Northern New York Agricultural Development Program
2017-2018 Project Final Report

Brown Root Rot of Alfalfa: Durable Genetics from Fourth Production Year Field Trial

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Background:

A field at William H. Miner Agricultural Research Institute at Chazy, NY, has been set aside for research on brown root rot (BRR) of alfalfa. This field was inoculated with several biotypes of BRR in 2009 and then an alfalfa trial was planted. The 2009 trial winterkilled in 2011-2012. In early summer 2012, surviving alfalfa was propagated and eight new alfalfa populations were developed. These eight populations were planted back to that same BRR field at Chazy in 2014. This report is about the process of selecting alfalfa plants from the BRR field in 2018.

Phoma sclerotioides, causal agent of brown root rot (BRR), is a soil-borne fungal plant pathogen causing root and crown rot of alfalfa, other perennial legumes, and overwintering grasses. This pathogen is unusual in that it is primarily active during late winter and early spring. It is sometimes described as a 'snow mold' because it actively

grows when the ground is covered by snow. The USDA Fungal Database (http://nt.ars-grin.gov/fungaldatabases/) lists *Phoma sclerotioides* as a low temperature parasite. Brown root rot has been reported in the Northeast and is associated with yield loss, winterkill, slow emergence from winter dormancy, and stand decline of alfalfa and with winterkill of grasses.

Brown root rot was first detected on alfalfa in the eastern United States in 2003 in Northern New York's Clinton County on a field close to the BRR field at Chazy. Regional surveys of alfalfa production fields suggest that BRR may be a serious factor impacting the health and persistence of alfalfa in the region. Brown root rot was found on a high percentage of plants in many fields.

In 2014, BRR was confirmed in an alfalfa trial in Ithaca, and was unofficially noted as responsible for stand decline at a farm in Lewis County. Alfalfa plants that had roots with no BRR symptoms from both of these locations have been incorportated into the Cornell Alfalfa Breeding Program, which should add genes for adaptation and resistance to BRR into advanced breeding populations.

Brown root rot can have severe effects on alfalfa yields. In Saskatchewan fields with heavy BRR disease pressure, BRR-resistant alfalfa varieties yielded 40 to 65 percent higher than BRR-susceptible varieties (second and third production years, three cuts per year); alfalfa varieties with moderate BRR resistance yielded 23 to 43 percent higher than BRR-susceptible varieties.

No management tools currently exist for BRR in NY, creating a concern for dairy farmers who grow alfalfa as a critical feed source for their cows. Furthermore, alfalfa varieties with resistance to BRR and adaptation to the Northeast are not available. Crop rotation is not an effective mangaement practice to control BRR; *P. sclerotioides* produces resting structures that can persist for extended periods in the soil without a suitable substrate, has a very broad host range, and can survive on organic matter in the soil.

Significant variability in BRR resistance has been observed among alfalfa varieties grown in Saskatchewan and in Wyoming. Two cycles of field selection for BRR resistance have been accomplished at Chazy, NY.

The results of the trial planted in 2014 with funding from the Northern New York Agricultural Development Program (NNYADP) were reported in the 2017-2018 NNYADP Project Report posted on the NNYADP website at www.nnyagdev.org. The activities from 2018 and summaries from past years are in this report.

Photo 1: Surviving alfalfa plants from Cornell experimental alfalfa populations in the trial planted in 2014 on the BRR field at Chazy, NY. Photo: J. Hansen.

Methods:

Research activities:

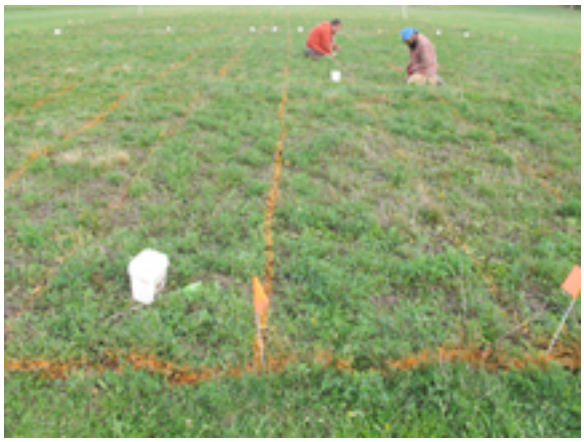
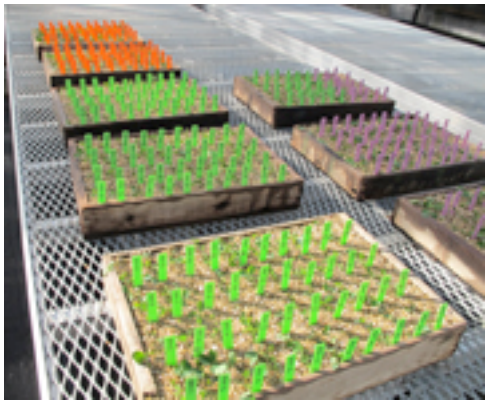
The alfalfa trial was planted in spring 2014 at William H. Miner Agricultural Research Institute at Chazy, NY. The trial entries are the eight populations developed from stem cuttings taken from survivors of the 2009 trial that winterkilled, plus the six base varieties: Ezra, Regen, N-R-Gee, Guardsman II, Oneida Ultra, and Seedway 9558 (Table 1).

On May 23, 2017, and October 16, 2018, visual percent plant-stand notes were taken on the alfalfa trial sown in 2014 at Chazy. The trial's forage was cut off and removed from the field three times in 2018 (fourth production year) with a small plot flail mower. The trial was not harvested for yield in 2018 because the plot outlines were not visible due to low and variable plant stands. The surviving plants by fall 2018 were presumed to be valuable genetic material.

