



Northern NY Agricultural Development Program 2016-2017 Project Report

Breeding Alfalfa Varieties with Resistance to Alfalfa Snout Beetle

Project Leader(s):

- Don Viands, Cornell University School of Integrative Plant Science, Plant Breeding and Genetics Section, 523 Bradfield Hall, Ithaca, NY; 607-255-3081; drv3@cornell.edu
- Jamie Crawford, Cornell University School of Integrative Plant Science, Plant Breeding and Genetics Section, 101 Love Lab, 126 Medicago Drive, 607-255-5043; jln15@cornell.edu
- Julie Hansen, Cornell University School of Integrative Plant Science, Plant Breeding and Genetics Section, 101 Love Lab, 126 Medicago Drive, Ithaca, NY; 607-255-5043; jlh17@cornell.edu
- Elson Shields, Cornell University Department of Entomology, 4144 Comstock Hall, Ithaca, NY; 607-255-8428, es28@cornell.edu
- Antonio Testa, Cornell University Department of Entomology, 4144 Comstock Hall, Ithaca, NY; 607-591-1493, at28@cornell.edu

Collaborators:

- Michael Hunter, Regional Field Crops and Soils Specialist, Cornell University Cooperative Extension, Northern New York; 315-788-8450, meh27@cornell.edu
- Joe Lawrence, Dairy Forage Systems Specialist, Cornell University PRO-DAIRY, Lewis County, 315-778-4814, jrl65@cornell.edu

Cooperating Producers:

- Lewis County; Marc Larabee, Grace-Way Farm, 9627 State Route 26, Lowville, NY 13367-2939

Background:

Alfalfa snout beetle (snout beetle, ASB), *Otiorychus ligustica*, is the most destructive insect pest of alfalfa in Northern New York (NNY). Alfalfa snout beetle is currently infesting soils in nine NNY counties and in Ontario, Canada, across the St. Lawrence

River from New York State. This pest causes severe yield and stand losses on alfalfa by larval feeding on alfalfa roots.

The Cornell alfalfa breeding program (D. Viands, J. Hansen, and J. Crawford) and the Cornell Entomology program (E. Shields and A. Testa) have been cooperating to develop a two-pronged approach to control alfalfa snout beetle on alfalfa:

- 1) identify and incorporate resistance genes into alfalfa varieties adapted to northeastern USA (breeding for resistance and the focus of this grant), and
- 2) identify and establish in NNY biological control nematodes (Shields and Testa).

Both of these insect control strategies are necessary to reduce alfalfa snout beetles to sub-economic numbers.

We continue to use the greenhouse screening method developed by E. J. Shields and A. Testa with funding from the Hatch Act and grants from the farmer-driven Northern New York Agricultural Development Program, to identify and select alfalfa plants that appear to be resistant to alfalfa snout beetle. Screening more than 30,000 seedlings annually, we have completed up to 15 cycles of selection in several alfalfa populations.

Other breeding strategies for developing alfalfa with resistance to alfalfa snout beetles have been digging surviving plants from trials on alfalfa snout beetle-infested fields to develop new populations, and intercrossing resistant populations to capture hybrid vigor.

Impacts from past research:

In previous reports, we showed significant progress developing alfalfa snout beetle-resistant alfalfa in experiments conducted under controlled greenhouse conditions. The greenhouse experiments are being complemented by field experiments in NNY.

From the results of several field experiments, progress is being accomplished in selection for alfalfa with resistance to snout beetle. **The first variety released from this breeding program, Seedway 9558 SBR, is now being used by growers in NNY.**

Seedway 9558 SBR has moderate resistance to alfalfa snout beetle both when tested in the greenhouse and in the field. However, our goal is to continue to develop resistant varieties that have higher levels of resistance to alfalfa snout beetle and to continue to test the most advanced breeding lines in field trials in NNY, both with and without application of the biocontrol nematodes that have been proven to reduce ASB populations to more manageable levels (NNYADP research).

We believe that higher levels of resistance are achievable and would provide more effective control. Furthermore, we have dug survivor plants from advanced breeding lines in field trials in alfalfa snout beetle-infested areas and these plants should add resistance and agronomic adaptation genes to the alfalfa snout beetle resistant germplasm populations.

Methods:

Alfalfa Snout Beetle Capture in NNY for Storage in Coolers at Cornell:

On April 27, 2017, several thousand alfalfa snout beetles were collected on Griffith Road in Lowville in Northern New York's Lewis County by Tony Testa and others from the Cornell Forage Breeding Project.

