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Growth and quality responses of low-maintenance turfgrasses to trinexapac-ethyl

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ABSTRACT

The positive effects of trinexapac-ethyl (TE) on turfgrass growth and tolerance to various types of stress could promote its use in low-input maintenance turfgrasses to reduce the expense associated with mowing. However, there is a general lack of information about TE effects in low maintenance turfgrasses, and especially when used in transition zone turfgrass mixtures. The objective of this study was to evaluate the response of three inter-specific turfgrass mixtures to three different application rates of TE under low maintenance conditions.

A 2-year field study was conducted from April 2006 to July 2008 at the Agricultural Experimental Farm of the University of Padova (northern Italy, 45°20′N, 11°57′E, elevation 8 m). Visual turfgrass quality (1–9 scale) and clippings biomass production of three mixtures were evaluated seasonally under four TE treatments with rates representing 0, 0.5, 1.0 or 1.5x the rates indicated on label instructions. Based on both visual quality and biomass production, turfgrass responded differently to TE application depending on dominant species in the mixture. Furthermore, our results suggested that changes over time in turfgrass botanical composition influence visual quality and biomass production through the experimental period. The main effect of TE treatments occurred in biomass production while the effect on turfgrass quality was mainly associated with the two highest TE rates. Application at a rate lower than the labeled seems to be enough for reducing biomass production without affecting turfgrass quality or even, in some seasons, improving it. Finally, we found that the effect of TE seems to weaken over time as turfgrass maturity advances.

1. Introduction

Maintaining a high quality turfgrass can be costly for turfgrass managers in terms of both time to labor and financial expense. In particular, mowing represents one of the greatest costs in turfgrass management, primarily in terms of labor and machinery. In addition, there are significant costs from an environmental standpoint as 40% of the energy used in the turfgrass maintenance is derived from fossil fuels (Busey and Parker, 1992), where prices have strongly increased in recent years. Another cost associated with mowing is represented by the disposal of grass clippings collected, because of current solid waste management policies that ban or penalize the contribution of yard debris to landfills (McCarty et al., 2004).

The use of plant growth regulators (PGRs), which are already widely used in high input turfgrasses, could increase in low-maintenance turfgrasses, such as home and public lawns, to reduce plant growth rate and therefore mowing frequency. Plant growth regulators are substances that influence physiological processes of plants at very low concentrations (Frankenberger and Arshad, 1995) and are widely used in turfgrass management to suppress shoot growth (i.e. Lickfeldt et al., 2001; Richie et al., 2001). When treating turfgrass with PGRs, the number of mowings can be reduced up to 50% over a 5- to 8-week period following an application (Batten, 1983). Plant growth regulators have been also shown to increase turfgrass canopy density (Ervin and Koski, 1998; Fagerness and Yelverton, 2001) and to provide wider and thicker leaf blades (Ervin and Koski, 2001; Gaussoin et al., 1997). As reported by many studies, PGRs can also enhance the overall quality of the turfgrass (Johnson, 1993). Moreover, PGRs are frequently used in creeping bentgrass (*Agrostis stolonifera* L.) turfgrasses for *Poa annua* L. suppression (Murphy et al., 2005; McCullough et al.,

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The use of PGRs in low-input areas is not new because PGRs have already been used to suppress *Paspalum notatum* Fluegge and *Lolium arundinaceum* (Schreb.) Darbysh. seedhead production in highway roadsides, airports, and golf course roughs (Goatley et al., 1998; Johnson, 1989). However, these areas have been typically treated with mitotic inhibitors (type 1 PGRs) which can cause undesirable effects such as phytotoxicity of treated leaves, reduced recuperative potential when the treated turfgrass was injured, and increased weed pressure due to reduced competition from treated turfgrasses (Goatley et al., 1998).

Because of their undesirable effects, type 1 PGRs are not used in fine turfgrasses where turfgrass quality is a priority. In these types of turfgrass, type 2 PGRs, which suppress growth through interference of gibberellic acid bio-synthesis, are more commonly used. Trinexapac-ethyl (TE) is a commonly used turfgrass PGR (Tradename Primo Maxx, Syngenta Crop Protection, Inc., Greensboro, North Carolina) that suppresses laminar cell elongation, decreasing the shoot growth and consequently the mowing frequency. This PGR is foliarly adsorbed and interferes with the gibberellin biosynthesis by inhibiting the 3-β-hydroxylase conversion of gibberellic acid-20 (GA20) to the physiologically-active GA1 (Adams et al., 1992). The benefits derived by TE application are not restricted only to the mowing frequency reduction. Trinexapac-ethyl has also been shown to improve turfgrass quality by providing a more dense turfgrass with a darker green appearance (Baldwin et al., 2006), increased tillering (Beasely et al., 2005; Fagerness and Yelverton, 2000), induces the production of thicker and shorter cells (Ervin and Koski, 2001) and increases specific leaf weight (Heckman et al., 2001). Research has also demonstrated that TE applications can have a positive effect on plant tolerance to various types of stress, including heat and drought (Brouwer et al., 2014).

