

NNY Agricultural Development Program 2006-2007 Project Report

Forage Soybean Advanced Breeding Line Evaluations & Food Grade Soybean Variety Trials

Project Leaders:

Peter Barney CCE of St. Lawrence County

Michael Hunter, CCE of Jefferson County

Michael H. Davis Dept. of Crop and Soil Sciences, Cornell University

Collaborators:

Thomas Devine, , USDA Sustainable Agriculture Systems Lab, Beltsville, MD

Jerry Cherney, Dept. of Crop and Soil Sciences, Cornell University

Forage Soybean Trials:

Background

Forage soybeans may be a viable alternative legume crop for Northern New York dairy farms that have difficulty growing alfalfa. Soybeans historically functioned as a forage crop, and some Northern New York farmers have recently experimented with harvesting grain-type soybeans for forage, but more widespread adoption of soybeans as a forage crop in the future will depend on the development of regionally adapted forage-type varieties that have desirable agronomic characteristics.

Dr. Thomas Devine, a USDA soybean breeder based in Beltsville, Maryland, started developing forage-type soybeans in the 1980's, and field evaluations of advanced lines from his program were first conducted in the Cornell Chazy research plots in 1995. Dr. Devine's early breeding work with forage-type soybeans produced very tall, relatively late maturing (maturity groups V – VIII) lines that generated high shoot biomass, but few seeds when grown at northern latitudes. Several advanced lines in the 1998 Chazy test were over 8' tall and yielded more than 10 tons/acre dry matter. Two major problems with the large, later maturity lines were

- (1) high NDF levels – a low proportion of which was digestible. While the yields with these lines were impressive, the thick stems required to hold the plants up resulted in forage with undesirably high fiber levels. Tall lines without thick stems tended to have a viney growth habit that produced a tangled, lodged canopy. Dense, thick canopies are difficult for some machinery to handle, and may also result in lower canopy conditions that favor white mold growth.
- (2) Lower crude protein levels. When grown in Northern New York, the late maturing varieties didn't produce much seed, and as a result crude protein levels were consistently lower than those in early maturing grain-type soybeans harvested for forage at the R6 (full seed) stage.

In an effort to address these limitations and develop lines that are well suited for production in more northerly latitudes, Dr. Devine crossed some of the original forage-type lines with earlier maturing varieties. Promising advanced lines, identified in 2005 and 2006, were selected for the 2007 test.

Objective

To support efforts to develop forage-type soybean varieties that are well adapted to Northern New York growing conditions by evaluating the agronomic performance of elite forage soybean breeding lines in replicated field trials.

Methods

Nine advanced breeding lines and two named forage-type varieties from Dr. Devine's forage soybean breeding program, plus two grain-type varieties from Iowa were included in the 2007 tests. Entries ranged from maturity group (MG) II to MG VI. Field trials were established at three sites in Northern New York: the Cornell research plots at the W.H. Miner Institute in Chazy, the CCE St. Lawrence County Research Farm in Canton, and an on-farm research location in Jefferson County.

Chazy Trial:

A randomized complete block experimental design with four replications was employed. Plots were located on a Roundabout silt loam soil with tile drainage (Field range 8). 200 lbs/acre 6-24-24 was broadcast applied and incorporated with a spring-tooth harrow prior to planting. Broadstrike+Dual herbicide was also pre-plant applied. Four-row plots were planted with 30" row spacings on May 23, 2007. All seed was inoculated prior to planting. Final harvest occurred on September 20, 2007. Entries were scored for plant height, maturity, leaf type, and lodging. In each plot two 20' long rows were chopped with a Carter harvester, weighed, and oven dried for yield and dry matter determinations. An additional five plants per plot were sampled for quality analysis. Quality sample plants were run through a chopper and immediately dried in ovens at 60° C.

Results

2006 results are tabulated in Tables 1&2, and 2007 results are presented in Tables 3&4.

2007 Entry Notes:

Donegal (check)—*Donegal*, one of the first tall, forage-type varieties released from Dr. Devine's breeding program, is a maturity group V soybean with large leaves. The variety has a viney growth habit that tends to result in a tangled canopy and accounts for its high lodging scores. *Donegal* produced the highest mean yield in the 2007 trial. Its performance was consistent with past years as it reached the R5 development stage by harvest, had an average yield of 3.7 tons/acre dry matter, NDF of 40.5%, and 16.7% crude protein.

Tara (check)—*Tara* is also a tall, large leaved, maturity group V release from Dr. Devine's program. *Tara* stands well and had few lodging problems in the 2007 trial. Reduced lodging problems are accompanied by a slightly higher mean NDF reading (42.3) compared to *Donegal*. *Tara* yields were similar to *Donegal*.

