1998 Forage Soybean and Corn Research Trial
A Collaborative Research Project Between
UVM Extension Service and Senesac Farm, Colchester, Vermont[1]

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Introduction

Dairy farmer interest in soybeans as a forage crop comes from a variety of directions. Soybeans are a very good source of protein, with roasted soybeans providing 42% crude protein (dry matter basis). (Gibson, 1995) In contrast to alfalfa, another important protein source produced on-farm, soybeans are an annual crop providing farmers with greater flexibility and lower costs as they design their crop rotations. Similar to other leguminous crops, soybeans offer the advantage of producing the nitrogen needed for their own development. Furthermore, the need for nitrogen for a following crop of corn or small grains is reduced by about 30 lbs/acre compared to a previous crop of corn. (Jokela, 1997)

Soybeans are typically grown as a grain crop and chopped for silage if it appears that the crop will not reach maturity or if time and equipment constraints do not make it feasible to harvest the crop for grain. The recent development of larger soybean plants has increased interest in soybean as a forage crop, although there is little research available that documents the yields of these new varieties. Furthermore, there is interest in the benefits of chopping soybeans with corn to promote good silage fermentation. (C. Altemose, personal communication)

Project Description

The research was conducted at the Senesac Farm in Colchester, Vermont in 1998. Land preparation and all crop production work was done by Jeff Senesac and his father Emile. Project design and technical oversight were provided by UVM Agronomy Specialist Craig Altemose. Dan Baker served as crop consultant, collecting pest and disease data, and assessing crop health throughout the season. UVM intern Kris Ellison compiled weather data.

The project involved strip cropping a forage soybean with a corn variety, alternating a 4-row planting of soybeans with a 4-row planting of corn. Seedway provided *"Bass"* forage soybean, maturity group 3, for use in the trial. The corn variety grown was a Dekalb 100 day silage blend.

Box 1:

Soil Test Results

pH	6.7
Avail. P	39.0 (high)
Res. P	160 (high)
K	36 (low)
Mg	82 (opt)
Al	11
Ca	1462
Effect. CEC	8.1
Zinc	3.1 (high)

Sampled prior to spreading manure

Soil Fertility

The research plots was located on Hadley very fine sandy loam soil. The soil is well-drained and flat. Continuous corn grown for silage is typically grown on this part of the farm and corn was the preceding crop on the research plot.

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[1]*Report prepared by Dan Baker, Jan. 1999*

Optimum soil pH is between 6.2 and 6.8 for soybeans. A typical 40 bushel/acre soybean crop removes approximately 130 lbs/acre of nitrogen, 40 lbs/acre P205 and 55 lbs/A of K20. The results of a soil sample taken on 4/28/98 and sent to the UVM lab are detailed in Box 1.

Soil fertility management involved spreading 10 tons/acre of dairy manure, incorporated within one day of spreading. Manure test results are described in Box 2. The soybeans were inoculated with *HiStick* inoculant at 100 grams per 60 lbs of seed. Synthetic fertilizer on the soybeans included only 200 lbs/acre of 15-15-15 fertilizer at planting. Corn starter was 230 lbs/acre of 12-24-12 fertilizer..

Box 2:

Manure Test

	lbs/wet ton
DM %	21.9
Total N	8.1
Organic N	7.2
Ammonium N	0.9
P205	5.4
K20	2.7
Calcium	3.0

Weed Control

Weed pressure was heavy, with velvetleaf dominating among the weeds. Initial weed control was imposed during field preparation using a field cultivator. A preemergence application of *Broadstrike+Dual* at 2 pints/acre on 5/21 resulted in excellent weed control until well after canopy closure. A complete weed list is provided in Box 3.

Box 3:

Weeds

velvetleaf (severe)
lambsquarters
plaintain
buckwheat
stinging nettle
shepherdspurse
burdock
dock
buttercup
ground ivy
box alder
fall panicum
crabgrass
reed canarygrass

Planting

The crop was planted on 5/18/98 at a depth of 1.5" for both the soybeans and the corn with rows running east-west. Soil temperature at 12:30 P.M. was 69 degrees at 5" soil depth. Rows were oriented east-west. Soybeans were planted using a Monoseen air planter in rows spaced 34" apart. The corn was planted on 32" rows with a John Deere corn planter. Ideally the soybeans would have been planted at a population of 200,000 ppa, but equipment limitations restricted the population target to no more than 170,000 (9-10 seeds/ft). The corn population target was 36,000 ppa.

