Carver
A New Soybean Variety for Alabama

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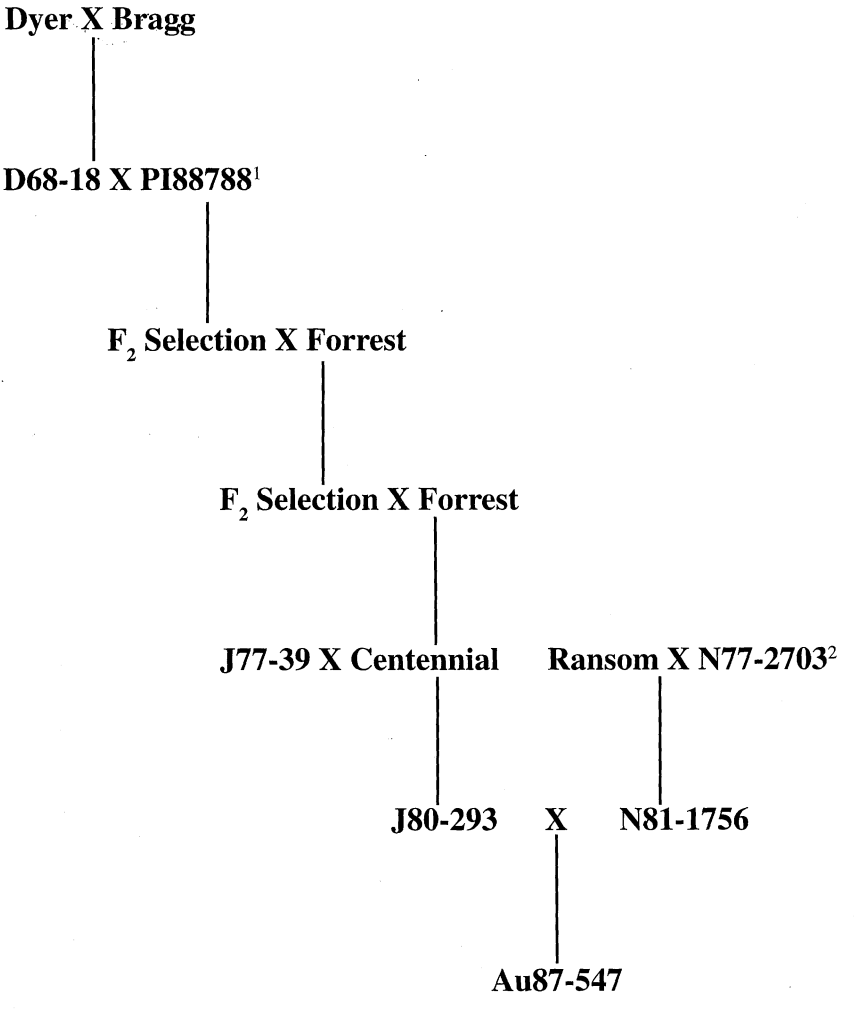
Lowell T. Frobish, Director
Auburn University, Alabama

Pedigree of Au87-547



[1]PI 88788 is the source of resistance to soybean cyst nematode race 14.
[2]N77-2703 is an inbred selection from YC_3 [a population developed by recurrent selection at North Carolina State University (Crop Science 19:315-318)]

Carver: a New Soybean Variety For Alabama

D.B. WEAVER, R. RODRIGUEZ-KABANA, D.G. ROBERTSON
C.A. THOMAS, R.L. AKRIDGE, AND R.R. SHARPE

CARVER IS A NEW SOYBEAN [*Glycine max* (L.) Merr.] variety released by the Alabama Agricultural Experiment Station (AAES) in 1994. It was released primarily to give Alabama soybean growers an early Maturity Group 7 variety with a combination of high yield and good resistance to nematodes and foliar diseases.