XB17—A large leaved, relatively tall entry that is listed a maturity group III line. In Chazy trials it has consistently matured with *Donegal* and *Tara*, which are both listed as maturity group V. *XB17* has exhibited a viney growth habit in previous trials, especially toward the top of the plant, and as a result has tended to have some lodging problems. In the 2007 trial it was shorter than previous years and did not lodge. The yields were also lower (mean of 3.1 tons/acre) than in previous trials.

97NYCZ33-1—A tall, large leaved selection that stands well and had no lodging problems. *97NYCZ33-1* is listed as a maturity group III, but matured slightly behind *Donegal*, *Tara*, and *XB17*, and had not reached the R5 development stage at harvest. Forage quality was similar to *Donegal* and *Tara*, but the line yielded less than the two checks.

IA2068—This Iowa grain type variety is a short, stocky maturity group II entry with relatively small leaves. *IA2068* was the shortest and earliest maturing entry in the trial. It reached development stage R6 by the late harvest, had no lodging, yielded in the middle of the pack (3.1 tons/acre dry matter average), and very favorable quality measures (NDF at 37.1, 20.3% crude protein).

IA3023—A relatively short, maturity group III grain type variety from Iowa with large leaves and no lodging in 2007. *IA3023* developed just slightly behind *IA2068* and *4-1#3* and did not quite reach R6 by harvest. This entry yielded with the taller, later maturing entries in 2006 (4.1 tons/acre dry matter), but had one of the lowest mean yields in the 2007 trial (2.9 tons/acre). Quality measures were favorable at 21% crude protein, an NDF of 38.5, and NDFD of 51.8.

F558—A new MG VI entry that only reached R2 at harvest. Lack of seed development resulted in low crude protein levels (16.2%), an NDF of 42.4% and an NDFD of 40.8%. The high fiber levels and low fiber digestibility is consistent with the lines tall stature and low lodging scores. *F558*, while a tall, late maturing variety, had one of the lowest mean yields at 2.9 tons/acre.

IGH12-1-1—A late maturing, MG VI entry that was similar in height to *Donegal*, but stood well and had few lodging problems. This line yielded with *Tara* and *Donegal*, reached an R stage of 3.0 at harvest, and had 16% crude protein. NDF was slightly higher and NDFD was significantly lower than *Donegal* or *Tara*.

SG13#53—Another tall, MG VI entry that produced only fair yields (3.1 tons/acre). *SG13#5* reached R2 by harvest and had the lowest crude protein levels (14.6%) in the trial. NDF and NDFD were similar to *IGH12-1-1*, and consistent with the lines tall stature and good lodging resistance.

AWS#4—The tallest entry in the 2007 trial (179.8cm), *AWS#4* was also among the top yielders. The MG VI line reached R2 by harvest and had low crude protein (15.0%) and high fiber levels (45.3% NDF and 40.8% NDFD).

97NYCZ26-1—Taller than the Iowa grain soybean varieties, but among the shortest forage-type entries, *97NYCZ26-1* stood well and had no lodging. Mean yield (2.9

tons/acre) was one of the lowest in the trial. This line was fairly early maturing as it reached R5.5 at harvest, and had decent forage quality measures: 18.1% crude protein, 40.7% NDF, and 47.5%NDFD.

4-1#3—Very early maturing, the line reached R6 at harvest. Height, yield, and lodging resistance were comparable to *97NYCZ26-1*, *F5#15*, and *F5#16* with respectable crude protein levels (18.7%) and fiber measures similar to the grain-type entries (37.6% NDF and 49.5%NDFD).

F5#15&F5#16—Two closely related selections that were similar in yield, height, lodging resistance, and quality measures to *4-1#3*, even though they matured somewhat behind *4-1#3*. *F5#15* had similar fiber levels to *F5#16* and *4-1#3*, but noticeably lower NDFD.

Forage Soybean Trial Discussion

Fourteen entries were included in the 2007 trial. Six entries, including the two checks, *Donegal* and *Tara* (both MG V), the two grain-type lines from Iowa, *IA2068*(MG II) and *IA3023* (MG III), and two promising selections, *XB17* (MG III) and *97NYCZ33-1* (MG III) were repeats from 2006. New additions in 2007 included one MG II line, two MG III lines, one MG IV line, and four MG VI lines (Table 3).

