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Cold tolerance in warm season turfgrasses

A thesis presented in partial fulfilment of the requirements
for degree of

Doctor of Philosophy
in Plant Science

at Massey University
Palmerston North, New Zealand

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2017
Abstract

Warm season (C₄) 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 (C₄) grasses due to their water use efficiency under heat stress and summer dormancy of cool season (C₃) 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, 10/6°C, 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 C4 grasses in temperate climates.
Acknowledgements

I am thankful to almighty Allah for all his blessings and bounties in my life. I duly regard Higher Education Commission of Pakistan for providing me a scholarship and Massey University, New Zealand for providing me excellent learning environment and support to pursue my goals. I am thankful to PMAS Arid Agriculture University, Rawalpindi, Pakistan for granting me study leave. I am also thankful to the Institute of Agriculture and Environment (IAE), Massey University for providing me the opportunity to attend the International Horticultural Congress 2014 in Brisbane, Australia and scholarship support for completion of studies and to the New Zealand Sports Turf Institute for their collaboration and funding support for my project.

I would like to express my deepest gratitude to my principal supervisor Professor Cory Matthew for all his kindness, guidance, patience, hard work and support throughout my study tenure. He provided the best learning environment and created excellent skill development opportunities for me. He is a true mentor and I feel myself fortunate having the opportunity to work with him. Undoubtedly I would not be able to achieve my goals without his kind support and supervision.

I am also grateful to my co-supervisor Dr Andrew Mitchell, Research manager and Agronomist at NZSTI, Palmerston North for his technical insight and help during the project. He not only helped from his industry knowledge but also provided support to establish the experiments and their maintenance on a long-term basis. I wish to express my thanks to my co-supervisor Dr Kerry Harrington, Senior Lecturer, IAE, Massey University for his counselling time management suggestions and availability at short notice when help was needed. It was an enjoyable experience working with him. Special thanks are due to Bill Walmsley, Keith Salisbury, Leigh Hunt and Nick Jones for their support in acquiring germplasm and helping me to familiarise myself with New Zealand sports turf industry.

My thanks are due to the staff members of the Plant Growth Unit, Massey University, Steve Ray, Lesley Taylor, and Lindsay Sylva for their help during my experiments in the glasshouse and controlled growth chamber. I was impressed with their problem solving capacity. I wish to express my thanks to Mark Osborne and Simon Orsborn for their technical and manual support. I am also thankful to Chris Rawlingson
for his equipment tutorials and technical support and Kay Sinclair for helping with lab management and material acquisition, as and when it was required. I would like to appreciate help from Sunmeet Bhatia and Cécile Duranton and Roberta Carnevalli to carry out analyses for me. Very special thanks to the kind face of the Institute, Denise Stewart for her advice in making this manuscript look like a thesis.

I have to say special thanks to my PhD fellow Lulu He, for teaching me analysis skills and her guidance during my laboratory work. My heart felt gratitude also goes to fellow PhD students Wei Zhang, Januarius Gobilik and Mauricio Maldonado, and other graduate student colleagues. Time spent in New Zealand and Massey University has become much more valuable with lots of memories due to the presence of my sincere friends Muhammad Naveed Anwar and Ahmed Raza. I am thankful to Dr Muhammad Ajmal for his presence and support who was always like a big brother to me. I would also like to commend other Pakistani scholars and community members for their presence which never let me feel homesick. I am greatly thankful to Dr. Nadeem Akhtar Abbasi, Dean FCFS for being, boss, brother, friend and mentor; your encouragement and follow up will be always remembered.

I greatly appreciate the contributions of my family to pursue my ambitions especially to my parents for their endless efforts to help in my life and my career. I am thankful to my Uncle Abdul Wahid for his mentoring and extraordinary support and love throughout my life. Most due love and gratitude to my sister Sadia Habib and brother Qasim Habib always like friends than siblings to me.

At last I will like to express my thoughts and sincere thanks for my loving wife Fatima Mazhar, being with me encouraging and supporting as and when it was needed, and to my gorgeous little man Muhammad Danyal for all the joys and love. You both are absolute treasure for me.
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