

Stresses associated with germination and establishment of overseeded turfgrasses

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Abstract

Overseeding is a practice that is commonly applied to dormant turfgrasses to provide an actively-growing turf surface during winter and early spring. This practice has been widely used across the south and transition zone on golf courses, athletic fields, and other recreational turf surfaces. Grasses used for overseeding are often more sensitive to biotic and abiotic stresses compared to the dormant warm-season grass and there is a need to identify new genetic resources and cultural practices that allow better utilization of this practice. This paper summarizes results from trials that investigated the effects of salinity and traffic on several commonly-used turfgrass species. Overall, the results from these trials indicate the ryegrass species, including diploid perennial ryegrass, tetraploid perennial ryegrass, and intermediate ryegrass, remain the most tolerant overseeding species of abiotic stresses such as salinity. In addition, these species are also more tolerant of traffic than grasses such as meadow fescue and annual ryegrass. Continued research is needed to identify grasses and management strategies that allow successful overseeding in harsh environments.

Introduction

Warm-season grasses such as bermudagrass (*Cynodon* spp.) continue to be the predominate turfgrass species used for golf courses, sports fields, and home lawns in tropical and transition zone areas of the world. Although bermudagrass has many positive attributes, such as good wear tolerance and recuperative potential, excellent heat and drought stress tolerance, and broad pest resistance, the species experiences a long winter dormancy period in many use areas. Because of this extended dormancy period, bermudagrass is often over-seeded with a cool-season turfgrass to provide an actively growing green surface for winter and early-spring sporting activities (Dudeck and Peacock, 1980; Schmidt and Shoulders, 1977).

Numerous grass species have been successfully used for overseeding, including annual (Italian) ryegrass (*Lolium multiflorum* Lam.), perennial ryegrass (*L. perenne* L.), intermediate ryegrass (*L. multiflorum* Lam. x *L. perenne* L.) creeping bentgrass (*Agrostis stolonifera* L.), rough bluegrass (*Poa trivialis* L.) and fine fescue (*Festuca* spp.) (Kneebone and Major, 1969; Schmidt and Shoulders, 1977; Richardson, 2004). Although all of these cool-season grasses have been successfully used in various overseeding situations, there is a continued need to develop new species and cultivars with applications to overseeding. In recent years, efforts to improve

turfgrass characteristics of both meadow fescue (*Festuca pratensis* Huds.) and tetraploid ryegrass (*L. perenne* L.) have led to new species with applications to overseeding dormant bermudagrass turf (Richardson et al., 2007).

Overseeding grasses, like all turfgrasses, often experience a range of environmental, biological, and cultural stresses such as diseases, limited water, poor-quality water, salinity stress and traffic from equipment or players. However, overseeding grasses are rarely provided with an extended establishment window in which the turf can be hardened and prepared for some of these stresses. As such, developing overseeding grasses with improved tolerance of biotic and abiotic stresses and developing management practices to minimize damage to seedling overseeding grasses are important research objectives.

Increased demand for potable water in southern locations where overseeding is practiced has increased the use of lower quality irrigation sources at many golf courses and sports turf facilities. Across the U.S., 12% of all golf facilities use recycled water, while 37% of golf facilities in the southwestern U.S. use some form of recycled water (Throssell et al., 2009). Although data is not available for other turf facilities, it is assumed that recycled water use is increasing around the country, especially in areas where potable sources are restricted. Although certain overseeding grasses such as perennial ryegrass can germinate in the presence of moderate salinity (Johnson et al., 2007), it is unclear how other overseeding species might respond to moderate or higher levels of salinity. Regardless, it is obvious that alternative grasses or cultivars with improved tolerance of poor-quality water would be of great benefit to turfgrass managers.

A major stress observed in all overseeding applications is the effects of traffic and play on the overseeding grasses, especially in the weeks following seeding, where seedlings are vulnerable to injury from equipment or humans. Although overseeding grasses have been shown to respond differently to traffic at maturity (Summerford et al., 2008; Minner and Valverde, 2005), there have been limited studies that have investigated the effects of traffic on overseeded turf during the seedling stage.

This paper will highlight studies conducted by our research program over the past 6 years that have investigated the effects of species, pre-plant cultivation, and salinity on the germination and establishment of overseeding grasses in a transition-zone environment.