Carver originated from the cross J80-293 x N81-1756 (see the pedigree). J80-293 is an experimental line selected from the cross J77-39 (same parentage as Bedford) x Centennial, and N81-1756 is an experimental line selected from the cross Ransom x N77-2703. N77-2703 is an inbred selection from YC_3, a population developed by three cycles of recurrent selection for yield at North Carolina State University.

The original cross was made at the Plant Breeding Unit (PBU), Tallassee, during summer 1984. The F_1 generation was grown during the winter of 1984-1985 in Belize, Central America, and the F_2 generation was grown at the PBU during the summer of 1985. The F_3 and F_4 generations were advanced from the F_2 by single-seed descent, and were grown in Belize during the winter of 1985-1986. F_5 seed (each tracing back to a different F_2 plant) were planted at the PBU in the summer of 1986.

Approximately 700 F_5 plants were harvested, threshed individually, and grown in F_5-derived F_6 rows in 1987. Approximately 85 $F_{5:6}$ lines were selected, and yield testing was begun on selected $F_{5:6}$ rows in 1988. Carver was tested under the experimental designation Au87-547 from 1988 until its release. Yield tests in Alabama consisted of four-row plots and three replications at the PBU in 1988 (preliminary test). Advanced tests were grown in 1989 and 1992 at the PBU; Sand Mountain Substation, Crossville; Brewton Experiment Field, Brewton; and at the Prattville Experiment Field, Prattville. Carver was tested in a farmer's field (John Gottler, Elberta) in Baldwin County beginning in 1989, and continuing until 1993. The field was infested with a mixture of root-knot nematode (*Meloidogyne* spp.) and soybean cyst nematode (*Heterodera glycines*) of undetermined race.

In 1990, Carver was entered (as Au87-547) into the Southern Regional Preliminary Group 7 of the USDA Uniform Soybean Tests. It was evaluated for yield and disease and nematode resistance characteristics at nine locations across the

Weaver is a professor, Thomas is a former research specialist, Akridge is former research associate, and Sharpe is a research assistant in the Auburn University Department of Agronomy and Soils. Rodriguez-Kabana is a professor and Robertson is a research associate in the AU Department of Plant Pathology. **This research was supported in part by a grant from the Alabama Soybean Producers.**

Southeast. Carver was advanced to the Uniform Group 7 Tests for similar evaluation at 23 locations across the Southeast in 1991, 22 locations in 1992, and 15 locations in 1993.

In addition to yield evaluations, Carver was tested in the greenhouse for resistance to Southern root-knot nematode (*Meloidogyne incognita*), peanut root-knot nematode (*Meloidogyne arenaria*), races 3 and 14 of the soybean cyst nematode, and stem canker (caused by *Diaporthe phaseolorum* f.sp. *meridionalis*). Resistance to frogeye leaf spot (caused by *Cercospora sojina*) was evaluated in field plots at locations where the disease occurred naturally. Additional evaluation for seed quality, protein and oil content, and seed size was done during the USDA Uniform Tests. Carver has been evaluated in replicated yield trials across the Southeast in a total of 69 environments. Carver has been evaluated (as Au87-547) in the Alabama Soybean Variety Trials in 1992 and 1993 in 12 environments.

Carver yielded 0.5 bushels per acre more than Stonewall and 3.8 bushels per acre more than Sharkey in the USDA Preliminary Group 7 Test in locations from North Carolina to Texas (Table 1). Maturity was two days earlier than Stonewall and one day later than Sharkey, maturing about October 16, on average. Height was somewhat shorter than Stonewall or Sharkey.

In the USDA Uniform Group 7 Tests during 1991, 1992, and 1993, Carver averaged about 3% lower yield than Stonewall (tables 2, 3, and 4). Maturity averaged about two days earlier than Stonewall. Mature plant height was two inches shorter than Stonewall, resulting in lower lodging scores than Stonewall. On average, seed protein content of Carver was slightly higher than Stonewall and seed oil content slightly lower. Seed size averaged 14.7 grams per 100 seeds, compared to 16.6 grams per 100 seeds for Stonewall. In Alabama Soybean Variety Trials, Carver yielded 7% more than Stonewall (tables 5 and 6).