More than 5,000 alfalfa snout beetles were collected in the spring of 2017 in NNY. Two videos are available on YouTube that document the spring emergence of the beetles in Lowville (search Alfalfa Snout Beetle on www.youtube.com). The beetles were taken back to Ithaca, put in clean petri dishes sealed with parafilm for storage in a cooler and were put in clean petri dishes every month until the beetles were used for egg production.

The beetles were taken out of storage in early July and fed alfalfa stem tips. During this eating phase, the beetles started laying eggs. The alfalfa snout beetle eggs were used to inoculate the alfalfa tubs. After 6 weeks or so, alfalfa plants that were not damaged by alfalfa snout beetle larval feeding were selected to develop new alfalfa populations.

Alfalfa Selection for Resistance to Alfalfa Snout Beetles:

The alfalfa populations for screening for resistance to snout beetle were planted in greenhouses at Cornell in Ithaca, NY, in late June. The seedlings were inoculated with ASB eggs in mid-July 2017. After inoculating with eggs, the tubs of alfalfa were left to grow in the greenhouse for another 6 to 8 weeks.

In early September, each alfalfa seedling in the tub was dug up and roots were washed to see the level of root scarring from the alfalfa snout beetle larvae. The seedlings that had no root feeding damage from the alfalfa snout beetle larvae were selected and grown in the greenhouse until flowering and pollinating to produce seed, thereby completing one cycle of selection.

Alfalfa Population Evaluation Trial in Greenhouse:

In 2017, eight replicates of eight alfalfa populations were planted in greenhouse tubs (Table 1): two population crosses, two populations selected for 9 cycles of breeding for resistance to alfalfa snout beetle, Seedway 9558 SBR, and three populations not selected for resistance.

The plants were inoculated with alfalfa snout beetle eggs in mid-July. In September, each plant in the experiment was dug and rated for ASB feeding damage on a 1 to 5 scale: 1 = no feeding damage, 5 = severe feeding damage.

Table 1: Alfalfa populations and varieties evaluated for resistance to alfalfa snout beetle larval feeding damage to roots; one evaluation completed in greenhouse, one evaluation planted in field (2-3 year experiment); NNYADP project, 2017.

Alfalfa Populations/Variety	Breeding for Alfalfa Snout Beetle
Seedway 9558 SBR	Seedway 9558 selected 7 cycles for ASB resistance
NY1204	NY9117 selected 9 cycles for ASB resistance
NY1201	Leafhopper resistant selected 9 cycles for ASB resistance
NY1518	Guardman II selected 1 cycle crossed to Seedway 9558 selected 9 cycles
NY1517	Seedway 9558 selected 12 cycles crossed to leafhopper resistant selected 12 cycles
NY9117	Not selected for ASB resistance
Seedway 9558	Not selected for ASB resistance
Guardsman II	Not selected for ASB resistance

Alfalfa Population Evaluation Trial in NNY Field:

In 2017, the spring planting season was quite rainy so many crops were planted late, including a new alfalfa trial at Lowville. Mr. Marc Larabee of Grace-Way Farms kindly permitted a new alfalfa trial to be planted in one of his fields that has high alfalfa snout beetle pressure. The trial was planted on June 13 and has nine replicates of nine alfalfa varieties/populations. The nine alfalfa trial entries are the eight populations tested in the greenhouse evaluation plus SW 315LH (Table 1), the new Cornell leafhopper-resistant alfalfa variety (expected to have low resistance to alfalfa snout beetle). Herbicides were applied to the trial on July 19.

On August 30, the first-growth forage was cut. The trial forage growth was not uniform enough for data collection. However, the plant stands in the plots were very uniform and the trial in excellent condition for harvest in 2018 and beyond. In the spring of 2018, the Shields group will apply nematodes to three of the nine replicates.

Results:

From the greenhouse selection protocol in 2017, five alfalfa populations were advanced one more generation this year, so that some populations have been selected up to 15 cycles. Seed has been produced for these new alfalfa populations.

A greenhouse evaluation of alfalfa snout beetle-resistant populations (Table 2) compared to populations not selected for resistance was completed in 2017. This evaluation had lower than expected levels of alfalfa snout beetle larval root feeding and differences among populations were less than in the past. However, the trends in comparisons showed improvements in resistance to alfalfa snout beetle in the advanced populations.

The average percentage of resistance for the three unselected populations was 31%, a higher level than expected, probably due to susceptible plants that escaped feeding damage and were rated as resistant.

Three populations in the evaluation had been selected for 7 to 9 cycles of resistance to ASB. The average percentage of resistance for these three selected populations was 36%.