Materials and Methods

Salinity effects on germination

A greenhouse study was conducted in which four overseeding species, including diploid perennial ryegrass, tetraploid perennial ryegrass, intermediate ryegrass, and meadow fescue. The four species were germinated in hydroponic solutions adjusted to four irrigation water salinity levels. The salinity levels included 7500, 10000, 12500, and 15000 mg L⁻¹ NaCl solutions, which

correspond to electrical conductivity values of ~12, 16, 20, and 24 dS / m. These levels were chosen based on results from a preliminary study where there was no inhibition of germination of any of these species up to 5000 mg L⁻¹ NaCl. The hydroponic system consisted of tubs (28 by 35 by 14 cm) in which a foam insulation board (thickness = 1.5 cm) was cut to fit inside the perimeter of the tub and floated on the hydroponic solution. Twelve holes (3.8 cm diam.) were cut into each board and a nylon screen (18 x 16 mm) was affixed with silicon glue to the bottom side of the insulation board, which placed the screen in contact with the solution. The base solution for each salinity treatment consisted of a complete, nutrient solution that delivered 50 ppm N using a fertilizer formulation (5-11-26, HYDRO-SOL, Peters Professional) specifically designed for hydroponic culture. Air was continuously supplied to each solution via an air stone (Aqua Mist, Penn Plax, Inc.) connected to an aquarium pump (Silent Air, Penn Plax, Inc.). Each solution concentration was replicated four times.

Twenty-five seeds of each species were placed in each of 3 subsample cells on top of the screen that was in contact with each solution. Germination was monitored frequently (every 1-2 days over the next 14 days) and a seed was considered to have germinated when both the radicle and coleoptile had emerged. Once a seed had germinated, it was counted and removed from the solution.

Pre-plant cultivation and traffic response of overseeded grasses

In Sep. 2007 and 2008, five cool-season turfgrasses, including annual ryegrass, intermediate ryegrass, meadow fescue, diploid perennial ryegrass, and tetraploid perennial ryegrass were overseeded into a mature (>4 yr) stand of bermudagrass (cv. Riviera) turf at the University of Arkansas Agricultural Research and Extension Center at Fayetteville. Species were seeded at similar seeding densities (Table 1). Plots were assigned one of three pre-plant cultivation treatments of core-aerification, verticutting, or an untreated control. Core-aerification treatments included a single pass with a greens aerifier (Toro Greens Aerator, Toro Co., Bloomington, MN) set up with 1.25 cm hollow-tines on a 5 x 5 cm spacing. Verticutting treatments were applied with a tractor-mounted verticutter (Jacobsen Turf, Charlotte NC) containing blades on 2.5 cm centers and set to a depth that reached the soil surface. Traffic was applied using a Cady traffic simulator (Henderson et al., 2005) making four passes at 1, 2 or 4 weeks after planting (WAP) or an untreated control.

The experimental design was a strip-strip plot with species considered the whole plot and pre-plant cultivation and traffic treatments applied randomly as strips across species treatments. The plot size for each species replicate was 3.6 x 3.6 m, while both the pre-plant cultivation and traffic treatments were applied in 1.2 m strips across the species plots. All treatments were replicated four times. Digital image analysis was used to determine turfgrass coverage of the

overseeded species when the bermudagrass turf was dormant (Richardson et al., 2001). For brevity, only the 2008 data will be presented in the present paper.

Results and Discussion

Salinity effects on germination

Germination was first observed with intermediate ryegrass in the lowest salt solution at 4 days after seeding (DAS) (Fig. 1). All of the ryegrasses began germinating in the 7000 and 10000 mg l⁻¹ solutions at 5 DAS. In the 12500 and 15000 mg l⁻¹ solutions, ryegrass germination was first observed at 7 DAS. In all solutions except the 15000 mg l⁻¹, germination of meadow fescue was first observed at 8 DAS, which is consistent with earlier reports comparing these species (Richardson et al., 2007). Minimal germination of meadow fescue was observed at the highest salt concentration (Fig. 1).

All of the ryegrasses obtained similar germination levels in each solution by 14 DAS and exceeded 80% germination in the lowest two salt concentrations (Fig. 1). There was a reduction in final germination of the ryegrasses observed at the 12500 and 15000 mg l⁻¹, with maximum germination of approximately 60% and 45%, respectively (Fig. 1). Meadow fescue followed a similar trend, except the final germination of this species was reduced to approximately 75% in the 10000 mg l⁻¹ solution, 20% in the 12500 mg l⁻¹ solution, and less than 5% in the highest salt concentration.

