Growth and Photosynthetic Efficiency of Supina Bluegrass During Cold Hardening

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INTRODUCTION

Cold acclimation involves a range of physiological and biochemical changes leading to cold tolerance. These changes are induced by a combination of decreasing temperatures and day lengths (photoperiods). Acclimation processes have been well-studied in some cereal (annual) crops but not in perennial turfgrass species.

The ability to maintain photosynthesis at cold temperatures has been associated with cold hardiness in grain crops. In previous tests, supina bluegrass (*Poa supina*) has shown the highest accumulation of fructans yet had the lowest photosynthetic efficiency compared to Kentucky bluegrass (*Poa pratensis*) and perennial ryegrass (*Lolium perenne*). One possible mechanism of cold tolerance in some species is the onset of dormancy early in the autumn, characterized partly by decreased growth and increased soluble carbohydrates (e.g., fructans).

Our hypothesis was that supina copes with cold temperatures by going dormant early in the autumn. If so, it should 1) slow growth sooner, 2) have a lower photosynthetic efficiency during autumn, 3) acclimate better and have a lower LT_{50} value (lethal temperature at which 50% of the plants are killed) compared to Kentucky bluegrass or perennial ryegrass.

MATERIALS AND METHODS

Supina bluegrass ‘Supranova’, Kentucky bluegrass ‘Touchdown’, and perennial ryegrass ‘SR4200’ were removed from field plots at the O.J. Noer Turfgrass Research and Education Facility (Verona, WI) in Sept. 2. Plants were placed in a greenhouse for seven days, then washed free of soil and roots and tillers were trimmed. Individual plants were placed in a hydroponic growing system fed with half-strength Hoagland’s solution. Plants were acclimated under one of two temperature regimes in growth chambers: Control = 4 weeks at 20 C, Acclimated = 2 weeks at 12/10 C followed by 2 wks at 2/0 C. Photosynthetic flux density was 250 µmol m^{-2} s^{-1} with a 12 hr photoperiod.

Data collected at two and four week periods included:

1) Growth: tiller and leaf number, root mass and length
2) Chlorophyll fluorescence kinetic tests (to determine photosynthetic efficiency)
3) LT_{50} values
4) Non-structural carbohydrate analysis of crowns

RESULTS AND DISCUSSION

Supina bluegrass developed significantly ($p \leq 0.05$) more topgrowth (leaf and tiller number) compared to Kentucky bluegrass or perennial ryegrass under constant 20 C conditions and during the first two weeks of cold acclimation. At four weeks after cold acclimation supina bluegrass continued to develop more leaves but no longer had significantly greater tiller development. Growth of all species slowed dramatically even after two weeks of cold acclimation. Supina bluegrass developed greater root mass during cold acclimation, while perennial ryegrass developed more root mass when kept at 20 C. Photosynthetic efficiency was equivalent among all species in all treatments. Photosynthetic efficiency decreased from 0.8 Fv:Fm four weeks after acclimation but was similar to plants in the control temperature (20 C) two weeks after cold acclimation. Thus, photosynthetic efficiency was a less sensitive indicator of cold temperatures than growth.

The cold acclimation process decreased the LT_{50} values of all species, with greater cold tolerance expressed after four weeks of acclimation compared to two weeks of acclimation. Supina bluegrass had the highest LT_{50} values indicating the lowest freezing tolerance. Carbohydrate samples are currently being analyzed.