Jiang and Fry (1998) demonstrated that foliar TE application improved turfgrass quality of perennial ryegrass (*Lolium perenne* L.) during dry-down, suggesting that TE may enhance drought tolerance. Beneficial effects of TE on bermudagrass (*Cynodon* spp.) have been observed in terms of fall green color retention (Richardson, 2002). McCann and Huang (2007) reported an improvement of drought and heat tolerance in creeping bentgrass as a consequence of TE application. They suggest also that the effects of TE on plant tolerance to combined drought and heat stress could be related to its effect on the promotion of photosynthetic capacity, associated with increased chlorophyll content and photochemical efficiency, and on the maintenance of cellular hydration.

The positive effects of TE on turfgrass tolerance to various type of stress could promote the use of this PGR in low-input maintenance turfgrasses to further reduce the expense associated with mowing and, perhaps, also by reducing irrigation requirements since TE is reportedly capable of reducing turfgrass evapotranspiration (Ervin and Zhang, 2007).There is a general lack of information about TE application in low-input maintenance turfgrasses, and especially on the response of turfgrass mixtures to PGRs. Most studies conducted to date have focused on one species or, at most, on blends of the same species and not on mixtures of different species that are often used in home and public lawns. The response to PGRs on different species composing a turfgrass mixture may vary significantly, especially in terms of vertical growth rate, turfgrass visual quality, and uniformity of the stand. In a previous study, Macolino et al. (2010) reported that TE had no effect on plant stand composition or competitive abilities of different turfgrass species in a mixed stand of cool-season turfgrasses. The objective of this research study was to evaluate the response of three inter-specific commercial turf-mixtures to three different application rates of TE under low-input maintenance conditions that are typical of a home or public lawns.

2. Materials and methods

A field study was conducted from April 2006 to July 2008 at the agricultural experimental farm of Padova University, in northern Italy (45°20′N, 11°57′E, and elevation 8 m), to compare the effect of three different treatment levels of TE on the visual quality and grass clipping biomass production of three commonly used turfgrass commercial mixtures under reduced-input maintenance. The study site has a humid sub-tropical climate with a yearly mean temperature of 12.2 °C and 824 mm of rainfall (Fig. 1), and can be classified as USDA plant hardiness zone 8. Three different turfgrass mixtures

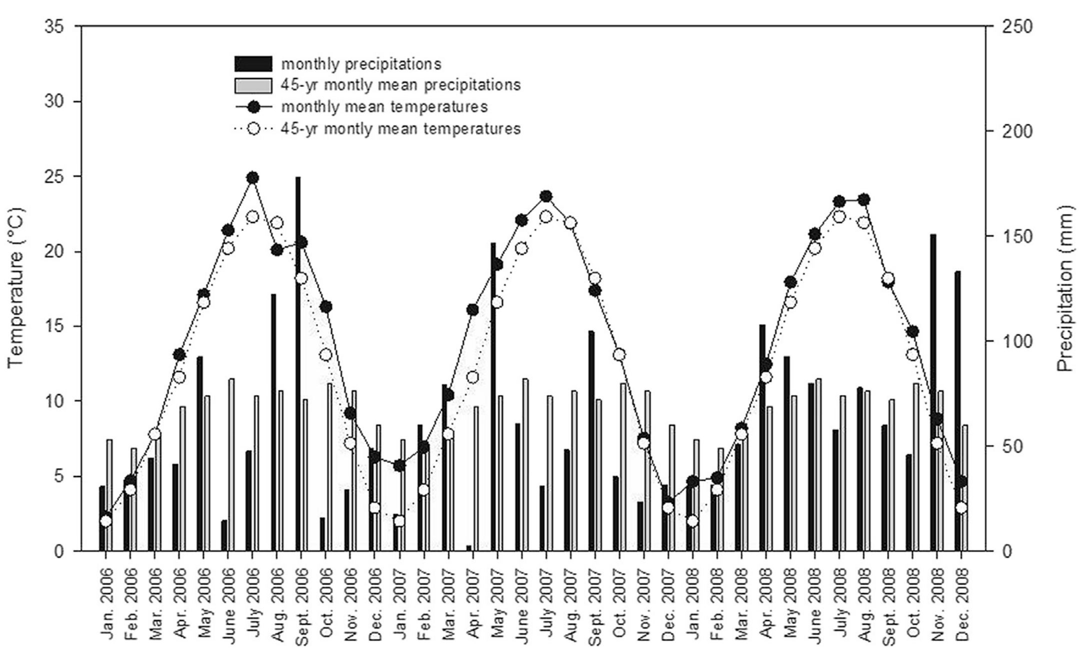

Fig. 1. Monthly mean air temperatures and monthly precipitations from January 2006 to December 2008 and long-term averages (45 years) at the agricultural experimental farm of Padova University, Legnaro, northeastern Italy.