The 2007 trial had a lower overall mean dry matter yield (3.2 tons/acre) than the 2006 trial (3.9 tons /acre), even though the 2007 trial had many more tall, later maturing (and theoretically higher yielding) entries. *Donegal* and *Tara* (both MG V), along with two new MG VI selections, *AWS#4* and *1GH12-1-1*, had the highest mean yields (Table 3). Crude protein levels of the four top yielding entries were in the 16-17% range, which is typical for later maturing forage-type lines that have very little seed filling prior to harvest. 2007 results provided another illustration of the trade-off between lodging resistance in the tall, forage-type soybean lines and fiber levels. *Donegal*, with its characteristic viney growth habit and associated high lodging scores, had more favorable fiber quality measures (lower NDF and higher NDFD) than the other three high yielding entries. *AWS#4*, *Tara*, and *1GH12-1-1* all stood well, but had higher fiber (NDF), a lower proportion of which was digestible.

In 2006, the two short, early maturing Iowa grain-type varieties appeared to defy the inherent trade-offs associated with maturity group, yield, percent crude protein levels, and fiber, as they produced yields comparable to the taller, later maturing, forage-type lines, but had much higher crude protein levels, lower NDF, and higher NDFD than the forage-type entries. The 2006 performance was not repeated in 2007 when the Iowa grain-type lines produced superior forage quality measures, but had significantly lower yields than the forage-type entries.

Food Grade Soybean Trials:

Background

Demand for high quality food grade soybeans continues to grow. Regional soybean processors are paying \$18.00 per bushel for organically certified, and \$10.00 per bushel for conventionally grown non-GMO soybeans, with additional price premiums paid for high protein varieties (varieties with a favorable 3:1 protein to oil ratio). Northern New

York farmers have considerable experience growing grain-type soybeans, and could significantly enhance their profit potential by incorporating food grade soybeans into their field crop rotations. If growers are going to be successful with food grade soybean production, it is essential that we identify food grade soybean varieties that are well adapted to Northern New York growing conditions and meet the quality specifications and requirements of the regional processors.

Objective

To test the agronomic performance of available varieties of food grade soybeans when produced under northern New York growing conditions.

Methods

Twelve commercially available food grade soybean varieties were included in the 2007 trial. A randomized complete block experimental design with four replications was employed. Food grade soybeans were grown on tile drained, certified organic fields with a Rhinebeck clay loam soil at the Cornell University Willsboro Research Farm. Trial plots were 10' wide and 20' long, and consisted of four rows with a 30" spacing between the rows. Target planting depth was 1" and all seed was inoculated with the appropriate *Rhizobium* sp. prior to planting. Plots were seeded May 30, 2007 and harvested October 18, 2007. Weed control measures included cultivation with a rotary hoe (two passes in opposite directions) when the plants were approximately 4" tall and had their first set of true leaves, and an additional between row cultivation with sweeps in mid summer (sweeps were mounted on an Allis Chalmers G tractor).

Food Grade Soybean Trial Results

The 2007 field season provided timely rains, and growing conditions were generally excellent. Most of the food grade soybean varieties performed well with an overall trial mean yield of 41.5 bu/acre (Table 5). *IF61* and *2IYP7* produced the highest mean yields of 45.9 bu/acre and 45.6 bu/acre, respectively. Most of the other entries yielded between 39 and 43 bu/acre. The one low outlier was *OAC Prudence* with a mean yield of 34.0 bu/acre. No disease or lodging problems were observed in the trial. Some shattering was observed with *OAC Champion* and its yield would likely have been higher if it had been harvested earlier. An additional one or two years of testing is needed to confidently assess the potential of these food grade varieties.

Outreach

Tabulated trial results will be posted on the Northern New York Agricultural Development Program website www.nnyagdev.org, and presented at regional extension meetings and field days.

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For more information:

Michael H. Davis (mhd11@cornell.edu), Research Associate, Dept. of Crop and Soil Sciences, Cornell University E.V. Baker Research Farm

Table 1. Stage of development and forage quality means at the early and late harvests in 2006.

Entry	R stage		NDF		% Crude Protein		9/15/06	
	Early Harvest 8/24/06	Late Harvest 9/15/06	Early Harvest 8/24/06	Late Harvest 9/15/06	Early Harvest 8/24/06	Late Harvest 9/15/06	% Fat	Rel. Feed Value
IA3023	4	6	35.8	35.1	20.2	21.4	3.9	178
97NYCZ33-1	2	4	40.6	41.0	17.7	17.0	2.4	147
IA2068	5	6	37.0	34.4	19.0	20.6	4.6	183
XB17	3	5	38.9	45.7	18.1	17.2	2.3	128
Tara	3	5	38.4	39.8	16.7	18.1	2.5	154
Donegal	2.5	5	39.5	40.8	17.0	17.9	2.3	149

Table 2. Mean mid-season relative maturity and lodging scores, final height, and yield for 2006 forage soybeans.

