Northern NY Agricultural Development Program
2014 Project Report

Brown Root Rot of Alfalfa: Challenges and Opportunities

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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), it 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 in the eastern United States in 2003 in Clinton County, NY on alfalfa. The results of subsequent surveys of alfalfa production fields conducted in Clinton County in 2004 and in New York, Vermont and New Hampshire in 2005 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). The BRR incidence observed in

northeastern United States is similar to that observed in Saskatchewan, Canada, where the disease has long been recognized as a serious problem for alfalfa production.

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. Peace, the BRR-resistant alfalfa variety grown in Saskatchewan and Alberta, performs poorly in New York, as it is highly susceptible to other alfalfa root rots common in New York. 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 differences in BRR resistance have been observed among alfalfa varieties grown in Saskatchewan and in Wyoming (Berkenkamp et al., 1991; Hollingsworth et al., 2005). If significant differences in BRR resistance are also observed among alfalfa varieties grown in New York, adoption of the most resistant varieties by growers in fields with high BRR pressure would be expected to increase forage yields. The most resistant varieties would also serve as sources of BRR resistance for alfalfa breeding to develop varieties with higher levels of resistance in plant material that is well adapted to our region.

A field plot trial was planted at The William H. Miner Agricultural Research Institute at Chazy, NY, on May 4, 2009 to determine whether currently available alfalfa varieties have any resistance to BRR. Five of the seven known intraspecific varieties of the BRR pathogen were found to be present in the soils at Miner Institute, so this is an excellent location to evaluate alfalfa varieties (Wunsch et al., 2010, 2011).

It is possible that through screening of alfalfa experimental populations on fields with the BRR organism that some or many varieties may already be moderately resistant.

In 2010, the not inoculated plots at the Miner Institute had yields that averaged 5.47 tons per acre and the inoculated plots averaged 5.55 tons per acre. Variability among the varieties for yield was significant, but inoculating with BRR had not impacted yield at this point. Plants were dug from the Vernal plots in the spring of 2010 and it was verified in Bergstrom's plant pathology lab that plants from the inoculated plots had the BRR fungus (51% incidence) in the roots and the not inoculated plots did not have the BRR fungus (1% incidence).

In 2011, the not inoculated plots averaged 0.10 tons per acre dry matter more than the inoculated plots, but this difference was not statistically significant.

In May 2012, it was communicated that significant ice sheeting had killed many alfalfa plants in the BRR trial and in another alfalfa trial at Chazy. The BRR trial was going into the third production year and the other alfalfa trial was going into the first production year. Thus the ice sheeting killed both older and younger alfalfa plants.

In May, visual estimates of percent stand of alfalfa remaining were taken and analyzed. It was determined that the plots were damaged beyond the point where yield data from harvesting the trial would be informative. Thus a new research goal was initiated. The research goal of this project was revised to develop alfalfa populations from the surviving plants in the BRR trial.

Six varieties from the Cornell Alfalfa Breeding Program that are currently or have been recently marketed in New York were entries in the BRR trial. On June 14, stem cuttings were taken from surviving plants in each of the six Cornell varieties from both the inoculated and not inoculated plots. The stem cuttings were grown in the Ithaca greenhouse and seed was produced. The seed produced was synthetic generation 1 seed and was not in sufficient quantities for yield trials.

In 2013-2014, second generation of seed on the eight populations was produced in quantities great enough for a plot trial to be planted in 2014 in the field that the cuttings came from. Second generation seed is needed for trials so that forage yield results are predictive of commercial forage yields. The goal of the 2014 plot trial was to initiate a test for yield improvement of the populations developed from plants that survived the challenge of winter injury and BRR damage compared to the original alfalfa populations the selections were made from (Table 1).

Table 1: Pedigrees of the populations produced from stem cuttings from the alfalfa plants that survived in the winterkilled Brown Root Rot Trial at Chazy in 2012.

