



Northern NY Agricultural Development Program 2016-2017 Project Report

Brown Root Rot of Alfalfa: Third Production Year Yield of Populations Developed After Exposure to Brown Root Rot Fungus and Ice Sheeting

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Background:

Phoma sclerotoides, 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. From the USDA Fungal Database

(<http://nt.ars-grin.gov/fungaldatabases/>), *Phoma sclerotioides* is listed as a low temperature parasite.

Brown root rot can have severe effects on alfalfa yields. Brown root rot (See Appendix A: Photo 1) has been reported in the Northeast in New York, Maine, Pennsylvania, Vermont, New Hampshire, and Ontario, Canada, 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 in Clinton County. 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, NY, and was unofficially noted as responsible for stand decline at a farm in Lewis County, NY. Alfalfa plants with resistance to BRR from both of these locations have been incorporated into the Cornell Alfalfa Breeding Program.

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. Peace, a BRR-resistant alfalfa variety in Canada, performs poorly in NY, as it is highly susceptible to other alfalfa root rots common in NY and it is not adapted to Northeast USA. Similarly, Lander, a BRR-resistant alfalfa variety bred for BRR resistance in Wyoming, is adapted to dryland, western locations.

Crop rotation is not an effective management alternative; *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. A field plot trial was planted at the William H. Miner Agricultural Research Institute at Chazy, NY, in 2009 to determine whether currently available alfalfa varieties have any resistance to BRR. In May 2012, significant ice sheeting had killed about 90% of alfalfa plants in the BRR trial at Chazy. The surviving plants in the BRR trial were propagated and seed was produced in the fall 2012. The surviving plants from the areas of the field inoculated with BRR were developed into separate populations. Similarly, plants propagated from the areas of the field that were not inoculated with BRR were developed into additional separate populations. In total, there were eight populations developed, four from inoculated sections of the field and four from the noninoculated sections. In 2013, the second synthetic generation seed was

produced for each of the eight populations. In 2014, these eight populations plus check varieties were planted in a plot trial at Chazy.

Methods:

Research activities:

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

On May 23, 2017, visual percent plant-stand notes were taken. The alfalfa stand was significantly reduced in 2017 due to an accumulation of plant stress factors including BRR, other root diseases, and winter stress. The trial was harvested twice in 2017, the third production year. Harvests were delayed due to frequent rain events in early summer, thus a third harvest was not possible in late summer. Yields from the third production year are summarized in the results section.

In 2016, an alfalfa nursery was transplanted to a field at the William H. Miner Agricultural Research Institute at Chazy, NY, to test alfalfa varieties and experimental populations for winter survival ratings. On May 23, 2017, each plant was rated on a scale of 1 to 5 where 1 was no winter injury and 5 was a dead plant. From these data, a winter survival score from 1 to 3 was assigned where 1 is extremely winterhardy, 2 is very winterhardy, and 3 is winterhardy. Included in this nursery were all the experimental alfalfa populations and varieties that were planted in the BRR trial in 2014. The winter survival results for the populations in the BRR trial are also presented in this report.

Results:

From the results of the second production year (2016) of the BRR trial planted in 2014, the alfalfa populations in the trial had higher yield than in 2015, but the relative rankings were remarkably similar to the results in 2015.

In 2016, the highest-yielding group consisted of six of the eight populations developed from the trial planted in 2009 that winterkilled in 2012.

Within the top-yielding group of six populations, four populations were from the field areas not inoculated with BRR. Thus, the BRR inoculum that was applied to one-half of the field in 2009 did not impact the yield of the populations developed from the inoculated and not inoculated areas of the field.

The remaining two populations in the top-yielding group were selected from the inoculated plot areas. From Seedway 9558 and Oneida Ultra, both of the respective populations developed from the inoculated and the uninoculated areas were in the top yielding group.

The 2016-2017 winter temperatures were above normal most months except for March, which was below normal temperature. There was below average snowfall for November to January and above average snowfall for February and March.

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) (Photos 2 and 3).