Yield performance of Carver in the nematode-infested field in Baldwin County has been good (Table 7). Carver averaged 30.2 bushels per acre over a four-year period, compared to 18.6 bushels per acre for Leflore, the nematode resistant check. Stonewall, which has a low level of resistance to root-knot nematodes, had a mean yield of 11.1 bushels per acre. In an extensive rotation experiment conducted in these same fields in 1994, Carver yielded significantly more than all other publicly developed cultivars with which it was compared, regardless of previous crop (tables 8 and 9).

Disease and nematode resistance, as evaluated in the USDA Uniform Group 7 Tests during 1991 and 1992, showed Carver has good resistance to races 3 and 14 of soybean cyst nematode, and good resistance to root-knot nematodes and frogeye leaf spot (tables 10 and 11). Carver is the only genotype in Maturity Group 7 that combines resistance to both prevalent races of soybean cyst nematode, both prevalent species of root-knot nematode, and frogeye leaf spot with good yielding ability. Carver is moderately susceptible to stem canker, however, and is not recommended for planting in fields that have a history of stem canker.

Carver has determinate stem termination, white flowers, light tawny pubescence, and tan pod walls. Seeds are yellow with black hila and dull seed coats. Breeder seed of Carver will be maintained by the AAES. Seed should be available for commercial plantings beginning in 1996.

TABLE 1. AGRONOMIC PERFORMANCE OF CARVER IN THE USDA PRELIMINARY GROUP 7 TESTS (NINE LOCATIONS), 1990

Line	Yield	Maturity	Height	Oil	Protein	SCN 3[1]	SCN 14
	Bu./a.	*Date*	*In.*	*Pct.*	*Pct.*		
Carver	37.8	10/16	31	20.7	42.3	R[2]	R
Stonewall	37.3	10/18	34	21.3	41.0	R	S
Sharkey	34.0	10/15	39	19.7	43.2	R	S
LSD (0.05)	3.9			1.3	1.8		

[1]SCN 3 and SCN 14 are soybean cyst nematodes, races 3 and 14 respectively.
[2]R = resistant, S = susceptible.

TABLE 2. AGRONOMIC PERFORMANCE AND SEED COMPOSITION OF CARVER IN THE USDA UNIFORM GROUP 7 TESTS (23 LOCATIONS), 1991

Line	Yield	Maturity	Height	Lodging[1]	Oil	Protein	Size[2]
	Bu./a.	*Date*	*In.*	*Score*	*Pct.*	*Pct.*	*G/100*
Carver	45.2	10/15	33	1.5	21.0	41.6	14.4
Stonewall	46.1	10/19	35	1.8	21.0	41.1	16.2
Hagood	42.9	10/21	39	2.3	20.1	42.5	13.8
LSD (0.05)	2.4						

[1]1 = upright, 5 = prostrate.
[2]Seed size is measured in grams per 100 seed.

TABLE 3. AGRONOMIC PERFORMANCE AND SEED COMPOSITION OF CARVER IN THE USDA UNIFORM GROUP 7 TESTS (22 LOCATIONS), 1992

Line	Yield	Maturity	Height	Lodging[1]	Oil	Protein	Size[2]
	Bu./a.	*Date*	*In.*	*Score*	*Pct.*	*Pct.*	*G/100*
Carver	42.4	10/16	31	1.6	20.6	42.4	15.1
Stonewall	45.0	10/19	33	2.1	21.0	42.0	17.4
Hagood	39.7	10/22	37	2.4	20.4	42.5	14.6
LSD (0.05)	0.6						

[1]1 = upright, 5 = prostrate.
[2]Seed size is measured in grams per 100 seed.

