The effects of waterlogging in contrasting perennial ryegrass (*Lolium perenne* L.) germplasm.

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Abstract

Waterlogging decreased root and shoot yield of perennial ryegrass seedlings by 48 and 52%, respectively. A decrease in root and shoot growth occurred between days 7-14 and 28-42 respectively. Shoot and root dry matter yield was shown to be sufficient to determine the tolerance of perennial ryegrass seedlings under continuous waterlogged and recovery conditions. Variation occurred for waterlogging tolerance between accessions, highlighting the possibility of improving the tolerance of perennial ryegrass cultivars to waterlogging.

Key Words

Waterlogging, perennial ryegrass, recovery, root and shoot mass.

Introduction

The Australian dairy industry is predominantly based on the year-round grazing of perennial ryegrass pastures. Dairy pastures in high winter-rainfall environments of Victoria often experience periods of waterlogging, with subsequent reductions in pasture growth and soil structure, due to pugging and soil compaction (1). Waterlogging affects more than 1.8 million hectares of Victoria, costing an estimated $36 million annually (2). Little research has been conducted in the effects of waterlogging on the growth of perennial ryegrass and no cultivars are available commercially that tolerate waterlogging. This study aimed to determine the effects of waterlogging on perennial ryegrass (*Lolium perenne* L.), and to identify growth parameters that could be used to screen large populations of perennial ryegrass for waterlogging tolerance.

Method

In all experiments, the treatments were applied at the three to four leaf stage of growth. In Experiment 1, shoot and root dry matter (DM) yield and their relative growth rates (RGR) of sequential harvests (day 0, 7, 14, 28, 42 & 53) were used to quantify the waterlogging tolerance of seedlings of eight perennial ryegrass cultivars commonly used in Australia. In Experiment 2, traits quantifying growth and development of 20 ryegrass accessions were compared under non-waterlogging (control), waterlogging for 21 days followed by seven days of drainage (recovery) and waterlogging for 28 days (waterlogging) conditions. In Experiment 3, one hundred accessions of perennial ryegrass seedlings, collected from areas of the world where temporary waterlogging is experienced, were compared under non-waterlogging (control) and waterlogging for 28 days (waterlogging) conditions. Shoot, root and dead leaves DM yield were measured 28 days after treatments were imposed.

Results and Discussion

In Experiment 1, eight cultivars of perennial ryegrass all had a similar level of tolerance to waterlogging. Waterlogging for 53 days affected growth by decreasing DM yield of roots by 48% and shoots by 52% (Fig.1). A decrease in the RGR of roots occurred between days 7-14. Waterlogging tolerance mechanisms may have been initiated after this initial decrease in growth, such as the formation of aerenchyma in roots. The decrease in root growth was not realised in shoots until between days 28-42. All plants survived the waterlogged conditions.

