



Northern NY Agricultural Development Program 2012-2014 Project Report

Breeding Alfalfa Varieties with Resistance to Alfalfa Snout Beetle

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Collaborator(s):

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- . Haskell Yancey, 7981 Long Pond Road, Croghan, NY 13327-2508
- . Michael Hunter, Field Crops Specialist, Cornell Cooperative Extension, Jefferson/Lewis counties
- . Joe Lawrence, CCA, Lowville Farmers Coop

Cooperating Producers:

Jefferson County: Alfalfa snout beetles were collected along the roads. The alfalfa trial harvested in 2014 was on land owned by Doug Shelmidine, Sheland Farms, Adams, NY. Also, plants were dug and used in breeding project for ASB resistance.

Lewis County: The alfalfa trial planted in 2013 and harvested in 2014 was on land owned by Gary Berrus, Limestone Ridge Farm, Lowville, NY. Also, plants were dug and used in the breeding project for ASB resistance. The alfalfa trial planted in 2014 was on land owned by Haskell Yancey, Croghan, NY.

Background:

Alfalfa snout beetle (ASB), *Otiorhynchus ligustica*, is the most destructive insect pest of alfalfa in Northern New York (NNY), and is continuing to spread. Alfalfa snout beetle is currently infesting nine NNY counties and has invaded Canada across the St. Lawrence River. Otherwise, there is no other known infestation of this insect in North America.

This pest causes severe yield and stand losses on alfalfa by larval feeding on alfalfa roots. New infestations are often mistaken for winter injury since the majority of plants die after the last harvest and before spring growth. With other introduced insect pests, two combined strategies have been effectively used to reduce the insect populations to manageable levels. These strategies are 1) identify and incorporate resistance genes into alfalfa varieties adapted to NNY (breeding for resistance) and 2) identify and establish in NNY biological control organisms from the native home of ASB.

None of the alfalfa varieties grown in northern USA during the 1990s appeared to be resistant when grown on a field heavily infested with ASB. In 1998 at Watertown, NY, the perennial *Medicago* core collection and other germplasms were evaluated for resistance/tolerance to root feeding damage by ASB by visually rating individual plants with a score from 1 to 5 (1 = no root damage, 5 = dead plant). The ASB damage score for 173 plant populations ranged from 3.7 to 4. This variability suggested that resistance genes may exist at a low level in a few populations. Therefore, we initiated recurrent selection to increase the level of resistance in the most resistant populations.

Because of the time-consuming and unreliable nature of field screenings, a greenhouse screening method was developed by E. J. Shields and A. Testa with funding from the Northern New York Agricultural Development Program. With this greenhouse screening method, the ASB population pressure can be controlled by the number of eggs applied uniformly to each flat and by the length of time that the larvae are allowed to feed on the alfalfa roots. Thus, plants with a low level of resistance can be selected and, over many cycles of selection, the frequency of resistance genes can be increased in several alfalfa populations. The first cycle of selection was completed on several plant populations in 2003, and selection has continued at the rate of one cycle per year. Screening an average of 20,000 seedlings annually, we have completed up to twelve cycles of selection in seven alfalfa populations.

Replicated field trials were established in ASB-infested fields in 2008, 2009, 2011 2013, and 2014. These field research trials have allowed comparison of cycles 0 and cycles 4 to 9 in several alfalfa populations to determine if the breeding efforts translate into differences in forage yield, plant stand, and root damage ratings in farmers' fields where ASB populations exist. Replicated yield trials are essential to evaluate alfalfa populations for performance in fields where ASB are at damaging levels and to determine variety potential of these populations.

Methods:

Breeding for Alfalfa Snout Beetle Resistance

About 12,800 alfalfa snout beetle adults were collected from NNY on May 8th by Cornell technicians (Entomology and Forage Breeding) for use in the greenhouse screening procedure. Alfalfa seedlings were inoculated with eggs collected from the beetles. About 35 days after inoculation, plants with the least injury were selected, and combined within populations to produce seed for the next cycle of selection. A total of about 16,750 plants were evaluated for resistance in 2014.

Field Evaluation of Alfalfa Snout Beetle Resistance in Alfalfa Populations

In each field trial, the most advanced alfalfa populations in the ASB breeding program are evaluated. This on-going evaluation is needed to identify the most promising populations for variety release and for evaluating progress in the breeding program. On a grower's (Doug Shelmidine) field that is naturally infested with ASB in NNY, a plot trial was established (2011) and harvested for the third production year (2014). In the fall, alfalfa plants were dug from the Guardsman II plots to incorporate in the breeding program.

A plot trial planted in Lowville on May 1, 2013 was harvested for yield in 2014. On November 5th 2014, all of the plants in an area of 1.8 feet x 3 feet in four replicates of the 2013 trial were dug. The plants were washed in the field and transported to Ithaca for scoring. Plants were rated from 1 to 5 where 1 was little to no root feeding damage and 5 was severe root feeding damage. Following digging in the trial, four replicates of the trial remain intact for harvesting in 2015.

A new plot trial was planted in Croghan, NY (near Lowville, Lewis County) on May 15, 2014. The farm cooperater is Haskell Yancey, a dairy and maple producer.

Results:

Yield: 2011 Trial, Sheland Farm, Adams: In 2012 and 2013, the trial was harvested three times each year (June, July, and August) and was harvested twice in 2014.

The Seedway 9558 population showed significant increases in yield between the unselected base population and cycle 4, and again between cycle 4 and cycle 7. Seedway 9558 cycle 7 is now commercially available as Seedway 9558 SBR. The cycle 8 population was lower in yield than cycle 7, however, only enough synthetic generation 1 seed was available to plant 4 replicates, thus the performance of cycle 7 is not directly comparable to the other populations planted with synthetic generation 2 seed in 8 replicates.

