Developing and Validating a New Method to Improve Breeding for Cold-tolerant Bermudagrass

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Objectives:

The overall objective is to develop a new technique that will simplify evaluation of cold-tolerant bermudagrass, thereby facilitating a breeding program for cold-tolerant hybrids. The specific objectives are:

1. *To validate the correlation of bermudagrass responses to aryloxyphenoxypropionate (AOPP) herbicide and cold temperature stress with a large-scale, field-based study for screening cold tolerance of experimental bermudagrass lines;*
2. *To identify the physiological basis of bermudagrass responses to AOPP herbicide and cold temperature stress.*

Bermudagrass occupies more acreage than any other turfgrass species in US golf courses. The major limiting factor for growing bermudagrass in the transition zone is plant's susceptibility to low temperature stress. One important mechanism for plants to cope with low temperature stress is to increase the level of fatty acid desaturation in membrane lipids. Our preliminary study conducted at the University of Missouri found that responses of six common bermudagrass cultivars to cold temperature were strongly correlated to responses to the AOPP herbicide Fusilade II®. It is known that AOPP herbicides inhibit acetyl coenzyme A carboxylase (ACCase), the key enzyme that regulates the biosynthesis of fatty acids. Therefore, the hypothesis of this proposed project was that there is a linkage between bermudagrass responses to cold temperature and sensitivity to AOPP herbicide. The potential outcome of this study is to provide breeders with an easy tool for screening cold-tolerant bermudagrass plants simply spraying experimental lines with AOPP herbicides and evaluating sensitivity.

A segregating population of bermudagrass was developed after crossing a cold-tolerant entry A12396 with a cold-sensitive entry A12395. The entry A12396 is a breeding line selected from the Oklahoma State University (OSU) bermudagrass germplasm for known cold hardiness. The entry A12395 is a collection from Puerto Rico which is susceptible to low temperature stress. Approximately 2,800 seeds were collected from the cross. Currently, 50 randomly selected seeds have been sown in the greenhouse at the University of Missouri, and the emerged plants will be propagated for future studies.

In the laboratory, a series of more detailed studies were conducted to validate the hypothesis by focusing on the two commercialized bermudagrass cultivars, 'Riviera' and 'Celebration', with each cultivar exhibiting cold-tolerant and cold-sensitive characteristics, respectively. Figure 1 represents the AOPP herbicide injury to 'Riviera' or 'Celebration' at 3 weeks after treatment (WAT). 'Celebration' clearly showed more injury following herbicide application.

A third study conducted involved pre-treatment of bermudagrass plants with low temperature stress at 4 °C for different periods of time, followed by application of AOPP herbicide. A two-hour 'recovery' period at optimal growth conditions was provided before subjecting the plants to the second stress (herbicide). The data analysis is ongoing. The representative image shown in Figure 3 demonstrated 'Riviera' and

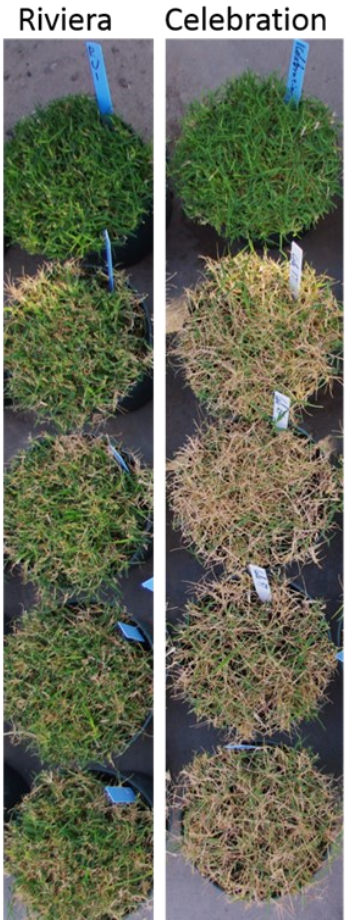

Figure 1. AOPP (Acclaim Extra®) herbicide injury to 'Riviera' (left) and 'Celebration' (right) bermudagrass at 3 weeks after treatment. Plants on the top row are untreated control, and plants below are herbicide-treated plants.

'Celebration' responses to Acclaim Extra® at 1 WAT. Compared to 'Riviera', 'Celebration' showed visible herbicide injury without pre-chilling temperature treatment. However, after 1 day or 4 days pre-treated with 4 ° C, 'Celebration' showed significantly reduced herbicide injury. These results support our hypothesis that bermudagrass responses to the two stresses are linked, and pre-treatment of the susceptible plants ('Celebration') with chilling stress improved their tolerance to herbicide application.