Pests and Disease

A number of pest and disease problems were observed during the growing season. Although no insect or disease problem reached a level at which control was warranted, a number of pests were observed that could pose problems in the future.

Early season
No dead seedlings were observed during scouting in 6/1 and 6/18. However, signs of *Fusarium root rot* was observed on the roots of a few seedlings (<1% plants affected). Soybeans at this time were in the V1 stage.

The most serious injury to affect the young soybean plants was carryover from the previous years application of the herbicide Banvel, whose active ingredient in *dicamba*. Lower leaves on the soybean plants were uniformly cupped and crinkled. Leaves higher than 5" were not affected. Photo 1 illustrates the injury observed in the field.

Photo 1: Dicamba injury

Some tearing of upper leaves was observed following a severe rainstorm, that might have also contained some hail. Leaves affected remained otherwise green and healthy. (See Photo 2)

The most significant insect injury during the early stage was that of the Mexican Bean Beetle (see Photo 3). This pest was first observed feeding on the soybean leaves on 6/17 and was present through 7/31. Mexican Beetles and their larvae were never observed at economically significant levels, and populations remained at less than 1% of plants. Damage from this pest can be significant however and economic injury levels have been set depending on the stage of the plant. For example, control is recommended when 1 -1.5 larvae/plant are found. Prior to full bloom control is recommended if 30-35% defoliation is observed and if defoliation reaches 15% during pod-set and pod-fill. Mexican Bean Beetles are strong fliers, capable of traveling long distances in search of new fields. The beetles overwinter under collections of brush and leaves although it is not known whether the low populations of beetles found overwintered in the area or flew in. (Sanchez-Arroyo, 1997).

Mid to Late Season Pests
The most significant soybean pest observed during the mid to late season was the Japanese Beetle. First found on 7/31, it remained in the field throughout August and a few individuals could still be found in Sept. (See Photo 4) Although not typically considered a pest of soybeans, this insect is

a voracious feeder and could pose problems for soybean producers if they become established in the field. Japanese Beetle populations were found on about 1% of plants by late August, after which their population declined. Control is recommended when 35% defoliation occurs prior to bloom or if defoliation reaches 15% during bloom. The beetle overwinters as a grub close to the soil surface. Populations are typically controlled by milky spore disease.

Small white spots were observed on upper leaves that may have indicated ozone injury.

Photo 2: Hail and Heavy Rain Damage

Photo 3: Mexican Bean Beetle

Insect pests on corn included a very few observations of Northern Corn Rootworm and more frequent signs of injury from European Corn Borer. Injury from this latter pest was observed on 2% of corn plants. Although generally not considered a major problem in silage corn, yield losses can be significant in corn crops grown for grain. Generally, control is accomplished by clean plowing in the fall and conservation of natural enemies. Insecticide treatment is generally not recommended and is not economical. (Cornell Recommends, 1998)

Photo 4: Japanese Beetle

Crop Growth

Table 1 tracks crop growth throughout the growing season. A small plot of grain soybeans grown adjacent to the research highlighted the difference between the forage soybeans and grain varieties. For example, at the end of July the forage soybeans were at stage R1 to R2 flowering with no pod development, while the grain beans Korada and Secord varieties) were in stages R3 to R4 with pod development on all plants. Forage beans were also notably taller and leafier than grain beans throughout the season. By harvest time, the grain beans were well on their way to drying down (R8) while the forage soybeans had just entered R7.

Nutrient deficiencies were readily apparent on the corn crop. The general yellow and pale plants characteristic of nitrogen deficiency was especially apparent in the lower and wetter spots in the field.