TABLE 4. AGRONOMIC PERFORMANCE AND SEED COMPOSITION OF CARVER IN THE USDA UNIFORM GROUP 7 TESTS (15 LOCATIONS), 1993

Line	Yield	Maturity	Height	Lodging[1]	Oil	Protein	Size[2]
	Bu./a.	*Date*	*In.*	*Score*	*Pct.*	*Pct.*	*G/100*
Carver	36.2	10/21	27	1.3	21.1	40.6	14.4
Stonewall	37.1	10/21	30	1.5	21.1	41.1	15.9
Haskell	38.7	10/23	31	1.9	21.2	39.8	15.5
LSD (0.05)	3.4						

[1]1 = upright, 5 = prostrate.
[2]Seed size is measured in grams per 100 seed.

TABLE 5. YIELD OF CARVER AND CHECK CULTIVARS IN ALABAMA STATE VARIETY TESTS, 1992

Line	Camden	Prattville	Marion Junction	Headland	Brewton	Fairhope
	Bu./a.	*Bu./a.*	*Bu./a.*	*Bu./a.*	*Bu./a.*	*Bu./a.*
Carver	51.9	37.9	59.4	26.3	55.7	48.4
Stonewall	50.5	35.0	53.9	19.7	54.7	40.7
Leflore	46.4	37.4	49.3	--	--	48.1
Bryan	35.1	40.8	50.0	19.4	48.0	44.7
Brim	56.3	39.5	58.9	24.8	61.8	57.9
Thomas	48.1	36.6	--	20.3	51.9	37.3
Test mean	46.1	40.3	52.6	24.4	53.0	45.3
LSD (0.05)	4.7	5.8	6.6	8.7	5.7	6.3

TABLE 6. YIELD OF CARVER AND CHECK CULTIVARS IN ALABAMA STATE VARIETY TESTS, 1993

Line	Belle Mina	Crossville	Marion Junction	Brewton	Brewton[1]	Fairhope
	Bu./a.	*Bu./a.*	*Bu./a.*	*Bu./a.*	*Bu./a.*	*Bu./a.*
Carver	57.4	27.9	49.1	46.4	50.4	42.1
Stonewall	50.4	28.2	50.4	41.1	45.7	43.7
Leflore	51.7	25.5	41.5	--	43.5	--
Bryan	53.7	25.8	49.1	42.5	47.7	44.0
Brim	55.6	20.1	46.7	--	--	--
Test mean	49.0	23.8	45.3	41.7	44.4	41.8
LSD (0.05)	7.8	3.6	7.3	5.5	7.4	4.3

[1]Very early-planted test.

TABLE 7. YIELD OF CARVER AND CHECK CULTIVARS AT ELBERTA, ALA., SITE OF SEVERE POLYSPECIFIC NEMATODE INFESTATION (*M. INCOGNITA*, *M. ARENARIA*, AND *H. GLYCINES* OF UNDETERMINED RACE)

Line	1989	1991	1992	1993
	Bu./a.	*Bu./a.*	*Bu./a.*	*Bu./a.*
Carver	29.2	32.5	25.7	33.4
Bryan[1]	--	--	22.1	25.1
Thomas	10.6	25.9	7.3	8.7
Ransom[2]	9.4	--	4.4	--
Stonewall	8.0	27.1	4.7	4.7
Braxton	7.7	26.4	--	--
Leflore[1]	5.6	28.3	17.4	23.1
LSD (0.05)	7.9	11.8	5.4	8.3

[1]Bryan and Leflore are nematode resistant checks.
[2]Brim was substituted for Ransom as the susceptible check in 1992.