Entry	Ht. (cm) 9/15	Scale 1-10	Scale 1-10*	Percent Dry Matter on 9/15/06	(tons/acre)
		Maturity Score on 8/9/06	Lodging Score on 8/9/06		Dry Matter Yield on 9/15/06
IA3023	97.5	10.0	1.0	22.7	4.1
97NYCZ33-1	138	5.3	1.0	21.3	3.1
IA2068	92	9.3	1.0	25.6	3.8
XB17	166.3	5.1	1.8	22.9	4.2
Tara	161.8	6.3	1.3	23.3	4.1
Donegal	179.5	4.3	3.5	19.9	4.0

*1=no lodging, 10=completely lodged

Table 3. Northern New York 2007 Forage Soybean Trial Results

Variety/Selection Line	Maturity Group	Dry Matter Yield	Moisture at Harvest	Plant Height	Lodging
		tons/a	%	CM	Scale 0-10
	Trial Mean	3.2	73.6	136.3	0.9
	LSD	0.5	1.42	12.7	0.8
	LSD P>	0.1	0.1	0.1	0.1
	CV	14.5	1.6	7.8	68.8
	F Test	0.1605	0.0231	0.0001	0.0001
97NYCZ26-1	II	2.9	73.1	128.8	0
IA2068	II	3.1	72.8	90.0	0
IA3023	III	2.9	74.4	96.3	0
XB17	III	3.1	73.6	139.8	1.0
97NYCZ33-1	III	3.1	74.7	134.0	0.3
4-1#3	III	3.1	72.8	129.5	0.3
F5#15	III	2.9	73.5	126.0	0
F5#16	IV	3.0	72.6	126.5	0
Tara	V	3.5	73.1	145.3	0.3
Donegal	V	3.7	74.9	167.3	8.0
AWS#4	VI	3.5	73.1	179.8	2.0
1GH12-1-1	VI	3.5	72.3	161.0	0.8
SG13#53	VI	3.1	74.4	142.0	0.3
F558	VI	2.9	75.2	146.0	0.5

Table 4. 2007 Forage Soybean Trial Forage Quality Results

Variety/Selection Line	Maturity Group	R-Stage At Harvest	Crude Protein	NDF	NDFD
		R-stage	%	%	%
	Trial Mean	4.5	17.4	40.9	45.2
	LSD	0.2	1.6	3.5	4.9
	LSD P>	0.1	0.1	0.1	0.1
	CV	4.3	7.5	7.3	9.1
	F Test	0.0001	0.0001	0.0011	0.0009
97NYCZ26-1	II	5.5	18.1	40.7	47.5
IA2068	II	6.0	20.3	37.1	44.0
IA3023	III	5.9	21.0	38.5	51.8
XB17	III	5.0	17.1	42.2	42.8
97NYCZ33-1	III	4.9	15.9	41.1	48.3
4-1#3	III	6.0	18.7	37.6	49.5
F5#15	III	5.4	19.1	37.8	43.8
F5#16	IV	5.1	19.4	37.9	49.0
Tara	V	5.2	16.3	42.3	46.3
Donegal	V	5.0	16.7	40.5	48.0
AWS#4	VI	2.4	15.0	45.3	40.8
1GH12-1-1	VI	3.0	16.0	43.7	41.0
SG13#53	VI	2.3	14.6	45.1	39.5
F558	VI	2.0	16.2	42.4	40.8

Table 5. 2007 Food Grade Soybean Trial Results

Variety	Yield	Moisture	Plant Height	Lodging
	Bu/acre	%	inches	0-9 scale
Trial Mean	41.5	12.8	33.3	0
LSD	3.9		2.0	
LSD P>	0.1		0.1	
CV	7.8	9.2	8.9	
F Test	0.0018	0.3051	0.0001	
1F61	45.9	13.2	28.2	0
21YP	45.6	12.9	35.5	0
OAC Oxford	42.8	11.7	35.7	0
2F11	42.6	13.3	27.2	0
CFO703	42.3	13.4	36.4	0
IA24	42.0	12.9	27.9	0
OAC Champion	41.8	13.0	32.0	0
SO8-80	41.6	13.6	32.9	0
SO3W4	40.4	12.5	33.4	0
1F44	40.2	11.5	34.4	0
Boyd	39.1	13.2	43.9	0
OAC Prudence	34.0	12.4	31.9	0