Northern NY Agricultural Development Program
2015-2016 Project Report

Alfalfa Winter Survival in Northern New York

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Background:

Alfalfa forage produced on farms in New York offers many advantages to producers such as drought tolerance, high protein feed for rations, and nitrogen fixation for improved nutrient management in rotations. Harsh winters typical of Northern New York (NNY) make winter survival as a trait in alfalfa varieties essential. Loss of a high quality perennial crop from winterkill is an economic blow to producers where both time and money are lost to crop rotation and reestablishment costs.

Some alfalfa varieties have better winterhardiness than others. However, alfalfa decline due to poor drainage and waterlogged soils will not be remedied by varieties with superior winterhardiness. Fall dormancy, measured as the amount of forage produced in the fall, has been used as a proxy for winter survival, such that varieties that are more fall-dormant and produce a lower amount of forage in the fall have better winter survival.

The fall dormancy rating scale is from 1: dormant to 9: nondormant. The Cornell Integrated Field Crops Guide (http://ipmguidelines.org/fieldcrops/) generally states that alfalfa varieties with fall dormancy ratings from 2 to 4 are well adapted to New York State climate. However, forage breeders have been developing varieties with more forage production in the fall that also claim to have improved winter survival. Genetic studies have shown that breeders should be able to develop alfalfa varieties with both fall forage production and excellent winter survival (Castonguay et al, 2006). Thus, varieties that have fall dormancy ratings of 5 or 6 and have been bred for superior winter survival rating should be tested for survival in NNY.

Forage yield trials for alfalfa and other forages are planted by the Cornell Forage Breeding Project each year in New York State. Until 2003, all the varieties entered were of fall dormancy 2, 3, or 4. Over the past 12 years, there has been a steady increase in the number of fall dormancy 5 varieties entered in the trials. The North American Alfalfa Improvement Conference has developed standardized tests for alfalfa that range from disease and pest resistance tests to agronomic tests like yield and fall dormancy (http://www.naaic.org/resource/stdtests.php). A test for winter survival was developed and has been used to describe alfalfa varieties.

Some tests like fall dormancy are required by the National Alfalfa and Miscellaneous Legume Variety Review Board, but winter survival is not a required test. Thus, many varieties are not rated for winter survival. Because of more fall regrowth in many modern varieties and the need for testing them under more severe winters, we have tested for alfalfa winter survival at the W.H. Miner Institute for Agricultural Research at Chazy, NY, in Northern New York.

The National Alfalfa and Miscellaneous Legume Variety Review Board requires that for a winter survival rating to be assigned to an alfalfa variety two separate winter survival ratings over either two years or two locations must be averaged. The test planted in NNY in 2014 was mostly winter-killed, probably from ice sheeting. Too few plants remained in the 2014 test in the spring of 2015 to use the data for assigning a winter survival rating to the alfalfa populations in that test. However, data collected on the surviving plants were reported in the 2015 Northern New York Agricultural Development Program research report titled Testing Alfalfa Cultivars and Germplasm for Winter Survival in Northern New York and posted at www.nnyagdev.org under Fields Crops: Alfalfa. The results (considered preliminary) from the 2015 trial are presented in this report; evaluation of the second trial, required by standard testing protocol, will be complete in May 2017.

Methods:

The winter survival alfalfa test of 2700 plants that was transplanted in May 2015 was scored for winter survival (average severity rating scale 1= no winter damage to 5= dead plant) on May 19, 2016. From these individual plant ratings, an Average Severity Index (ASI) for each alfalfa variety and experimental population was calculated.

The formula for ASI is the sum of the proportion of the plants at each rating scale or ASI = ((# of plants rated 1*1)+(# of plants rated 2*2)+(# of plants rated 3*3)+(# of plants

rated 4*4)+(# of plants rated 5*5))/total number of plants. From the ASI, a winter survival rating is assigned from 1: most winterhardy to 6: least winterhardy.

Another winter survival test was transplanted on May 19, 2016, so that two winter survival ratings will be taken in Chazy and averaged for a final winter survival score. If the check varieties planted in the tests have the expected amount of winterkill, then the winter survival scores from the experiments will used to describe the varieties or populations as prescribed by the National Alfalfa and Miscellaneous Legume Variety Review Board. This research project will not be complete until the 2016 trial plants are rated in the spring of 2017. The results will be added as addendum to this report.

