PROGRESS REPORT
JANUARY 2010

Physiological Factors Associated with Cold Deacclimation for Annual bluegrass and Creeping bentgrass

Principle Investigators:
M. DaCosta and J.S. Ebdon
University of Massachusetts

PROJECT SUMMARY AND OBJECTIVES

Low temperature injury and winterkill are major limitations in the management of annual bluegrass on putting greens and fairways in New England. Low temperature acclimation, or hardening, is an important aspect of plant survival of freezing temperatures; however, acclimation levels can be reversed (deacclimation) during freeze-thaw events throughout late winter and early spring, thus leaving the plant susceptible to freezing injury. The loss of cold hardiness in response to deacclimating temperatures has been associated with injury of annual bluegrass. Creeping bentgrass, however, does not readily respond to temperature fluctuations and seems to remain in a metabolically dormant state. The physiological basis for these differences in deacclimation potential is not fully understood. Therefore, we proposed two projects with the following specific objectives:

Project I: Quantify the critical temperature thresholds required for deacclimation of annual bluegrass and creeping bentgrass

Project II: Examine early physiological and biochemical changes in response to deacclimating temperatures.

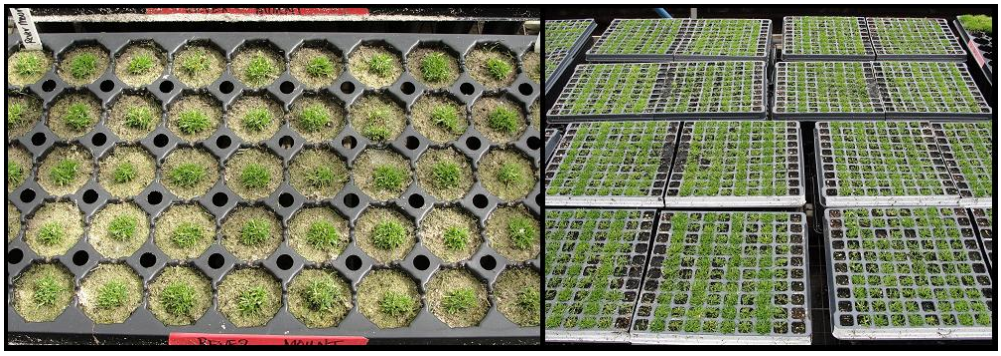
This research will identify predisposing factors responsible for differences in deacclimation for two species that vary significantly in their susceptibility to winter injury. Results from the research will provide us with a greater understanding of how environmental conditions and cultural practices contribute to deacclimation. Based on this information, we will have greater insight on how to reduce deacclimation potential, either through cultural practices and/or manipulation of the plant deacclimation signaling process, in order to improve winter survival. Lastly, because of the uncertainty currently associated with deacclimation events, these different physiological factors may also be valuable for predicting loss in cold hardiness levels throughout winter months.

PROGRESS

Four annual bluegrass ecotypes with different levels of freezing tolerance were obtained this past summer from Dr. Annick Bertrand, Agriculture and Agri-Food Canada. Dr. Bertrand's research group has conducted significant amount of work evaluating freezing and anoxia tolerance of annual bluegrass ecotypes from around the United States and Canada. For comparison, we also obtained 'Penncross' creeping bentgrass plugs from field plots at the Joseph Troll Research Facility for our studies.

Due to the limited annual bluegrass that could be obtained from Dr. Bertrand, we spent a significant amount of time vegetatively propagating plant material for our studies. Annual bluegrass and creeping bentgrass plugs were grown in a greenhouse and maintained at a height of

0.5 inches, watered three times per week, and fertilized once per week with full strength Hoagland's solution to provide nutrients and facilitate plant establishment. By December 2009, we had sufficient plant material to begin Project I, which included 2,400 annual bluegrass plugs and 2,400 creeping bentgrass plugs, as pictured below.

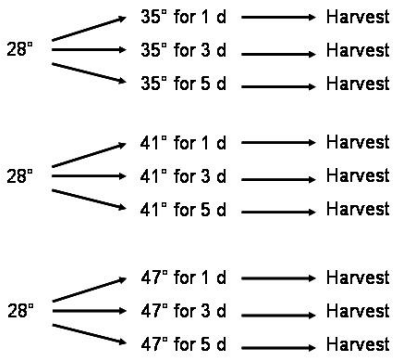


Project 1: Evaluation of Temperature Thresholds for Deacclimation

At the end of December 2009, plants were moved from the greenhouse into a growth chamber and subjected to cold hardening at a constant temperature of 35 ^{o}F with an 8-h photoperiod. Following a three week hardening period at 35 ^{o}F, plants were moved to 28 ^{o}F and lights turned off in order to simulate natural hardening under snow in frozen soil.

At the beginning of January 2010, we started the deacclimation treatments where plants will be subjected to a combination of different deacclimating soil temperatures and durations. Plants will be moved from 28^{o} F to 35, 41, or 47^{o} F for 1, 3, or 5 days (as illustrated below) Following each of the 9 treatment combinations (temperature and duration), plants will be harvested for freeze tests to evaluate 50% killing temperature (LT_{50}). In addition, we will be cycling plants from above freezing temperatures to below freezing temperatures to simulate freeze-thaw cycles in order to evaluate differences in the rehardening potential among the two species. Deacclimation and rehardening capacity of annual bluegrass and creeping bentgrass will be determined based on changes in the LT_{50} compared to the initial freezing tolerance at constant 28 ^{o}F.

Experimental design



Harvesting and preparing plants for freeze tests

We expect to complete Project 1 by April 2010. The data generated from this experiment will be used to determine an optimal deacclimating temperature regime for subsequent experiments for Project 2.