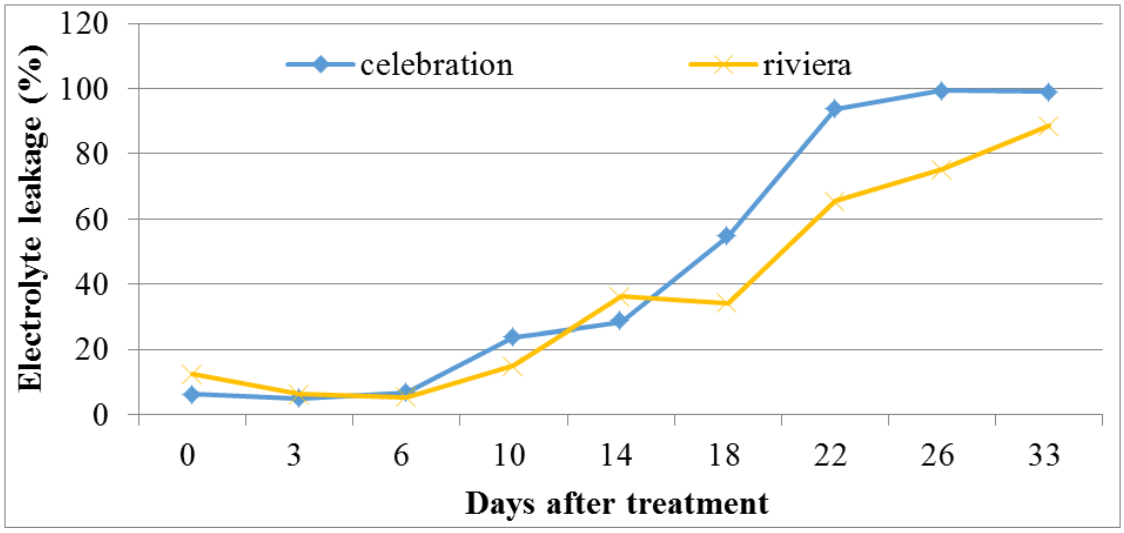

Figure 2. Electrolyte leakage of 'Riviera' and 'Celebration' after various days under low temperature stress at 4 °C.

A fourth laboratory study is undergoing to evaluate the two bermudagrass species for the uptake and translocation of isotope-labeled AOPP herbicide.

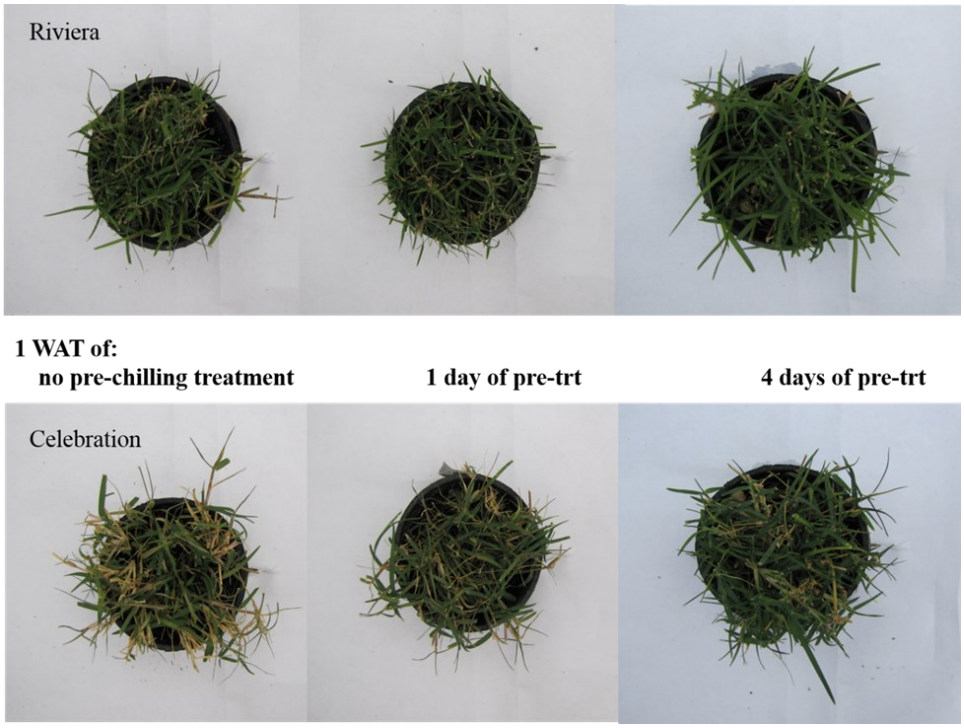

Figure 3. Representative image of bermudagrass 'Riviera' (top) and 'Celebration' (bottom) responses to Acclaim Extra® application at 1 week after treatment. Prior to herbicide application, plants were subjected to either no pre-treatment (left), 1 day at 4 °C (middle), or 4 days at 4 °C (right).

Summary

- A segregating bermudagrass population was developed following crossing of a cold-tolerant and cold-susceptible entry.
- Laboratory validation studies provided more evidences of the hypothesis that bermudagrass responses to cold temperature and AOPP herbicide are possibly linked.
- Field plots will be established by using the segregated populations after the laboratory pre-screening for cold tolerance, and the population will be evaluated for AOPP herbicide tolerance over the next two growing seasons.