Results:

2015 Winter Survival Trial: Standard Alfalfa Check Varieties

Six standard alfalfa varieties of known winter survival characteristics were planted in the test to compare to the varieties with unknown winter survival ratings (Table 1). Ideally the varieties' ASI would range from 1.60 to 4.80, and average 3.18 as in the standard test for winter survival. The ASI ranged from 1.77 to 4.92 with an average of 2.87 for the alfalfa planted in 2015 at Chazy, NY. Thus, the test at Chazy was less severe than an ideal standard test. A successful test must show a significant difference (with 95% confidence) between the class 2 and class 4 check varieties.

Also, the class 6 check variety must have an ASI of 4.6 or higher. The 2015 test met both of these requirements. However, the variety 'Archer' had an ASI of 3.08 vs. an expected value of 4.00. Thus, Archer did not have the expected winter survival reaction. Since all of the non-check alfalfa populations had ASI ratings less than 3, the non-compliance of the check variety with an ASI of 4 is not of concern for this test.

Table 1: 2015 Chazy NY alfalfa winter survival standard test check varieties' Average Severity Index compared to Expected Average Severity Index and corresponding Winter Survival Rating.

Winter Survival Check Varieties	Average Severity Index of 2015 Chazy Test	Expected Average Severity Index	Absolute Value of Expected minus Average	Winter Survival Rating**
ZG 9830	1.77	1.60	0.17	1.0
5262	2.01	2.20	0.19	2.0
WL325HQ	2.36	2.90	0.54	3.0
G-2852	3.05	3.60	0.55	4.0
Archer	3.08	4.00	0.92	5.0
Cuf 101	4.92	4.80	0.12	6.0
LSD (95%)	0.34			

KEY: **Winter Survival Rating 1 is 'Extremely Winterhardy'; 2 is 'Very Winterhardy; 3 is 'Winterhardy'; 4 is Moderately Winterhardy; 5 is Slightly Winterhardy; 6 is Non-Winterhardy.

2015 Winter Survival Trial: Winter Survival Ratings
There were 12 alfalfa varieties in the winter survival test at Chazy. Of these 12 varieties, five were commercially-available varieties from forage breeding companiesin the U.S. and seven were commercially-available varieties developed by Cornell University.

The fall dormancy (FD) ratings of the 12 varieties were:

- FD 2: Very Dormant (1 variety)
- FD 3: Dormant (3 varieties)
- FD 4: Dormant (4 varieties)
- FD 5: Moderately Dormant (4 varieties) (Figures 1 and 2).

Winter survival (WS) ratings are designated as: 1 Extremely Winterhardy; 2 Very Winterhardy; 3 Winterhardy; 4 Moderately Winterhardy; 5 Slightly Winterhardy; 6 Non-Winterhardy.

The winter survival ratings of the 12 varieties by FD groups were:

- FD 2: WS 2 Very Winterhardy
- FD 3 varieties: all Winterhardy: WS 2.5 to 2.8.
- FD 4: WS 2.0 to 2.8: two of the four FD4 varieties: WS 2: Very Winterhardy; two WS 3: Winterhardy.
- FD 5: Three of the four FD 5 varieties: WS 2: Very Winterhardy, one FD5 variety: WS 3: Winterhardy.

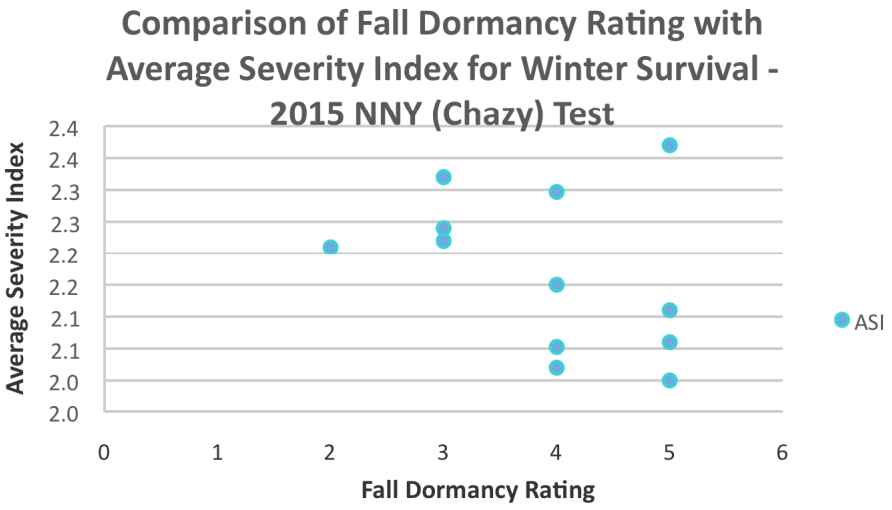

Figure 1: Fall dormancy (FD) rating (1: most fall dormant or low growth in the fall to 5: less fall dormant or more growth in the fall) compared to Average Severity Index for winter survival (1: most winter hardy to 4.8: least winter hardy) for 12 varieties in the NNY trial at Chazy, NY, 2015, ASI ranged from 2.0 to 2.4.