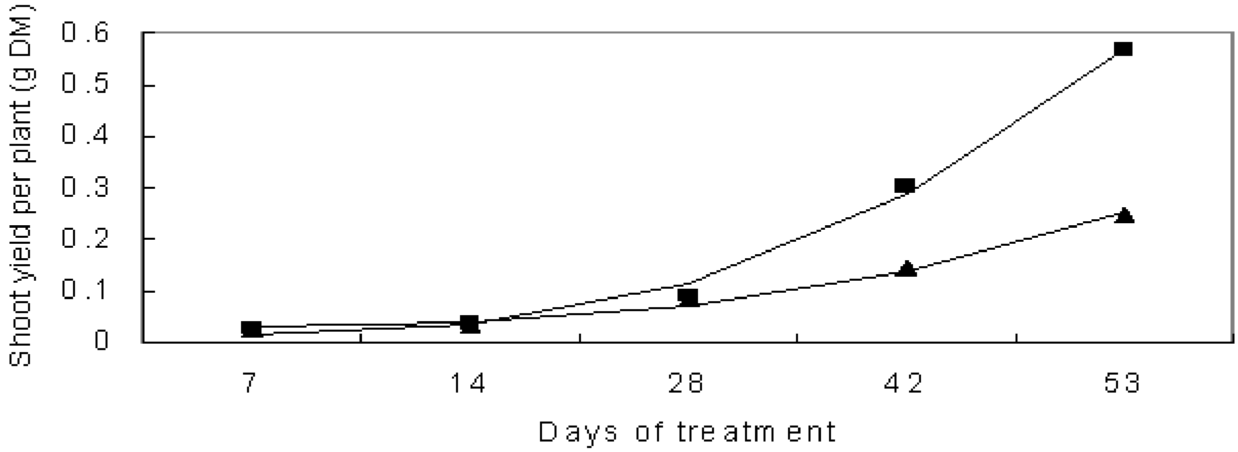

Fig. 1. Average shoot DM yield of eight perennial ryegrass seedlings in Experiment 1 (▲waterlogged, non-waterlogged ■).

In Experiment 2, shoot and root DM yield was found to be a practical means of determining differences in waterlogging tolerance between perennial ryegrass accessions from large populations. There was considerable variation between treatments for each accession (Fig. 2). The accession Fennema was found to be tolerant of waterlogging in the waterlogging and recovery treatments. Evidence in this experiment suggests that selection of a waterlogging-tolerant accession may be made under a waterlogging or a recovery treatment.

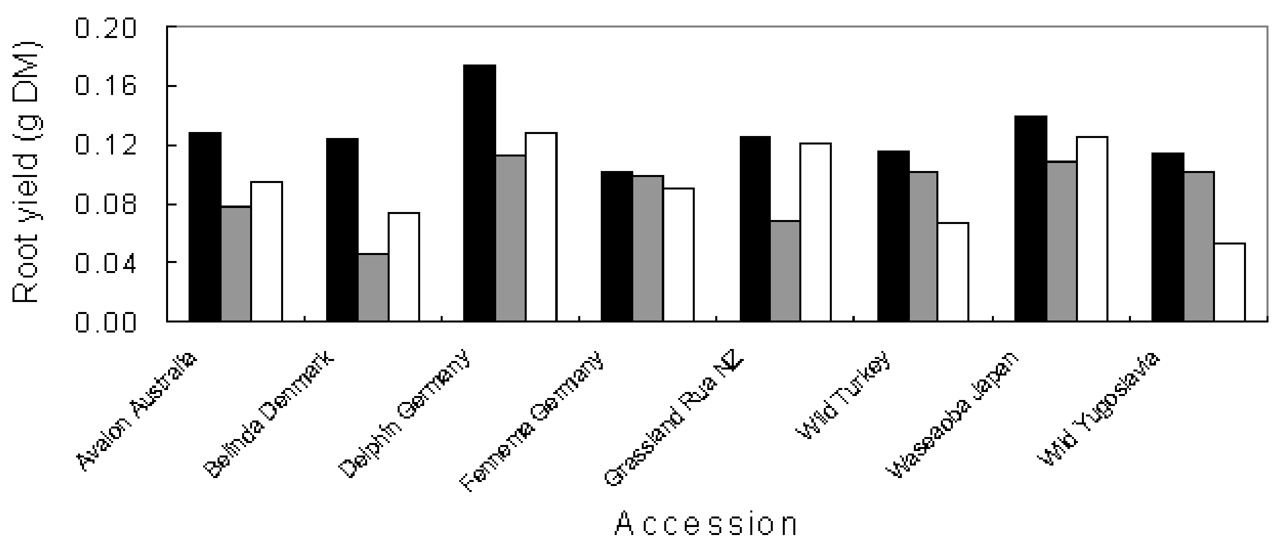

Fig 2. Root DM yield after 28 days of treatment in Experiment 2. (Accession name followed by country of origin) (non-waterlogged ■, waterlogged ■, recovery ☐).

In Experiment 3, variation was also identified for waterlogging tolerance in a large population of perennial ryegrass, highlighting the possibility of breeding a cultivar that is tolerant of waterlogging. A mapping population could be developed from tolerant and intolerant lines and used to identify QTLs (quantitative trait loci) for tolerance to waterlogging and increase the efficiency of selection for waterlogging tolerance.

Acknowledgements

The Dairy Research and Development Corporation provided funding for the work. Thanks are extended to the technical staff who worked on the project and to Gavin Kearney for statistical advice.

References

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