Cold tolerance in warm season turfgrasses

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Abstract

Warm season (C_4) turfgrasses are a popular choice for sports and public venues in tropical, subtropical, arid and semiarid climates due to their spreading characteristics, multiple stress resistance, including water deficit and heat tolerance, and faster establishment. However intolerance of low temperature is the key limitation to their use in temperate regions. The New Zealand turf industry has a growing interest in warm season (C_4) grasses due to their water use efficiency under heat stress and summer dormancy of cool season (C_3) grasses, especially in the upper parts of the North Island. Twelve commercially available cultivars of four warm season grass genera (*Cynodon, Zoysia, Paspalum and Pennisetum*) were established in a glasshouse and ten cultivars in field at Palmerston North, New Zealand, using seeds and stolon cuttings. This phase of the project was carried out from November 2012 to January 2015, with three major aspects of turf function measured. Established plots were scored for quality attributes (colour, texture, uniformity, ground cover and overall quality) as prescribed by NTEP (National Turf Evaluation Program, USA). Field plots became dormant and began browning in late autumn. Browning progressed and became more visible by the end of winter. Glasshouse plots displayed better overall turf quality than field plots except for seeded *Cynodon* varieties which showed susceptibility to Anthracnose fungal attack. Vegetative *Cynodon* varieties (Agridark, Windsor green and Santa Ana) performed well along with Sea spray (*Paspalum vaginatum*). Regal Staygreen (*Pennisetum clandestinum*) proved more cold tolerant than other varieties but, being coarse textured, cannot attain high acceptance in the turf industry. A subsequent experiment was focused on detailed morphology and growth pattern of these varieties. It was observed that glasshouse plots developed fewer roots per node and a lower total root mass compared with those grown in field conditions. In field plots stolon structures were more compact with a high number of horizontal stolons. Rhizome appearance differed between the glasshouse and the field and during the first year of establishment only vegetatively established *Cynodon* varieties developed rhizomes under field conditions and only Agridark in the glasshouse. However, during the next growing season all varieties in the field, except Zenith, had formed rhizomes. Seeded couches failed to produce rhizomes in the glasshouse even after their 2nd growing season. Detailed study of stolon morphology confirmed findings on turf mat quality from visual scoring, and identified a pattern of ecological interest in that

varieties of the genera *Cynodon* and *Zoysia* formed compound or triplet nodes, with root, branch and internode formation allocated to different leaves.

A second phase of the research investigated cold tolerance in warm season turf grasses and the response of four varieties from three different warm season turf species Agridark and Windsor Green (*Cynodon dactylon*), Sea Spray (*Paspalum vaginatum),* and Zenith (*Zoysia japonica*) when exposed to low but non freezing temperatures. This experiment aimed to identify low temperature tolerance thresholds at various exposure durations, to help turf mangers define temperature tolerance of available varieties. Plants were established in trays in a glasshouse and were exposed to a series of progressively decreasing temperatures (16/10°C, 12/8°C, 10/6ºC, 8/4°C and 6/2°C, day/night) with 2 weeks at each temperature step, or to sudden, short exposure to the same temperatures for 2 weeks. Colour change during the various combinations of low temperature exposure, and recovery after damage were observed along with measurement of selected physiological indices including proline, malondialdehyde (MDA) and carbohydrate accumulation. It was found that longer exposure with gradually lowered temperature was more detrimental to plants than sudden, short exposure. Seashore paspalm (Sea spray) exhibited better colour retention during cold exposure than the other three varieties in this experiment. Levels of proline and MDA in leaf and stolon tissue, and carbohydrate status tended to return towards pre-stress levels when plants were placed in a glasshouse for recovery from these cold-stress challenges.

The ecological significance of the triplet stolon structure is unclear but deserves further study. Understanding that cold damage is a cumulative process rather than a sudden event when a threshold is reached, will be helpful to development of recommendations for turf industry use of C_4 grasses in temperate climates.

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