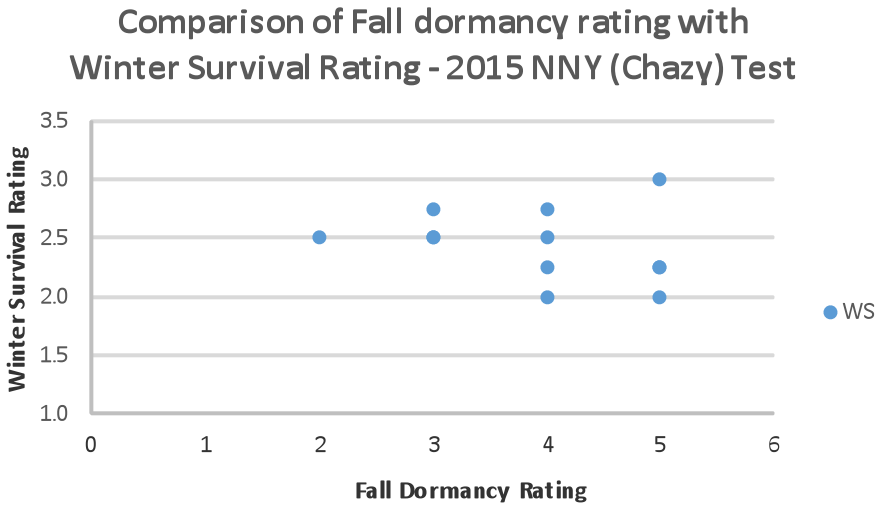

Figure 2: Fall dormancy rating (1: most fall dormant or low growth in the fall to 5: less fall dormant or more growth in the fall) compared to Winter Survival (WS) Rating (1: most winter hardy to 6: least winter hardy) for 12 varieties in the NNY trial at Chazy, NY, 2015. FD ratings range from to 2 to 5. WS ratings ranged from 2.0 to 3.0. Also see Figure 1.

Winter Survival Ratings of Alfalfa Populations from NNY Brown Root Rot Trial
This project also included winter survival rating of alfalfa populations of plants inoculated with Brown Root Rot (BRR) for another Northern New York Agricultural Development Program research project (breeding BRR-resistant alfalfa trials) planted at Chazy, NY. By spring 2012, that trial had mostly winterkilled, so the very few surviving plants were dug from Cornell alfalfa varieties in the trial, both from areas that had been inoculated with BRR and from area that had not been inoculated with BRR. The inoculated (+) and not inoculated (-) populations were kept separate. Seed was increased and used to plant in the winter survival tests.

The winter survival of the populations developed from the surviving plants at Chazy was compared to the unselected base populations, varieties (A to F, Figure 3.), to see if improvements in winter survival (lower number represents better winter survival) had been made (Figure 3). Varieties of related genetic backgrounds were combined so C and D were combined (CD) and E and F were combined (EF). For three of the four inoculated vs. not inoculated comparisons of varieties, the populations developed from plants dug from the inoculated area of the plots had better winter survival ratings than the unselected (not inoculated) populations.