Some of the advanced populations were crossed. The two crosses tested had the average percentage of resistance was 40%. The population that is a cross of two populations selected for 12 cycles of resistance to alfalfa snout beetle had the highest percent resistance at 44%.

Table 2: Percent resistance to alfalfa snout beetle (ASB) for alfalfa populations in the Cornell University Alfalfa Breeding Program. This evaluation was completed in a greenhouse in 2017; NNYADP Project, 2017.

Population	Breeding History for Resistance to ASB	% Resistance
NY9117	Not selected for ASB resistance	26
Seedway 9558	Not selected for ASB resistance	38
Guardsman II	Not selected for ASB resistance	29
Seedway 9558 SBR	Seedway 9558 selected 7 cycles for ASB resistance	42
NY1204	NY9117 selected 9 cycles for ASB resistance	37
NY1201	Leafhopper resistant alfalfa selected 9 cycles for ASB resistance	29
NY1518	Guardman II selected 1 cycle crossed to Seedway 9558 selected 9 cycles	36
NY1517	Seedway 9558 selected 12 cycles crossed to leafhopper resistant alfalfa selected 12 cycles	44

Conclusions/Outcomes/Impacts:

From the results of field and greenhouse experiments, progress is being made in selection for alfalfa with resistance to alfalfa snout beetle. The first variety released from this breeding program, Seedway 9558 SBR, is now being used by growers in NNY. This variety has moderate resistance to alfalfa snout beetle and when used in combination with the entomopathogenic nematodes that have been released by Dr. Elson Shields’ NNYADP alfalfa snout beetle research project should provide some control against this destructive insect.

Our goal is to continue to developing resistant varieties that have higher levels of resistance to alfalfa snout beetle and to continue testing the breeding lines developed in field trials in NNY and in greenhouse evaluations. New alfalfa populations that have improved resistance to alfalfa snout beetle are also being tested for other traits of interest to producers such as fall dormancy and disease resistance. We believe that higher levels of resistance are achievable and would provide more effective control. Seed company representatives are very interested in adding a new alfalfa snout beetle-resistant variety with higher resistance to their sales line-up.

Outreach:

The progress in developing alfalfa snout beetle-resistant alfalfa was shared at:

- March 22, 2017: Extension presentation on 2016 Forage Yield Summary and Breeding for Insect Resistance in Alfalfa, Empire Tractor, Cazenovia, NY.
- July 6, 2017: Seedsmen's Field Day, Ithaca, NY,
- November 14, 2017: Cornell Cooperative Extension In-Service Meeting
- December 21, 2017: Annual Meeting with Seedway.

Outreach is often to extension educators who work with the regional farmers. A factsheet for posting and distribution is in Appendix 1.

Next Steps:

Although significant breeding progress has been accomplished, we believe that much higher levels of resistance will be needed and can be achieved through further breeding efforts. Thus, selection and breeding work, followed by evaluation, need to continue to develop alfalfa with lower root damage score and higher percent resistance. Additional field experiments are needed to determine the benefits (higher yield and less root feeding damage) of higher levels of resistance under actual growing conditions and climate as these plant populations are developed. Also of interest is to concentrate on combining resistances to ASB and potato leafhoppers into new varieties of alfalfa. Additionally, Seedway 9558 SBR is being tested for resistance to clover root curculio, another serious root feeding insect on alfalfa.

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Reports and/or articles in which results of project have been published:

- Yields of Seedway 9558 SBR on fields that are not infested with alfalfa snout beetle - New York Forage Legume and Grass Cultivar Yield Trials Summary for 2017 – Season Totals. J. Hansen, D. Viands, R. Deubler, J. Crawford, J. Schiller, R. Crawford, Department of Plant Breeding and Genetics, College of Agriculture and Life Sciences, Cornell University, Ithaca, NY 14853, <https://plbrgen.cals.cornell.edu/research-extension/forage-project/ny-forage-yield-results>

For More Information:

- Dr. Donald R. Viands, Cornell University Section of Plant Breeding and Genetics, School of Integrative Plant Science, 523 Bradfield Hall, Ithaca, NY 14853-1902; 607-255-3081; drv3@cornell.edu; <http://plbrgen.cals.cornell.edu/people/profiles/viandsdonald.cfm>
- Dr. Julie L. Hansen, Cornell University Section of Plant Breeding and Genetics, School of Integrative Plant Science, 101 Love Lab, Ithaca, NY 14853-1902; 607-255-5043; jlh17@cornell.edu
- Marc Larabee, Grace-Way Farm, 9627 State Routes 26, Lowville, NY 13367-2939.