# Northern New York Agricultural Development Program
## 2016 Project Report

## Brown Root Rot (BRR) of Alfalfa: Second Production Year Yield of Populations Developed After Exposure to BRR Fungus & Ice Sheeting


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### Background:

*Phoma sclerotioides*, causal agent of brown root rot (BRR), is a soil-borne fungus causing root and crown rot of alfalfa, other perennial legumes, and overwintering grasses. Primarily active during late winter and early spring (Cormack 1934), BRR is associated with yield loss, winterkill, slow emergence from winter dormancy, and stand decline of alfalfa (Berkenkamp et al. 1991, Hollingsworth et al. 2003) and with winterkill of grasses (Larsen et al. 2007).

Brown root rot was first detected on alfalfa in the eastern United States in 2003 in Clinton County, NY. The results of subsequent 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, and most of the lesions caused by the disease progressed into the cortical (internal) tissues of roots and

crowns (Wunsch et al. 2007). 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.

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 (Berkenkamp et al. 1991).

No management tools currently exist for BRR in New York State. Peace, a BRR-resistant alfalfa variety 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. Crop rotation is not an effective alternative: *P. sclerotioides* produces resting structures that can persist for extended periods in the soil without a suitable substrate (Cormack, 1934); it has a very broad host range; and it can survive on organic matter in the soil (Davidson, 1990).

Significant variability in BRR resistance has been observed among alfalfa varieties grown in Saskatchewan and in Wyoming (Berkenkamp et al., 1991; Hollingsworth et al., 2005). 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 adapted to the Northeast USA have any resistance to BRR.

In May 2012, significant ice sheeting killed approximately 90% of alfalfa plants in the BRR trial (third production year) and approximately 25% of plants in an alfalfa variety trial (first production year) at Chazy. The research goal of the BRR project at that time was revised to develop alfalfa populations from the surviving plants in the BRR trial, rather than compare yields of varieties. Six varieties from the Cornell Alfalfa Breeding Program that are currently or have been recently marketed in NY were entries in the BRR trial. The surviving plants in the 2009 BRR trial were propagated and seed was produced in the greenhouse in the fall 2012. In 2013, the second synthetic generation seed was produced and planted in a plot trial at Chazy in spring 2014.

It is anticipated that the selected populations may be significantly improved in adaptation to the winterkill conditions that occurred in 2011-12 and/or in resistance to BRR. These populations are being tested for yield and persistence in a replicated plot trial that was planted in 2014 on the field where selections were made, and in the area where BRR was first discovered in Northeast USA. The field at Chazy has an elevated amount of BRR inoculum in the soil. Thus, if yields of the populations selected from the field sites inoculated with BRR are higher than the yields of the populations selected from the uninoculated areas, then this is evidence for genetic improvement for resistance to BRR.

Furthermore, the plants that survived the ice-sheeting, winterkill event may be improved for winterhardiness. Thus, the original varieties were planted in the 2014 trial to compare with the selected populations to test for genetic improvement.

If evidence exists for genetic improvement of either BRR resistance or winterhardiness, then adoption of these types of improved varieties would be expected to increase forage yields on farms in NNY. These populations were developed from alfalfa varieties bred and adapted to NY and should have good resistance to the five major alfalfa diseases. The best populations may also serve as sources of genes to increase the level of resistance to BRR and/or winterhardiness in the alfalfa breeding program in NY.

## Methods:

The alfalfa trial was planted in spring 2014 at William H. Miner Agricultural Research Institute, 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 (Seedway 9558, Oneida Ultra, Guardsman II + N-R-Gee, Ezra + ReGen). The trial entries are replicated six times.

The trial established well in 2014 and had excellent stands going into the winter 2015-16. In 2016 the trial was harvested three times for a second production year for dry matter yield comparisons of the selected and base populations. Harvest dates were June 13, July 19 and August 29. Fertilizer and pesticides were applied by Cornell employees at the Willsboro farm as needed.

## Results:

The 2015-2016 winter temperatures were above normal and there was low snowfall. The 2016 growing season was abnormally dry from the end of May 2016 and continuing into 2017. Appendix Table 1: Yields averaged 3.38 tons per acre dry matter over three harvests in 2016 (1.3 tons per acre more than in 2015).

The alfalfa populations in the trial had higher yield than in 2015, but relative rankings were remarkably similar to the results in 2015. The correlation between total season yield in 2015 and total season yield in 2016 was 0.9.