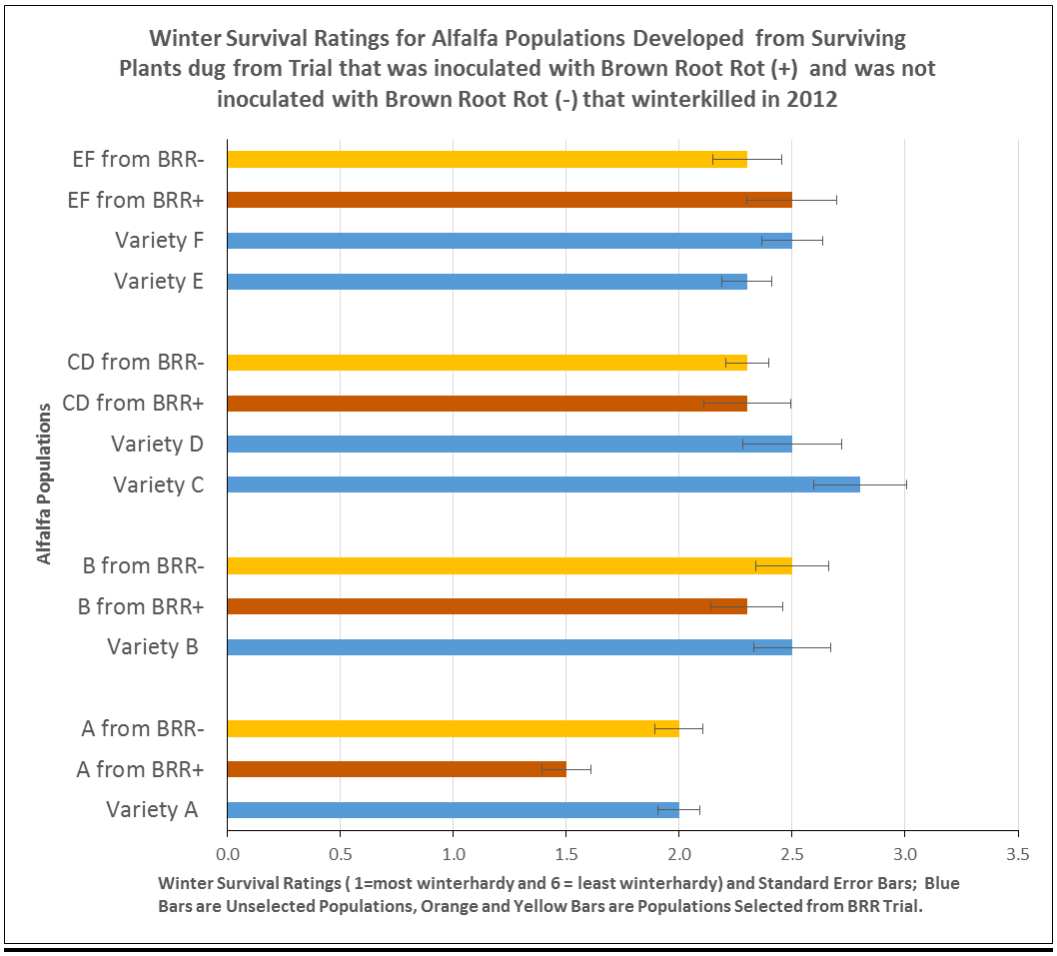

Figure 3: Winter survival ratings of experimental alfalfa populations developed from surviving plants dug from winterkilled BRR trial plots at Chazy, NY. Key: the lower winter hardy rating number, the more winterhardy the variety.

Conclusions/Outcomes/Impacts:

The results of this study are preliminary since results from a second test (planted in May 2016) with the same alfalfa varieties and populations is needed according to the standard test protocol.

For test planted in 2015, within each FD class (classes 3, 4 and 5: Dormant to Moderately Dormant, there was a range in winter survival rating from WS 2 to 3: Very winterhardy to Winterhardy. Since both of these ratings, fall dormancy and winterhardiness, impact forage yield, it is best for producers to review yield data from alfalfa forage yield trials conducted in New York State to make a more informed selection of the varieties that perform best in New York State, particularly in NNY. These data are available at https://plbrgen.cals.cornell.edu/research-extension/forage-project/ny-forage-yield-results.

Outreach:

Since the results presented in this report are from a first-year test and are preliminary until the test planted in May 2016 is rated and analyzed in the spring of 2017, outreach to

producers is premature. From one year's results, the indications are that the winter survival standard test conducted at Chazy, NY, may be very useful to predict winter survival of alfalfa varieties in NNY. Selection of surviving plants from winterkilled experiments in NNY may be a useful plant breeding tool for improving winter survival of alfalfa.

Next Steps:

The 2016 winter survival field trial varieties will be rated for winter survival in May 2017. These results will be summarized and presented to producers in 2017-2018.

Acknowledgments:

Seed of the fall dormancy 5 alfalfa varieties was donated by Allied Seed, L.L.C. , W-L Research, and Pioneer Hi-Bred.

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

Summary reports will be developed and presented at meetings and outreach events once the second winter survival test has been rated and summarized in May 2017.

Yields of alfalfa varieties of various fall dormancy ratings are available: New York Forage Legume and Grass Cultivar Yield Trials Summary for 2016 – Season Totals. J. Hansen, D. Viands, R. Deubler, J. Crawford, J. Schiller, R. Crawford, School of Integrative Plant Science, Plant Breeding and Genetics Section, College of Agriculture and Life Sciences, Cornell University, Ithaca, NY 14853; https://plbrgen.cals.cornell.edu/research-extension/forage-project/ny-forage-yield-results.

For More Information:

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