The total yield over the three production years averaged 7.3 tons per acre (2.4 tons per acre per year). In general, yields were low due to reduced plant stands, wet soils, and weather fluctuations over the three production years.

None of the base populations or varieties were in the top yielding group. Peace and Lander were developed for resistance to *P. sclerotioides* from biotype 1, however, the fields at Chazy have biotypes 1, 2, 3, and 5. Thus the resistance to BRR in Peace and Lander does not seem to be sufficient for Northern NY (data not shown)

Table 1: Alfalfa varieties and experimental populations in the 2014 BRR trial at Chazy, NY; third production year results for %stand, yield, rank for yield, and winter survival.

2014 Brown Root Rot Trial - Chazy NY		% Stand	3-Yr Total Yield	Yield Rank at Chazy	2016-17 Winter Survival
Populations	Pedigree	23-May-17	tons/acre	(out of 16)	Rating*
NY1322	GII NR.Gee not inoculated	60	8.07	1	1.0
NY1323	Seedway 9558 not inoculated	43	7.89	2	1.7
NY1325	Oneida Ultra not inoculated	49	7.78	3	2.0
NY1319	Seedway 9558 inoculated	46	7.74	4	2.3
NY1324	Ezra + Regen not inoculated	46	7.65	5	1.3
NY1321	Oneida Ultra inoculated	45	7.65	6	1.3
Guardsman II	Guardsman II (GII)	37	7.06	8	2.3
NY1320	Ezra + Regen inoculated	40	7.02	9	2.3
Ezra	Ezra	38	7.00	10	2.3
Regen	Regen	38	6.93	11	2.0
Oneida Ultra	Oneida Ultra	37	6.91	12	2.0
NY1318	GII NR.Gee inoculated	48	6.80	13	2.3
Seedway 9558	Seedway 9558	32	6.60	14	2.7
N-R-Gee	N-R-Gee (NR.Gee)	30	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.

Similar to 2016, the top yielding group of six populations were populations selected from the field that winterkilled in 2012 (Table1). The top group averaged 48% stand and the remaining group of eight trial entries averaged 38% stand. The top group yielded 7.8 tons per acre total yield and had an average winter survival rating of 1.6 compared to 6.9 tons per acre and 2.2 winter survival rating for the remaining group.

The eight populations developed from surviving plants in the 2009 trial were compared to the varieties the populations were selected from: Guardsman II, Ezra, Regen, N-R-Gee, Oneida Ultra, and Seedway 9558. The populations averaged 7.6 tons per acre total yield compared to the varieties that averaged 6.8 tons per acre. The average rank for yield for the populations was 5 and for the varieties was 12. The average winter survival rating for the populations was 1.8 and for the varieties was 2.2.

Conclusions/Outcomes/Impacts:

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. One population, NY1322, had the highest yield and was extremely winterhardy (winter survival rating of 1.0). This population is being tested for disease resistance and fall dormancy, and has potential to be a new cultivar for growers in Northern NY and the Northeast.

Outreach:

The progress in developing alfalfa adapted to the Northern NY climate from surviving plants in a BRR trial was shared at the 2017 Seedsmen's Field Day on July 6, 2017, in Ithaca, NY, at Cornell Cooperative Extension In-Service Meeting on November 14, 2017, and at the Annual Meeting with Seedway on December 21, 2017. A factsheet for posting to the web WHERE? is under development.

Next Steps:

Next steps in research are to continue evaluating the experimental alfalfa populations developed from the BRR trial that winterkilled. These populations also need to be tested for resistance to BRR, although the procedure to do this has not been determined at this time.

From the 2014 BRR trial at Chazy, there is an opportunity for an additional cycle of selection. The alfalfa plants that survive the winter of 2017-18 are excellent candidates for genetic improvement and cultivar development. These plants will be dug and incorporated into the alfalfa breeding program in 2018. Three additional populations were developed from plants exposed to BRR in a trial in Ithaca, NY. These populations need to be further tested in trials for yield and other characteristics.

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