Of the sixteen trial entries, 6 populations were in the highest-yielding group. The highest-yielding group consisted of six of the eight populations developed from the trial planted in 2009 that winterkilled in 2012. However, four of the six populations were selections from the plot areas that were not inoculated with BRR. The remaining two populations were selected from the inoculated plot areas.

Four of the six top-yielding populations were developed form surviving Seedway 9558 and Oneida Ultra plants. 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.

## Conclusions/Outcomes/Impacts:

In 2016, there were significant yield differences among the alfalfa populations and varieties that were similar to 2015 results. The highest-yielding alfalfa populations were the ones developed from plants propagated from the surviving plants from the 2009 trial

that winterkilled in 2012. The populations in the top-yielding group were mostly from the areas of the field that were not inoculated with BRR, however, these populations may have some resistance to BRR since the fields at Chazy were found to have BRR organism in the soil prior to field inoculation of some parts of the field in 2009.

## Outreach:

The progress in developing brown root rot-resistant alfalfa was shared at the Annual Seedway Meeting on December 20, 2016. A factsheet will be posted to the Forage project website at https://plbrgen.cals.cornell.edu/research-extension/forage-project/publications.

## Next Steps:

Since BRR is a slow infection of alfalfa roots, it will be important to harvest this trial in 2017 or for the third production year. The trial results will give researchers information about alfalfa survival in fields with BRR and in Northern New York in general.

**Acknowledgments:** Cornell University Agricultural Experiment Station; The William H. Miner Agricultural Research Institute at Chazy NY

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## Appendix:

**Table 1: Yield Summary: Brown root rot alfalfa trial, sown in May 2014, Chazy, NY.**

| Alfalfa Trial at Chazy, NY, Sown May 2014 - Yield Summary<br>Alfalfa Populations from field with Brown root rot after winterkill | | | | |
|---|---|---|---|---|
| | 2016 | | 2-Yr | |
| Alfalfa Populations/Varieties | Total Season | % Trial Mean | Total | % Trial Mean |
| | T/A | | T/A | |
| **G II + N-R-Gee (not inoculated)** | **3.70** | **109** | **5.94** | **109** |
| G II + N-R-Gee (inoculated) | 3.24 | 96 | 5.14 | 95 |
| Guardsman II (G II - Variety) | 3.27 | 97 | 5.30 | 98 |
| N-R-Gee (Variety) | 3.17 | 94 | 5.01 | 92 |
| **Seedway 9558 not inoculated** | **3.63** | **107** | **5.90** | **109** |
| **Seedway 9558 inoculated** | **3.63** | **107** | **5.83** | **107** |
| Seedway 9558 (Variety) | 3.19 | 94 | 5.12 | 94 |
| **Ezra + ReGen (not inoculated)** | **3.57** | **106** | **5.79** | **107** |
| Ezra + ReGen (inoculated) | 3.38 | 100 | 5.37 | 99 |
| Ezra (Variety) | 3.31 | 98 | 5.33 | 98 |
| ReGen (Variety) | 3.35 | 99 | 5.22 | 96 |
| **Oneida Ultra-not inoculated** | **3.57** | **106** | **5.73** | **105** |
| **Oneida Ultra- inoculated** | **3.48** | **103** | **5.62** | **103** |
| Oneida Ultra (Variety) | 3.30 | 98 | 5.34 | 98 |
| Lander (Variety) | **3.44** | 102 | 5.52 | 102 |
| Peace (Variety) | 2.89 | 86 | 4.78 | 88 |
| Trial Mean | 3.38 | | 5.43 | |
| F-entries | 3.90 ** | | 5.73 ** | |
| LSD(0.05) | 0.30 | | 0.40 | |
| CV(%) | 7.8 | | 6.5 | |
| T/A = tons per acre dry matter. ** = statistically significant at P<0.01<br>Yield values in Bold = the top-yields based on highest yield minus LSD(0.05). | | | | |

**In 2012, surviving plants of 6 alfalfa populations were dug from the winterkilled trial. The trial that winterkilled had two sections, one inoculated with Brown root rot and one not inoculated. Alfalfa plants from each variety from each section were dug and used to create new alfalfa populations. These populations plus the original named varieties were planted in a new trial in 2014. The varieties were compared to the populations developed from plants dug from the inoculated areas and to the populations developed from plants dug from the not inoculated areas in the 2014 trial.** Yields averaged 3.38 tons per acre dry matter over three harvests in 2016 (1.3 tons per acre more than in 2015.