The overall conclusion from this study is that tetraploid ryegrass has similar salt tolerance, relative to seed germination, as other commonly-used ryegrass species. As these grasses are being applied to many overseeding situations, further research on its salt tolerance as a mature plant would be worthwhile. Germination of meadow fescue appears to be more sensitive to increasing salt levels compared to the ryegrasses and would not be currently recommended in areas where low-quality water is being used. However, it should be noted that the salt concentrations used in this study were quite high. The 10000 mg l⁻¹ solution would approximate a 1:1 mixture of fresh water and sea water and there was minimal germination inhibition observed in any species at that salinity level.

Pre-plant cultivation and traffic response of overseeded grasses

Aerification and verticutting both provided better establishment for over-seeding grasses compared to the untreated control although differences were not dramatic (Fig. 2). A similar trial was conducted in the 2009 season on a site with higher soil compaction and the pre-plant cultivation treatments had a bigger impact on initial establishment (data not shown).

Traffic applied 4 WAP was consistently more detrimental than traffic applied at 1 and 2 WAP in all overseeding species (Fig. 2). The reason for this is currently unclear, but apparently traffic

applied later in the fall was more detrimental, as the turf had less time to recover before growth slowed due to low temperatures. In one year of our studies, the pre-plant aerification also helped reduce damage from traffic on seedlings (data not shown). This may be the result of reduced compaction from the aerification. Regardless, these results suggest that cultivation can enhance establishment of overseeding grasses and this could be very beneficial in transition-zone environments where there is a limited establishment period in the fall.

References

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Table 1. Overseeding species used in field study and their corresponding seeding rates.

Species:	Cultivar	Seeding Rate	
		(g m ⁻²)	Seeds / cm ²
Annual ryegrass	Gulf	68	3.4
Intermediate ryegrass	50% Transist / 50% Tranzeze	63	3.4
Meadow fescue	AMF29	63	3.4
Diploid perennial ryegrass	Integra	59	3.4
Tetraploid perennial ryegrass	T3	93	3.4

Figure 1. Germination of four, cool-season turfgrass species in solutions with various NaCl concentration. Error bars represent the least significant difference (P=0.05) for comparing species within a salinity level.

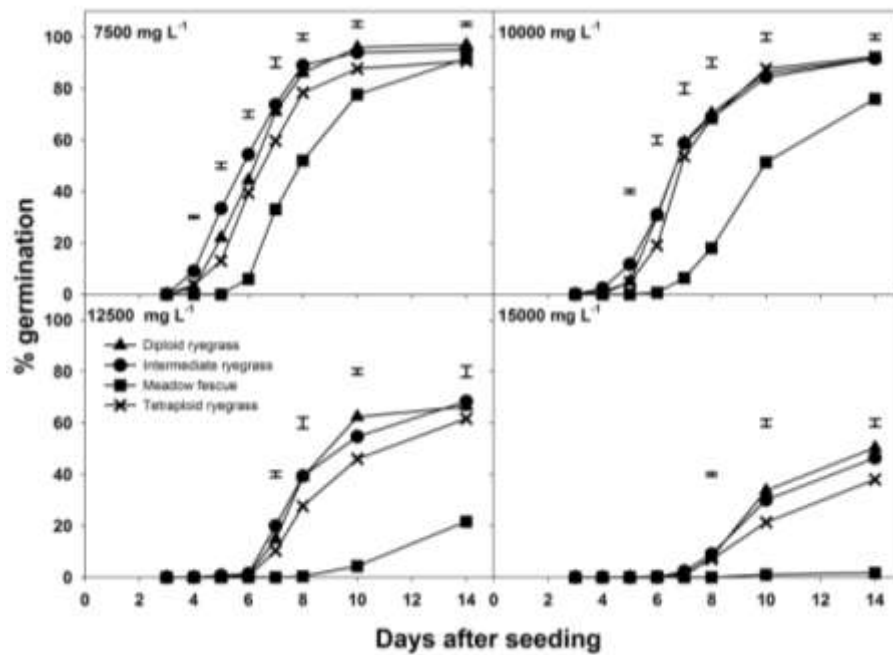


Figure 2. Establishment of five overseeding turfgrass species as affected by cultivation and traffic. Different letters represent significant difference between either cultivation treatments or traffic treatments, as determined by a least significant difference test (P=0.05).

