were higher at 20 kg/ha manganese application compared with control. In general, germplasm growth and yield were higher at pH 7 and 6.3 and poor at pH 5.3. Germplasm line PI 324924 showed normal plant growth and higher yield at pH 5.3. It appears that strongly acid condition of the soil at pH 5.3 resulted in manganese toxicity to the germplasm lines except for line PI 324924. The data suggest differences in tolerance to toxicity of Mn by various germplasm lines under strong acid condition of soil.

Table 17. Effect of rate of manganese and soil pH levels on seed yield of soybean germplasm

pH levels	PI 159,319	PI 324,924	PI 960,895	L-76-0132
	g/plant			
		Mn: 0Kg/ha		
7.0	12.75	9.71	10.31	3.47
6.3	13.92	11.12	15.10	5.49
5.3	3.85	15.57	13.79	3.75
	30.51	36.40	30.20	12.71
		Mn: 10Kg/ha		
7.0	8.38	5.20	10.91	5.43
6.3	9.31	7.35	10.32	6.49
5.3	5.09	9.03	9.97	5.70
	22.78	21.58	31.20	17.62
		Mn: 20Kg/ha		
7.0	18.60	7.00	13.57	3.83
6.3	11.91	7.61	10.97	4.47
5.3	10.54	11.50	12.21	3.93
	41.05	26.11	36.75	12.23
	94.35	84.09	98.15	42.56

(J. R. Allen, Tuskegee Institute, AL)

Two cultivars recommended for central Alabama, 'Bragg' and 'Lee', were selected for the screening process. The two cultivars were planted in plots 4 x 6m in which Mn or Zn were added at the rates of 0, 4, 8, and 16 kg/ha. There were three rows per plot and the soil was a Norfolk sandy loam (fine, loamy siliceous, thermic typic paleudult). Each micronutrient was added to plots by broadcasting, then lightly disced into the soil. After micronutrients were added, *Rhizobium*-inoculated seed of each soybean cultivar were planted in each row at the rate of 45 kg/ha. At the blooming stage, five plants from each plot were harvested for Mn and Zn determination. The remaining plants were allowed to remain until pod-ripening stage and then harvested for total dry matter and seed yield determination.

Tissue analyses for Mn and Zn concentration are not yet available; however, dry-matter and seed-yield analysis showed that both Bragg and Lee are directly affected by soil Mn and Zn concentration. Seed yield of Lee in the Mn-treated plots tended to be lower than that of Bragg. In addition, at all levels of applied Mn, seed yield of Lee was lower than the control (Table 19). For the Zn-treated plots, seed yield of Bragg at all levels at pH 6.5 varied little from the control. Conversely, seed yield of Lee for the same pH level was generally lower for the 8-to-16-kg/ha rates than control plants. While seed yield of Bragg was considerably higher at pH 6.5 than at pH 5.0, that of Lee, although higher at pH 6.5 than at 5.0, the difference in yield between the two pH levels was not as great as it was for Bragg. At pH 6.5, total dry-matter accumulation was highest with the 4 kg/ha of both Mn and Zn. Increasing the concentration of these two micronutrients above this level tended to decrease dry-matter production. Generally, at pH 5.0, dry-matter production tended to be lower than control plants at all levels of applied Zn (Table 18).

The effect of Mn and Zn on seed yield was somewhat more variable than for total dry matter. Generally, however, seed yield of Bragg at pH 6.5 in the Mn-treated plots was slightly higher for the 8-to-16-kg/ha rates than the control plants (Table 19).

Table 18. Effect of Mn and Zn on total dry matter yield of Bragg and Lee

Micronutrient concentration	pH	Mn		Zn	
		Bragg	Lee	Bragg	Lee
0 Control	5.0	12.6	9.8	22.9	11.7
	6.0	13.7	8.5	19.0	12.9
4	5.0	10.1	7.9	15.5	19.1
	6.5	25.2	12.6	26.2	19.4
8	5.0	11.8	12.0	12.9	11.9
	6.5	17.0	16.9	20.6	10.2
16	5.0	14.1	10.8	8.6	12.9
	6.5	12.6	15.9	4.3	17.0

Table 19. Effect of Mn and Zn on seed yield of Bragg and Lee

Micronutrient concentration	pH	Mn		Zn	
		Bragg	Lee	Bragg	Lee
		kg/ha			
0 Control	5.0	1887	1847	1733	2676
	6.5	1973	2472	5468	3060
4	5.0	1994	1609	2360	2734
	6.5	1715	1689	5417	2830
8	5.0	1693	2213	2238	2299
	6.5	2121	1445	4205	3089
16	5.0	1506	1575	2866	3692
	6.5	2317	2206	5102	2913