Examination of Cold Deacclimation Characteristics for Annual Bluegrass and Creeping Bentgrass

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Objectives:

1. Determine the effects of different above-freezing temperature and duration combinations that result in a loss in freezing tolerance of creeping bentgrass and annual bluegrass.
2. Examine early changes in carbon metabolism associated with deacclimation of creeping bentgrass and annual bluegrass.

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Premature deacclimation associated with warming periods during winter and early spring can negatively impact turfgrass freezing tolerance and enhance susceptibility to freezing injury. Some limited research suggests that annual bluegrass (*Poa annua* L.) and creeping bentgrass (*Agrostis stolonifera* L.) may differ in their capacity to resist premature deacclimation, which can contribute to interspecific differences in winter injury potential. Therefore, research is necessary to understand the factors that trigger deacclimation in grasses and to identify plant traits that contribute to enhanced deacclimation resistance and freezing tolerance.

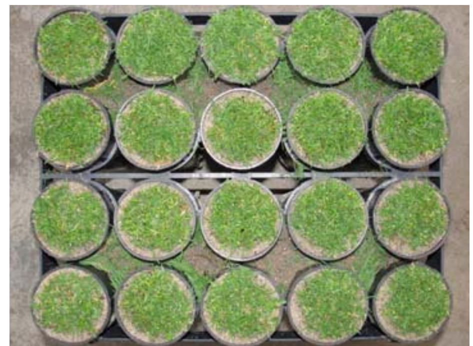
In Experiment 1, plant materials consisted of one annual bluegrass (AB) ecotype (previously shown to exhibit sensitivity to freezing temperatures) and one creeping bentgrass (CB) cultivar ('L-93'). Following establishment, plants were moved to a controlled environment growth chamber and exposed to a cold acclimation regime of 2° C for 2 weeks, followed by subzero acclimation -2° C for 2 weeks. Next, plants were exposed to one of six deacclimation treatments that consisted of the following temperature degree and duration combinations: 4° C for 1day or 5 days, 8° C for 1day or 5 days, and 12° C for 1day or 5 days. Changes in freezing tolerance (lethal temperature at which 50% of plants were killed, LT_{50}) for each species were monitored during cold acclimation and deacclimation.

Differential survival of annual bluegrass and creeping bentgrass following a deacclimation event. (Photo credit: Michael Buras, Longwood Cricket Club)

We found that creeping bentgrass achieved higher freezing tolerance at the end of the cold acclimation period (LT_{50} of -21.2°C) compared to annual bluegrass (LT_{50} of -17.7°C). When plants were exposed to 4° C for 1 day, both species exhibited a small loss in freezing tolerance compared to that at -2° C. However, annual bluegrass deacclimated to a greater extent compared to cree[omg bemtgrass in response to most deacclimation treatments. As expected, greater deacclimation for both species was observed at higher above-freezing temperatures (i.e., 12° C) and in response to greater duration of exposure (i.e., 5 days).

To better understand the underlying causes for differences in deacclimation resistance among the two species, we conducted a second experiment to examine early physiological changes of AB and CB in response to deacclimation, with a focus on carbon metabolism parameters. For Experiment 2, one AB ecotype (freezing sensitive, SS-1) and one creeping bentgrass cultivar ('Penncross') were exposed to a cold acclimation regime of 2° C for 2 weeks, and subzero acclimation at -2° C for 2 weeks. Following the cold acclimation period, plants were then exposed to a deacclimation treatment of 8° C for 5 days. During the cold acclimation and deacclimation periods, we measured canopy photosynthesis and respiration rates, leaf chlorophyll fluorescence parameters, and leaf and crown carbohydrate contents.

Similar to results from Experiment 1, we found that CB achieved higher freezing tolerance compared to AB, and CB also maintained higher freezing tolerance after exposure to 8° C for 5 days.



Annual bluegrass and creeping bentgrass were exposed to deacclimation conditions in controlled environment growth chambers.

During deacclimation, AB restored carbon metabolism parameters more rapidly compared to CB, as exhibited by a more rapid increase in photochemical yield and higher photosynthesis and respiration rates.

Although more rapid up-regulation of carbon metabolism may provide AB with a competitive advantage during spring recovery, these responses may also lead to greater susceptibility of AB to freezing injury in response to mid-winter warming events. Research is currently underway to understand additional factors that may be responsible for differences in deacclimation resistance between AB and CB.

Summary Points

- The freezing tolerance of AB and CB following a period of cold acclimation was influenced by both the magnitude of temperature increase and duration when exposed to simulated winter warming events.
- AB generally exhibited a greater loss in freezing tolerance at lower temperatures and shorter durations, which may account for greater susceptibility to freezing injury for this species.
- In response to deacclimation, AB exhibited a more rapid capacity to restore carbon metabolism compared to CB, based on higher photochemical yield, photosynthesis, and respiration rates.