Guardsman II continues to perform well under ASB pressure. This variety has not been selected for resistance to ASB. Surviving plants of Guardsman II from the third production year field at Adams were dug to incorporate in the ASB breeding program. Seedlings grown from the seed produced on the dug plants will be screened for a cycle of selection in the greenhouse in 2015.

Yield: 2013 Trial, Limestone Ridge Farm, Lowville: In the first production year, the ASB selections of Seedway 9558 (Cycles 4, 7, and 9) were the highest yielding populations in the trial. Of the seven germplasm sources planted in the trial, five of them had higher yield for the populations developed for ASB resistance compared to the unselected population. The plant stands in this trial were lower than expected likely due to intense ASB feeding damage and due to Brown root rot injury plus plant death. Since the feeding damage was so intense, the trial entries were evaluated for root feeding damage one year earlier than planned or at the end of the first production year.

Root Ratings: 2013 Trial, Limestone Ridge Farm, Lowville

Of the seven populations evaluated in Lowville, six of the selected populations had higher percent resistance to ASB compared to the unselected base populations. The MIII population did not show any increase in percent resistance to root feeding compared to the unselected populations. The alfalfa populations selected for 8 or 9 cycles (not including MIII) ranged in percent resistance from 17% to 29%, whereas the original unselected populations ranged from 6% to 19% resistance. Thus, selection for resistance to ASB in the greenhouse resulted in alfalfa populations that have improved resistance in fields with high populations of ASB. Plants of Seedway 9558 cycle 9 were dug and the ones without feeding damage were grown in the greenhouse. Crosses with these plants are being incorporated into the breeding program.

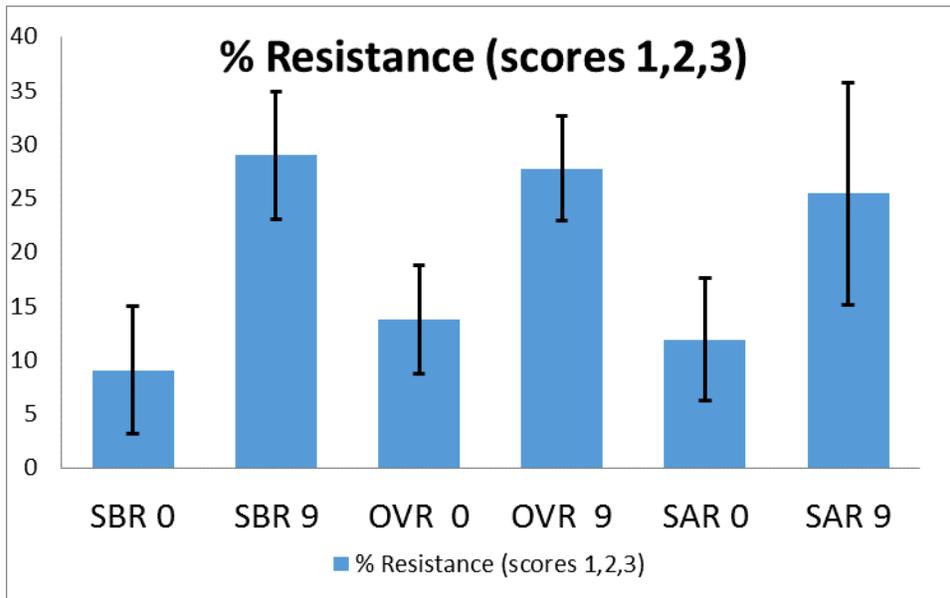


Figure 1: Three alfalfa populations and percent resistance to Alfalfa Snout Beetle. Plants were dug from the 2013 trial in Lowville and rated for Alfalfa Snout Beetle damage where 1 is no feeding damage and 5 is severe damage. See Appendix for figure showing results for all seven alfalfa populations.

2014 Trial: Yancey Farm, Croghan:

The 2014 trial in Croghan was successfully established. The trial was planted in two field areas. First, six replicates were planted for harvesting for yield. Second, three

replicates were planted that will be inoculated with nematodes in 2015. The trial was planted mid-May and there were lots of ASB adults walking around the field area. The soil type the trial is planted on is a Colton fine sandy loam, a preferred environment for alfalfa snout beetles.

Conclusions/Outcomes/Impacts:

From the results of several field experiments, progress is being accomplished in selection for alfalfa with resistance to ASB. The first variety released from this breeding program is Seedway 9558 SBR and this variety has moderate resistance to ASB. This level of resistance, in combination with the nematodes that have been released by Dr. Elson Shields' research project, should provide some control against this insect. However, our goal is to continue development of resistant varieties that have high resistance to ASB. We believe that higher levels of resistance are achievable and would provide more effective control in the long term.

Outreach:

Alfalfa snout beetle resistance breeding and accomplishments were presented at the Seedsmen's Field Day in July and at the Extension In-Service Meeting in November.

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 need to continue to develop alfalfa with lower root damage score. Also, additional field experiments are needed to determine the benefits (higher yield and less root feeding damage) of higher levels of resistance as these plant populations are developed. Also of interest is to concentrate on combining resistances to ASB and potato leafhoppers into one variety.

Acknowledgments:

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

Yields of Seedway 9558 SBR on fields not infested with alfalfa snout beetle: New York Forage Legume and Grass Variety Yield Trials Summary for 2014 – 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; <http://plbrgen.cals.cornell.edu/cals/pbg/programs/departamental/forage/foragetest.cfm>

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