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Influence of grass species and endophyte infection on weed populations during establishment of low-maintenance lawns

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Abstract

This four-year field study evaluated the influence of grass species and endophyte infection on weed density and cover in stands of tall fescue and perennial ryegrass managed as low maintenance lawns. Bare ground, turfgrass cover, and weed cover varied over time with grass species. Stands of tall fescue generally had more bare ground, greater weed cover, and less grass cover than stands of perennial ryegrass during the first year following seeding. However, this trend was reversed over time with stands of perennial ryegrass having more bare ground, more weed cover, and less turfgrass cover compared to stands of tall fescue after four years. The influence of endophyte infection was much weaker than predicted having a significant negative influence only on cover by one weed species, *Cerastium vulgatum*. Results indicated that grass species and fungal endophyte infection may influence patterns of weed occurrence in low maintenance lawns, although the influence of grass species is likely far more important in this regard. Observed patterns in plant cover and density mainly reflected establishment and growth characteristics of the two primary grass species planted.
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Keywords: Perennial ryegrass; Tall fescue; Weed density; Weed cover; Bare ground

1. Introduction

Current management of lawn weeds depends heavily on the use of synthetic herbicides. This is due primarily to the lack of effective alternatives and to a relatively low tolerance for weeds in lawn ecosystems. However, concerns about human health risks and environmental impacts associated with traditional management practices have forced practitioners to consider alternative management strategies. There is increasing emphasis on cultural practices that promote grass density, and on the use of selective herbicides when appropriate (Johnson and Murphy, 1992). Proper cultural practices involving selection of appropriate grass species and cultivars (Emmons, 2000), optimum mowing height and frequency (Lush and Rogers, 1992; Watschke and Schmidt, 1992), sufficient fertility (Turner et al., 1979), and annual cultivation (Murphy and Rieke, 1994) can improve the vigor, competitiveness, and persistence of grasses over other plants. Still, despite a general adherence to integrated pest management principles, most weed management studies in this system focus on the efficacy or residual activity of synthetic herbicides. Few studies have evaluated or described the biological aspects of lawn weed management, especially in situations where intensive chemical management is not practical or desirable. Because of the increasing area of land occupied by lawns in the US (>10 million ha), there is a need for studies supporting the development of sustainable management practices in this system.

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Because inter-specific differences between grasses can be important predictors of turf vigor and persistence, grass species selection may also have implications for weed invasion in lawns (Busey, 2003). Although rapid turfgrass establishment is important for resisting weed colonization, it may not be a good predictor of long-term performance (Gardner and Taylor, 2002). Unfortunately, few long-term studies have examined the influence of grass species selection on patterns of weed encroachment in low maintenance lawns.

Another factor, which is often overlooked in terms of its potential impact on the competitive ability of lawn grasses, is infection by symbiotic fungal endophytes. Fungi in the genus *Neotyphodium* form symbiotic relationships with several important grass species. The nature of this symbiosis is such that the fungus benefits from access to plant nutrient and photosynthetic resources while infected plants benefit from enhanced tolerance or resistance to environmental stress (Elmi and West, 1995; Ravel et al., 1995). Because the endophyte relies entirely on the plant mutualist for sustenance, it imposes a small physiological cost on the host. A number of studies indicate that endophyte-infected plants exhibit a considerable competitive advantage over their non-endophytic congeners (Clay and Holah, 1999; Clay et al., 1993; Latch et al., 1985). However, under some circumstances in heterogeneous environments, endophyte infection has been deleterious to the plant (Richmond et al., 2003; Cheplick, 1997) and competition with the fungus for nutrients or photosynthate has reduced plant growth (Cheplick et al., 1989), thereby reversing the advantage of endophyte infection.

Perennial ryegrass, *Lolium perenne* L., is a non-creeping, bunch-type grass that germinates and establishes quickly whereas tall fescue, *Festuca arundinaceum* Schreb. is a weakly rhizomatous species with a slower establishment rate (Emmons, 2000). These two grass species are both commonly infected with the symbiotic fungal endophytes *Neotyphodium lolii* Glenn, Bacon, Price & Hanlon, and *Neotyphodium coenophialum* Glenn et al., respectively. Because of differing establishment and growth characteristics of the two grass species, it was hypothesized that perennial ryegrass should initially be less prone to weed invasion than tall fescue, but that it may also be less competitive over the long term. Based on the results of studies indicating that endophyte infection may improve the competitive ability of infected grasses in unmanaged systems, it was also hypothesized that lawns containing a high proportion of endophyte-infected plants should resist weed invasion compared to lawns with lower levels of endophyte infection. A four-year field study was conducted to examine the influence of grass species and endophyte infection on weed community dynamics in a low-maintenance lawn system comprised primarily of either perennial ryegrass or tall fescue. For this study, weeds were defined as any plant species other than the grasses used to establish the experimental lawns. Results of this study should provide land managers, planners, and developers with useful information regarding the importance of grass species selection and endophyte infection in the planning and implementation of low-maintenance lawns and urban landscapes.

2. Materials and methods

Seeds of endophyte-infected perennial ryegrass (cv. Palmer III) and tall fescue (cv. Alamo) were obtained from Loft's Seed Co. (Bound Brook, NJ, USA). Infection by the fungal endophytes *N. lolii* and *N. coenophialum*, respectively, was reduced or removed from half of the seeds of each grass species by storing the seeds in an environmental chamber at 37 °C (60–80% rH) for six weeks (heat-treated). The remaining seeds were stored in a cooler at 5 °C. Endophyte-infection levels and germination rates were determined by planting heat-treated and untreated seeds in a pasteurized 1:1:1 sand:soil:peat mixture in the greenhouse. Data on germination rates were collected after two weeks. After eight weeks of growth, 20 plants from each treatment were sampled for endophyte infection using a tissue print immunoblot technique modified from Gwinn et al. (1991). For perennial ryegrass, heat treatment reduced germination from 87 to 78% whereas endophyte infection was reduced from 90 to less than 1%. For tall fescue, heat treatment reduced germination from 84 to 75% whereas endophyte infection was reduced from 87 to less than 5%. The seed treatments allowed establishment of research lawns containing low and high endophyte-infection levels for the same variety and seed-lot of each grass species.

Sixteen research lawns, each measuring 6.1 m × 6.1 m (37.2 m^2), were established during September, 1999 on the grounds of the Ohio Agricultural Research and Development Center, in Wooster, Ohio. Soil at this site was Wooster silt-loam (fine-loamy, mixed, mesic oxyaquic fragiudalph). Glyphosate was applied to kill all existing plant material at the study site. The soil was then roto-tilled, raked, and culti-packed prior to seeding. Seeding was performed by broadcasting seed over each new lawn area. Seeding rates were adjusted according to germination rates. In order to produce stands with similar plant densities, perennial ryegrass was seeded at a rate of 193.5 kg viable seed/ha whereas tall fescue was seeded at 344.1 kg viable seed/ha. Pelletized paper mulch (Seed-Aid™, AIMCORE Consumer Products LCC, Buffalo Grove, IL, USA) was applied immediately after seeding at a rate of 2440 kg/ha to keep the seed bed evenly moist and to avoid washing. Each grass species-by-endophyte combination was replicated four times in a completely randomized design.

Lawns were managed under a low-maintenance regime which excluded application of fertilizers, herbicides, and insecticides. Lawns were cut weekly at a height of 8.9 cm using a mulching mower which chopped and returned the clippings to the lawns. Irrigation was used as needed only