Early Physiological Changes Associated in Cold Deacclimation of Annual bluegrass and Creeping bentgrass

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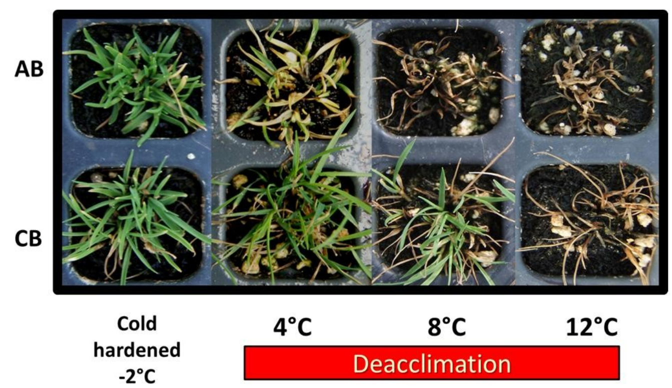
Objectives:

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 physiological changes associated with deacclimation sensitivity of creeping bentgrass and annual bluegrass, with a focus on carbon and protein metabolism parameters*

Premature deacclimation associated with warming periods during winter and early spring can negatively impact turfgrass freezing tolerance and lead to winterkill. Some limited research suggests that annual bluegrass (Poa annua L.) (AB) and creeping bentgrass (Agrostis stolonifera L.) (CB) differ in their capacity to resist 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. The specific objectives of our research were to (i) determine the effects of different above−freezing temperature and duration combinations that result in deacclimation of CB and AB, and (ii) examine early physiological associated with deacclimation sensitivity of CB and AB, with a focus on carbon and protein metabolism parameters.

In Experiment 1, we compared one AB ecotype (previously shown to exhibit sensitivity to freezing temperatures) and one CB cultivar (´L−93´). Plants were exposed to a cold acclimation regime of 2°C for 2 weeks, followed by subzero acclimation −2°C for 2 weeks in controlled environment chambers. Following cold acclimation, plants were then exposed to one of six deacclimation treatments that consisted of the following temperature degree and duration combinations: 4°C for 1d or 5d, 8°C for 1d or 5d, and 12°C for 1d or 5d. Changes in freezing tolerance (lethal temperature at which 50% of plants were killed, LT50) for each species were monitored during cold acclimation and deacclimation. We found that CB achieved higher freezing tolerance at the end of the cold acclimation period (LT50 of −21.2°C) compared to that of AB (LT50 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, AB deacclimated to a greater extent compared to CB in response to most deacclimation treatments (Figure 1). As expected, the greatest deacclimation potential for both species was observed at higher temperatures (i.e., 12°C) and greater duration (i.e., 5 days).

Figure 1. Losses in freezing tolerance and resulting injury to annual bluegrass (AB) and creeping bent−grass (CB) following exposure to deacclimation tem−peratures of 4, 8 and 12° C for 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

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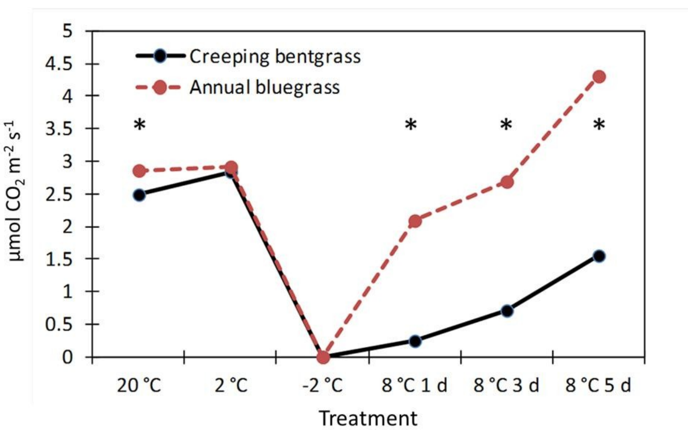
parameters. For Experiment 2, one AB ecotype (freezing sensitive) and one creeping bentgrass cultivar (´Penncross´) were exposed to a cold acclimation regime as in Experiment 1. Plants were then exposed to a deacclimation treatment of 8°C for up to 5 days. During cold acclimation and deacclimation periods, we measured canopy photosynthesis and respiration rates, leaf chlorophyll fluorescence parameters, and leaf and crown carbohydrate contents. As found in Experiment 1, CB achieved higher freezing tolerance compared to AB in response to cold acclimation, and CB also maintained higher freezing tolerance following exposure to 8°C for 5 days. During deacclimation, AB restored carbon metabolism parameters more rapidly compared to CB, as exhibited by a greater increase in canopy photosynthesis and respiration rates and higher photochemical yield components (Figure 2). 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.

An additional experiment is currently underway to further evaluate early changes in the metabolism of important carbon and nitrogen metabolites involved in freezing tolerance, including carbohydrates, amino acids, and proteins, that may be responsible for differences in deacclimation resistance between AB and CB. In our preliminary work, we determined that CB maintained higher levels of fructans during deacclimation compared to AB. Furthermore, CB and AB exhibited distinct differences in their soluble protein profiles and presence of dehydrins proteins during deacclimation. The experiment is currently being repeated to confirm initial observations.

Figure 2. Changes in canopy photosynthesis of an–nual bluegrass (AB) and creeping bentgrass (CB) in response to different cold acclimation (20, 2 and −2°



Summary Points

- Annual bluegrass (AB) generally exhibited a greater loss in freezing tolerance at lower temperatures and shorter durations.
- In response to deacclimation, AB exhibited a more rapid capacity to restore carbon metabolism compared to CB, based on higher canopy photosynthesis, respiration, and photochemical yield components.
- Preliminary results from current experiments also suggest that differences in the metabolism of specific carbohydrate fractions and proteins, such as dehydrins, may also account for differences in deacclimation sensitivity among the two species.
- The more rapid shift in AB carbon and nitrogen metabolism may lead to greater susceptibility of this species to freezing injury in response to mid–winter warming events.

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