Northern New York Agricultural Development Program
2013 FINAL 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 cultivars yielded 40 to 65 percent higher than BRR-susceptible cultivars (second and third production years, three cuts per year); alfalfa cultivars with moderate BRR resistance yielded 23 to 43 percent higher than BRR-susceptible cultivars (Berkenkamp et al. 1991).

No management tools currently exist for BRR in New York. Peace, the BRR-resistant alfalfa cultivar 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 cultivars 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 cultivars grown in New York, adoption of the most resistant cultivars by growers in fields with high BRR pressure would be expected to increase forage yields. The most resistant cultivars would also serve as sources of BRR resistance for alfalfa breeding to develop cultivars with higher levels of resistance in plant material that is more 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 cultivars have any resistance to BRR. Five of the seven known infraspecific 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 cultivars may already be moderately resistant. In 2010, the not inoculated plots had yields that averaged 5.47 tons per acre and the inoculated plots averaged 5.55 tons per acre. Variability among the cultivars for yielding ability 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 cultivars 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 14th, stem cuttings were taken from surviving plants in each of the six Cornell cultivars 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.

The objective of this current project is to produce the second generation of seed on the eight populations and to produce enough seed 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.

Methods:

For each of the eight populations, bout 190 plants were established in the greenhouse from the first generation seed produced on the original plant selections. Each of the eight populations (Table 1) were placed in a room with bumblebees over a two to three week period of time in order to maximized seed production. Seed was harvested from each plant and processed to remove the seed pods.

The field that the original trial was planted in was plowed in the spring 2013, and sorghum-sudangrass cover crop was planted in the summer. The field was fall-plowed to prepare for spring 2014 planting.

Results:

For each of the eight populations, the amount of seed produced was abundantly adequate for use in planting a plot trial in 2014. This seed will be very useful for future research work on brown root rot of alfalfa.

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.

(Guardsman II + N-R-Gee)-Chazy selection inoculated
(Guardsman II + N-R-Gee)-Chazy selection uninoculated
Seedway 9558-Chazy selection inoculated
Seedway 9558-Chazy selection uninoculated
(Ezra + Regen)-Chazy selection inoculated
(Ezra + Regen)-Chazy selection uninoculated
Oneida Ultra-Chazy selection inoculated
Oneida Ultra-Chazy selection uninoculated

It is anticipated that the selected populations may be significantly improved in resistance to BRR and may be more winter hardy. It is of interest to test these populations in a plot trial in the future. The field that was planted in 2009 was mapped with GPS coordinates

prior to plowing such that the location of the field areas inoculated with BRR could be readily found at future plantings of this field.

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 cultivars by growers in fields with high BRR pressure would be expected to increase forage yields. These populations were developed from alfalfa cultivars developed in and adapted to New York. The most resistant cultivars 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. Also in NNY, a presentation was made to growers at a meeting in Belleville on March 13, 2013.

Next steps.

The eight populations developed will need to be tested in one or more plot trials, and in 2014 these populations will be planted on the same field that was inoculated with the BRR organism. The trials should be harvested through the third production year. 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 cultivars.

Acknowledgments: Cornell University Agricultural Experiment Station

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

NNYADP Press Release Nov. 5, 2013. NNY Research advancing Battle vs. Brown Root Rot. http://www.nnyagdev.org/index.php/2013/11/06/nny-research-advancing-battle-vs-brown-root-rot/

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Photos:

Photo 1: Alfalfa plants in the greenhouse ready for pollination. Location: Guterman greenhouse, Ithaca, NY, Tompkins County, photo: Jamie Crawford.

Photo 2: Bumblebee pollinating alfalfa. Location: Guterman greenhouse, Ithaca, NY, Tompkins County, photo: Jason Schiller.