TABLE 8. PERFORMANCE OF CARVER AND OTHER CULTIVARS IN NEMATODE-INFESTED FIELD (GOTTLER FIELD), ELBERTA, ALA., 1994

Previous crop	Carver	Bryan	Leflore	Thomas	Stonewall	Brim	Braxton	LSD
	Bu./a.	*Bu./a.*	*Bu./a.*	*Bu./a.*	*Bu./a.*	*Bu./a.*	*Bu./a.*	*Bu./a.*
Soybean	53.6	46.4	45.2	37.2	36.8	28.9	13.3	2.2
Sorghum-sudangrass	56.5	52.2	43.5	43.7	42.3	36.7	39.2	2.7
Fallow	54.4	51.5	43.5	42.9	39.4	38.0	34.5	2.7
Mean	54.6	49.5	44.7	40.6	39.1	30.3	26.7	1.4

TABLE 9. PERFORMANCE OF CARVER AND OTHER CULTIVARS IN NEMATODE-INFESTED FIELD (KAISER FIELD), ELBERTA, ALA., 1994

Previous crop	Carver	Bryan	Leflore	Thomas	Stonewall	Brim	Braxton	LSD
	Bu./a.	*Bu./a.*	*Bu./a.*	*Bu./a.*	*Bu./a.*	*Bu./a.*	*Bu./a.*	*Bu./a.*
Soybean	27.1	22.1	22.8	18.5	12.9	5.2	7.5	1.9
Cotton	38.4	31.9	34.7	30.6	30.2	22.4	20.1	1.9
Mean	32.8	27.0	28.8	24.5	21.6	13.8	13.8	1.3

TABLE 10. DISEASE AND NEMATODE RESISTANCE CHARACTERISTICS OF CARVER AND CHECK CULTIVARS IN THE USDA UNIFORM GROUP 7 TESTS, 1991[1]

Line	*M. incognita*	*M. arenaria*	SCN 3	SCN 14	Stem canker	Seed qual.
Carver	2.3	2.2	R	R	1.0	1.8
Stonewall	5.0	3.5	R	S	1.0	1.6
Hagood	2.8	3.5	R	S	2.0	1.6

[1]*Meloidogyne incognita* (Southern root-knot nematode) and *M. arenaria* (peanut root-knot nematode) are rated on a scale of 1 to 5 where 1 = no galling and 5 = severe galling in greenhouse tests. SCN 3 and 14 are *Heterodera glycines* (soybean cyst nematode) races 3 and 14 and are rated R (resistant) or S (susceptible) based on numbers of cysts produced (relative to a known susceptible) in the greenhouse. Stem canker (*Diaporthe phaseolorum* f. sp. *meridionalis*) is rated on a scale of 0- 9 where 0 = no disease and 9 = all plants dead in the field. Seed quality is rated on a scale of 1 to 5 where 1 = excellent quality and 5 = very poor quality, based on a visual rating. Seed quality is determined by a variety of disease and environmental factors.

TABLE 11. DISEASE AND NEMATODE RESISTANCE CHARACTERISTICS OF CARVER AND CHECK CULTIVARS IN THE USDA UNIFORM GROUP 7 TESTS, 1992[1]

Line	*M. incognita*	*M. arenaria*	SCN3	SCN14	Frogeye leaf spot	Stem canker	Seed qual.
Carver	1.6	1.5	R	R	1.0	3.8	1.8
Stonewall ...	4.5	4.3	R	S	1.0	2.3	1.9
Hagood	1.3	3.5	R	S	1.0	4.4	1.7

[1]*Meloidogyne incognita* (Southern root-knot nematode) and *M. arenaria* (peanut root-knot nematode) are rated on a scale of 1 to 5 where 1 = no galling and 5 = severe galling in greenhouse tests. SCN 3 and 14 are *Heterodera glycines* (soybean cyst nematode) races 3 and 14. Frogeye leaf spot(*Cercospora sojina*) is rated on a scale of 1 to 5 where 1 = no lesions and 5 = 25-50% leaf area infected based on field trials at Jay, Fla. Stem canker (*Diaporthe phaseolorum* f. sp. *meridionalis*) is rated on a scale of 1 to 6 where 1 = no disease and 6 = dead based on plants inoculated in the field at Stoneville, MS. Seed quality is rated on a scale of 1 to 5 where 1 = excellent quality and 5 = very poor quality, based on a visual rating. Seed quality is determined by a variety of disease and environmental factors.