Pedigrees of Alfalfa populations	#of plants, first generation	Grams of seed, second generation
(Guardsman II + N-R-Gee)-Chazy selection inoculated	130	491
(Guardsman II + N-R-Gee)-Chazy selection uninoculated	91	301
Seedway 9558-Chazy selection inoculated	41	711
Seedway 9558-Chazy selection uninoculated	55	273
(Ezra + Regen)-Chazy selection inoculated	94	729
(Ezra + Regen)-Chazy selection uninoculated	98	142
Oneida Ultra-Chazy selection inoculated	45	416
Oneida Ultra-Chazy selection uninoculated	49	225

Methods:

Seed of sixteen trial entries were prepared for spring planting at Chazy, NY. The trial was planted with these sixteen alfalfa populations or varieties; eight populations listed in Table 1, six varieties not selected (Guardsman II, N-R-Gee, Seedway 9558, Ezra, Regen, Oneida Ultra), and two Western alfalfa varieties selected for resistance to BRR (Peace and Lander).

A field at The William H. Miner Agricultural Research Institute in Chazy, NY was prepared for spring planting. The field planted was the same field from which the selections for BRR resistance and winter survival were made in 2012. For each alfalfa population or variety, six replicates were planted in an incomplete block design. Due to a rainy spring, the alfalfa trial was planted later than recommended on June 2nd. The trial established well, was sprayed twice with pesticides and was cut off once. Data were not collected on the trial in 2014.

Results:

It is anticipated that the selected populations may be significantly improved in resistance to BRR and may be more winter hardy. Although the winter 2014-2015 was very cold, there was snow cover for much of the winter (Table 2). The fungal pathogen (*Phoma sclerotioides*) that causes BRR becomes increasingly active when soil temperatures cool. Brown root rot is described as a "snow mold" because its growth is most rapid when soils are covered by snow. The snow depth this winter appears to have been conducive for active BRR disease progression. The trial will be assessed for winter survival in spring 2015 and will be harvested three times during the growing season.

Table 2: Maximum snow depth in Ellenburg Depot, NY (20 miles west of Chazy).

Month / Year	Maximum Snow depth Range (inches)
November 2014	0 - 2
December 2014	1 - 14
January 2015	1 - 6
February 2015	5 - 14
March 2015 (first half)	7 – 13

http://nowdata.rcc-acis.org/btv/

Conclusions/Outcomes/Impacts:

If significant differences in BRR resistance are observed in one or more of the eight populations selected from the field plots at Chazy, then following further testing, one or more of these populations would be developed into a new cultivar. Then adoption of these resistant varieties by growers in fields with high BRR pressure would be expected to increase forage yields. These populations were developed from alfalfa varieties developed in and adapted to New York. The most resistant varieties would also serve as sources of genes to increase the level of resistance to BRR in our alfalfa breeding program in New York.

Outreach:

Breeding alfalfa for brown root rot resistance and associated accomplishments were presented at the Seedsmen's Field Day in July and at the Extension In-Service Meeting in November.

Next steps:

We anticipate that the BRR plot trial at Chazy will be harvested in 2016 and 2017.

From trials on fields known to be infested with the BRR organism it will be possible to determine whether the populations were improved in BRR resistance and winterhardiness. Once plants that are resistant to BRR are identified, these plants can be incorporated into new breeding lines and varieties. The plant stand in the plots at Chazy will thin over the years and at some point in the future it may be possible to select plants again for resistance to BRR (selection cycle 2). Since the field was inoculated with BRR, the plants that survive are likely to be resistant to this disease.

The eight populations developed will need to be tested in additional plot trials, particularly on fields where BRR symptoms have been found. In Ithaca, plants dug from a field at the Cornell University Agricultural Experiment Station were diagnosed with BRR. This field will be planted again in 2016, so the BRR populations from Chazy will be planted at that time.

Acknowledgments: NNYADP and Cornell University Agricultural Experiment Station

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

NNYADP Press Release: 'Winter Weather Damage Not Stopping NNY Brown Root Rot-Resistance Researchers, ' Kara Lynn Dunn, March 28, 2014. Media that picked up this release include Country Folks Newspaper, Dairy Business Magazine, Empire State Farmer, Farm Progress Daily, Gouverneur Tribune, Lancaster Farming, Malone Telegram, Morning Ag Clips, New York Ag Connection, Pennsylvania Ag Connection, Plattsburgh Press Republican, Watertown Daily Times Farm and Garden insert, and Twitter.

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Photos

Photo 1: Typical Brown root rot symptoms on alfalfa roots; Lowville, NY, Lewis County; photo: Julie L. Hansen.