A soil nitrogen test was taken in mid-July both in the soybean plots and in the corn plots. Within the soybean plot 28 ppm nitrogen was measured, while in the corn plots soil N was only 19 ppm. Generally, soil nitrogen for corn is deficient when it is below 25 ppm. To assess the changes in soil nitrogen over the course of the season another N-test was taken on 8/21. This test showed only 2 ppm in the soybean plots and 1 ppm in the corn plots. Samples taken between the corn and soybean plots found only 2 ppm.

Potassium deficiency could be seen during the latter part of the growing season on the “firing” along the edges of the leaves. It was also very common to find ears that had not fully developed.

Table 1: Crop Growth & Development			
Date	***Seedway “Bass” Forage Soybeans - Group 3***		***Corn*** ***Dekalb - 100 day Silage Blend***
	Stage	***Comments***	
5/18/98		*Planted on 34" rows @ 1.5" deep.* *Soil temp. = 69^0 @ 5" depth.* *Target population was 170,000 ppa*	*Planted on 32" rows @ 1.5" deep* *Target population: 36,000 ppa*
6/1	*VC*	*1st True leaves, plants 1-1.5" tall*	*2 leaf stage*
6/17	*V1*	*2nd trifoliate leaf unfolded* *Plants 4.5" - 5" tall* *Population: 102,908 ppa* *Nodules forming*	*6 leaf stage* *10"-12" tall* *Population: 36,435 ppa*
6/26	*V3*	*Nodulation light*	*N-test taken*
7/15	*V5-V6*	*Plants not yet flowering.* *21-25" tall.* *Large nodules on taproot, few on lateral roots*	*10-11 leaf stage.* *N-deficiency observed*
7/22	*R1*	*Flowering*	*Small, circular white spots with dark margins observed on leaves*
7/31	*R2*	*Flowering continues, no pods* *Rows nearly canopied over.* *Plant height 32"-45"*	*Tassling*
8/17	*R3-R4*	*Pods developing*	*K deficiency observed. N deficiency.*
8/25	*R5*	*Seed filling*	*Milk stage*
9/16	*R6*	*Pods have beans, some beans still developing*	*Corn dented. Tips did not fill.*
9/23	*R6-R7*	*Most pods green, with nearly 1 pod/plant yellowing.* *Lower pod height 5-6" from soil.*	*Fusarium on stalks.* *Corn borer*
9/24		*Harvest*	*Harvest. Full Dent*

Results

The crop was harvested on 9/24 at the beginning of the R7 stage. Samples of the forage soybean was harvested by hand at a height of 5" and weighed in the field to estimate yields. The remainder

of the soybean and corn crop was chopped with a standard corn chopper. For the feed nutrient analysis the soybean forage sample was taken at the chopper and the mixed corn/soybean sample was taken when the forage was blown into the silo. Harvesting at the R7 stage balances the goals of providing both the greatest tonnage possible with the highest protein levels. In this particular research trial, corn stage was also a factor and the readiness of the corn crop necessitated harvest of the forage soybean at the beginning of its harvest window.

Pods on the forage soybeans were 5"-6" above the soil, making it possible for the chopper to harvest nearly all the grain available. There was an average of 62.8 pods/plant, ranging from 51 to 73 pods/plant. Box 4 provides data on the distribution of the number of beans per pod.

Box 4

Distribution of Beans/Pod

Beans/Pod	% Pods	Range	Pod Length
3 Beans	53.5%	48-59%	1.6" - 1.8"
2 Beans	29%	26-32%	1.3" - 1.6"
1 Bean	10%	8-12%	1.0"- 1.4"
No Bean	7.5%	3-12%	<1"

Table 2 presents the yield data from the soybean plot. The forage soybean compares quite favorably to yields from alfalfa, the most common alternative legume crop. Whereas average yields from all soybean plots were 3.3 tons D.M./acre, alfalfa grown on the Senesac Farm only provides 2-3 tons D.M./acre. Furthermore, the soybean crop is only harvested once, compared to three harvests to obtain the full tonnage for the alfalfa crop. For comparison, a typical corn crop yields an average of 6 tons D.M./acre.