In the fall of 2018 (October 16), the plots were outlined with landscape paint after using a tape measure to identify the plot locations. Then, from each plot of the cycle 1 populations selected from the 2009 BRR Trial (NY1318 to NY1325), one stem cutting was taken from each of the best 10-15 plants in each plot (Photos 2, 3). The best plants were defined as the biggest plants with the longest stems. Plants with long stems were considered to be less fall-dormant than plants with short stems. Only one stem was harvested from each selected plant so that inbreeding depression is avoided.

The stems were taken to the Cornell University greenhouses and cuttings from each stem were rooted in vermiculite. After the cuttings started to grow, the biggest cutting from each plant was potted and grown to flowering stage. Then, the plants were used to produce seed in the greenhouse using bumblebees as pollinators. Seed produced on plant cuttings of five populations will be sent to cooperators in Idaho for caged seed increases.

The greenhouse-produced seed will be sent to Idaho in early April 2019. The seed produced in Idaho will be sent to Cornell in fall 2019 for planting in yield trials in 2020.

Photos 2, 3: Left: Cornell technicians taking cuttings from surviving alfalfa plants from BRR trial at Chazy, NY. Right: cuttings from BRR trial at Chazy in the greenhouse at Cornell University. Photos by J. Hansen

Results:

The percent stand, averaged over the trial was reduced from 62% in the second production year (2016) to an average of 43% in the third production year (2017), to an average of 35% in 2018 (Photos 4, 5, Table 1). From the surviving plants in the trial planted in 2014, five new alfalfa populations were developed in 2018 (Table 2).


Photos 4, 5: Left: View of BRR trial across a replicate showing reduced plant stand in the third production year at Chazy, NY. Right: View of BRR trial showing plot to plot differences in plant stand in the third production year at Chazy, NY. Photos by J. Hansen

Table 1. Alfalfa varieties and experimental populations in the 2014-sown brown root rot trial at Chazy, NY, third and fourth production-year results for %stand (2017 and 2018), yield (2015, 2016, 2017), rank for yield, and winter survival (2016-2017).

Populations	% Stand 23-May-17	% Stand 16-Oct-18	3-Yr[ǂ] Total Yield tons/acre	Yield[ǂ] Rank at Chazy (out of 16)	2016-17 Winter Survival Rating*
NY1322	60	45	8.07	1	1.0
NY1323	43	42	7.89	2	1.7
NY1325	49	40	7.78	3	2.0
NY1319	46	42	7.74	4	2.3
NY1324	46	45	7.65	5	1.3
NY1321	45	33	7.65	6	1.3
Guardsman II	37	31	7.06	8	2.3
NY1320	40	34	7.02	9	2.3
Ezra	38	30	7.00	10	2.3
Regen	38	33	6.93	11	2.0
Oneida Ultra	37	32	6.91	12	2.0
NY1318	48	35	6.80	13	2.3
Seedway 9558	32	28	6.60	14	2.7
N-R-Gee	38	38	6.56	15	2.0

* Winter Survival Rating: 1=Extremely winterhardy 2=Very winterhardy 3=Winterhardy.

Yield Rank: #7 was Lander and #16 was Peace, not tested for winterhardiness.

[ǂ] 3-Yr Yields are totals from 2015, 2016, and 2017.

Table 2: Alfalfa experimental populations developed from 2014 BRR trial at Chazy, NY.

Populations developed from 2012 BRR Trial	Pedigree	New Populations developed from 2014 BRR Trial	Number of Plants Selected
NY1322	Guardsman II + N-R-GEE	NY1918	93
NY1318	Guardsman II + N-R-GEE	NY1915	104
NY1323 and NY1319	Seedway 9558	NY1914	144
NY1325 and NY1321	Oneida Ultra	NY1917	144
NY1324 and NY1320	Ezra + Regen	NY1916	144

Conclusions/Outcomes/Impacts:

BRR-resistant alfalfa experimental populations developed from surviving plants in a winter-killed trial at Chazy, NY, were improved for yield and winter survival compared to the varieties the populations were selected from. These experimental populations are being tested in other trials to verify these results. Five new alfalfa populations selected under harsh environmental conditions on the BRR field at Chazy were developed in 2018. These populations are the second generation, or cycle of selection, from this field inoculated with BRR. The field most likely has a high pathogen load of BRR for testing the ability of the bred-populations for resistance.

Outreach:

The progress in developing BRR resistant alfalfa was or will be shared at:

- July 3, 2018 Seedsmen's Field Day, Ithaca, NY, 69 participants.
- July 9, 2018 Dairy Sustainability Interns, Ithaca, NY, 9 participants.
- November 14, 2018 Cornell Cooperative Extension In-Service Meeting, Ithaca, NY, about 15 participants.
- February 20, 2019 Annual Meeting with Seedway and Allied Seed LLC, Ithaca, NY, about 6 participants.

Outreach is often to extension educators who then can educate the farmers that they work with. An updated factsheet for posting to the web and widely sharing will be published.

Next Steps:

Next steps in this research are to evaluate the second generation of experimental alfalfa populations developed from the BRR field at Chazy. In 2019, the BRR field will be rotated to a cover crop and prepared for planting in 2020.

Acknowledgments:

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

"Snow Mold" Brown Root Rot Research Update:

- http://www.nnyagdev.org/index.php/category/press-releases/page/11/
- May 2018 Empire Farm and Dairy
  04-09-18 Country Folks agricultural newsletter
- 04-02-18 Focus on Farming
- 03-28-18 Morning Ag Clips
- 03-27-18 CCE Jefferson County Ag News
- 03-27-18 Progressive Forage Magazine
- 03-27-18 New York Ag Connection
- 03-27-18 Dairy Agenda Today
- 03-26-18 Cornell Field Crops Blog

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