Table 2 also shows the influence of shading of the soybean crop by the adjacent corn crop. In all plots the southernmost soybean rows were lower yielding than the northern rows. The crop yield increased by nearly 37% south to north. The 1998 season had more cloud cover and greater precipitation than most years and further research will be needed to see whether the influence of shading would be as pronounced in a more typical year.

Table 3 contains the results of the laboratory analysis of the nutrient quality of the soybean silage and the corn/soybean mixed silage. The soybean silage clearly boosted the protein content of the mixed silage, however, harvesting soybeans at R7 as opposed to R8 clearly has some costs, as CP as % of DM in roasted soybeans typically reach 42%. (Gibson, 1995). The soybean silage and corn/soybean mixed silage also provided reasonably high energy levels when compared with a corn crop taken off an adjacent field which returned only 0.67 Nel Mcal/lb on a D.M. basis. Overall nutrient levels were down in almost all fields on the farm this year due to exceptionally wet conditions. A more typical year would have corn returning energy in the 0.74 Nel Mcal/lb range on the Senesac Farm.

The dairy herd fed the mixed silage appeared to accept the soybean forage. Farmer Jeff Senesac noted that the relatively small quantity of feed made it difficult to assess impact on milk production.

Table 2: Yield Data (Tons DM/A) 1998 Seedway "Bass" Forage Soybean (Maturity Group 3) Senesac Farm - Colchester, VT					
	Row 1 (South)	Row 2	Row 3	Row 4 (North)	*Plot Average*
Plot 1	3.52	3.61	3.86	3.84	*3.71*
Plot 2	2.86	3.49	4.16	4.14	*3.66*
Plot 3	2.55	2.62	3.02	3.52	*2.93*
Plot 4	2.39	2.84	3.55	4.02	*3.20*
Plot 5	2.83	3.05	3.63	3.05	*3.14*
Plot 6	2.47	2.66	3.39	4.19	*3.18*
Row Average	*2.77*	*3.05*	*3.60*	*3.79*	*3.30*
Harvested by hand at 5" on 9/24/98 @ 22.45% DM					

Table 3: Nutrient Analysis 1998 Seedway "Bass"Forage Soybean (Maturity Group 3) Senesac Farm - Colchester, VT							
	% DM	% CP	% ADF	% NDF	% Fat	% Ash	Nel Mcal/ lb
Soybean							
As Fed	22.45	5.45	7.30	8.45	1.70	2.20	
DM Basis		24.15	32.5	37.85	7.6	9.75	0.645
Corn/Soybean							
As Fed	29.8	3.2	9.15	13.1	1.2	1.7	0.19
DM Basis		10.85	31.0	44.4	4.2	5.65	0.66
Samples taken of chopped soybeans and soy/corn immediately after harvest							

Conclusion

Forage soybeans can produce high yields and a good quality silage in Vermont. When strip cropped between rows of corn the resulting silage has higher protein than corn silage alone. The nitrogen benefit to the corn crop was not immediately apparent in this trial, although precipitation

during 1998 was at record-breaking levels and nitrogen deficiency was widespread both on the Senesac Farm and throughout the region. Strategies such as varying row and plot width, as well as orientation should be assessed with the aim of mitigating the impact of shading of the soybeans by the corn crop.

Bibliography

Cornell Recommends for Integrated Field Crop Management (1998). Cornell Cooperative Extension, Cornell University, Ithaca, NY

Gibson, Stew (1995) *Feeding Soybeans: Whole, Raw or Heat-Treated Beans, Soybean Silage.* University of Vermont Extension Service, Presented at the Vermont Soybean Conference and Trade Show, Dec. 15, 1995. Essex, VT

Jokela, Bill (1997) *DRAFT:Soil Fertility Management for Soybeans in Vermont.* University of Vermont Extension Service, Burlington, VT

Iowa Cooperative Extension Service (1994) *How a Soybean Plant Develops* Special Report #53. Iowa State University, Ames, Iowa

Sanchez-Arroyo, Hussein (1997) *Featured Creatures: Mexican Bean Beetle.* Dept. Of Entomology and Nematology, University of Florida, publication #EENY-15

Sinclair, J.B and Backman, P.A. (3rd edition) *Compendium of Soybean Diseases*. APS Press.