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Effects of trinexapac-ethyl on stolon development in potted Patriot bermudagrass

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Abstract: A recent technique developed for establishment of warm season turfgrasses is based on the transplant of single plug plantlets pre-rooted in the nursery. Plantlets are obtained from one-node sprigs about 2 cm long derived from stolon fragmentation. Usually, stolons must be cut several times to obtain sprigs of the right length because of overly long internodes. In the present study, potted plants of Patriot bermudagrass grown in the nursery were treated with trinexapac-ethyl (TE) at the rates 0.1, 0.2, 0.4 and 0.8 kg a.i. ha^{-1}. TE application was aimed at obtaining internode shortening in order to facilitate the stolon division practice. In fact, TE-treated plants showed a decrease in the average length of internodes with respect to control at any applied rate. Nevertheless, the lowest rate applied (0.1 kg a.i. ha^{-1}) did not assure a prolonged effect while the highest rate (0.8 kg a.i. ha^{-1}) caused a decrease in the yield of sprigs. Therefore, our results suggest that TE may be advantageously used and at rates of 0.2-0.4 kg a.i. ha^{-1} to control stolon development of Patriot bermudagrass for nursery purposes.

1. Introduction

Although in Italy lawns are traditionally established with cool season grasses, the use of warm season species has been increasing over the last two decades (Croce *et al.*, 2004; Volterrani *et al.*, 2010). Warm season grasses show several advantages over cool season species. They tolerate high temperatures and drought, show lower water consumption, tolerate higher salinity concentrations in the soil and in irrigation water, establish rapidly and present excellent recovery properties due to the abundant production of stolons and rhizomes (Biran *et al.*, 1981; Carrow and Duncan, 1988; Beard, 1989; Dudeck and Peacock, 1993; Beard and Sifers, 1997; Volterrani *et al.*, 1997; Croce *et al.*, 2006; Harivandi and Marcum, 2008).

Bermudagrasses (*Cynodon* spp.) are the warm season turfgrass species most widely used in the transition and warm regions of the world due to their aggressive growth habit, tolerance to a wide range of mowing heights, marked resistance to many abiotic stresses, and the high quality of the cultivars recently developed by breeding programs (Wu *et al.*, 2009).

A technique recently developed for turf establishment of warm season species is based on the transplant of single plug plantlets pre-rooted in the nursery (Volterrani *et al.*, 2008). Nursery activity consists of the pot cultivation of donor plants from which stolons are collected, divided into one-node sprigs about 2 cm long, then cultivated in alveolate trays until the formation of mature plantlets. The crucial point of this practice is stolon fragmentation. This operation is very time consuming and consequently labour-costly. In fact, stolons must be cut several times to obtain sprigs of the right length due to long internodes.

The effectiveness of trinexapac-ethyl (TE) in controlling bermudagrass growth is reported by many authors (Johnson, 1994, 1997; Fagerness and Yelverton, 1999; Lowe and Whitwell, 1999; Fagerness and Yelverton, 2000; Fagerness *et al.*, 2002; Bunnel *et al.*, 2005; McCullough *et al.*, 2005; Baldwin *et al.*, 2006; McCullough *et al.*, 2007; Baldi *et al.*, 2010). In these reports, TE is applied to bermudagrass turfs in order to facilitate their management (mainly by reducing mowing requirements), ameliorate their quality or enhance stress tolerance (e.g. salinity tolerance or cold tolerance). The rates of TE normally adopted in bermudagrass turf management are around 0.11 kg a.i. ha^{-1}, which is the recommended rate for bermudagrass maintained at golf fairway height (Cooper, 2003). Plant height, texture, density, clipping weight and root mass are the growth parameters related to plant response to TE to be considered.

On the contrary, since turf establishment by means of pre-rooted plantlets propagated by stolon in the nursery has been recently developed, the effects of plant growth regulators (PGRs) on grass plants grown to produce propagating material have not been investigated. Furthermore, parameters such as stolon length, internode length and stolon number, important for nursery activity, have been seldom considered.

Traditionally, PGRs are classified into two main groups, Type I and Type II, according to their biological mode of

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action. Type I PGRs inhibit cell division and differentiation in the plant meristems and are excellent seedhead inhibitors; Type II compounds suppress growth by inhibiting the biosynthesis of gibberellic acid, which is needed for cell elongation (Watschke *et al*., 1992).

In turfgrass, three of the most commonly used PGRs [flurprimidol (FL), trinexapac-ethyl (TE) and paclobutrazol (PBZ)] are Type II chemicals (Lowe and Whitwell, 1999). Turf plants treated with Type II PGRs usually show an altered morphology of leaves and a more compact growth habit due to a reduced internode length (Rossi, 1993). Therefore, for their mode of action, Type II PGRs may presumably be useful to reduce stolon length by controlling internode elongation.

In this paper, the effects of TE on potted plants of bermudagrass grown in the nursery are described. The aim of the TE treatment was to obtain a stolon shortening to facilitate the stolon division practice and, hopefully, without reducing the overall production in sprigs, that result from the number of stolons per plant and the number of nodes per stolon.

2. Materials and Methods

Plant material, growing conditions and experimental treatments

The experiment was carried out between April and June 2010 at the Pacini Horticultural Nursery located in Rigoli (Pisa), central Italy (45°45' N, 10°26' E, 6 m a.s.l.).

On 7 April 2010, plantlets derived from one-node sprigs of bermudagrass [*Cynodon dactylon* (L.) Pers. x *C. transvaalensis* Burtt-Davy] cv. Patriot were transplanted in 20 cm-diameter, 3.80 l volume polyethylene pots (three plantlets per pot) filled with peat (Baltikum-S132; 92% organic matter, pH 5.5-6.5, electrical conductivity 0.6-1.0 dS m^{-1}) fertilized with 2 g l^{-1} of Osmocote-Pro (Scotts) 18-10-11 + 2 MgO.

On 12 May 2010, after stolons had started to develop, plants were trimmed down to the pot rim height and five treatment rates [0 (= control), 0.1, 0.2, 0.4 and 0.8 kg a.i. ha^{-1}] of TE [(4-cyclopropyl-α-hydroxy-methylene)-3,5-dioxocyclohexanecarboxylic acid methyl ester] were applied by foliar spraying (1250 l ha^{-1}) of the commercial product Primo Maxx (Syngenta).

During the experiment, plants were irrigated as needed by an overhead sprinkler system. During the period, average maximum and minimum temperatures were 35°C and 20°C, respectively, while relative humidity (R.H.) reached 55% and 70% as minimum and maximum values, respectively.

A randomized block design was adopted with five replicates per treatment (1 replicate = 1 pot).

Data collection

After treatment, stolon length and the number of nodes per stolon were recorded weekly for seven weeks on three stolons per pot, and average internode length was calculated. On 30 June 2010, seven weeks after treatment, fresh weight and dry weight of aerial biomass (after oven-drying at 80°C for 48 hr) and the number of stolons of each pot were determined. In addition, the total number of sprigs per pot was calculated as the product of the number of stolons per pot and the final number of nodes per stolon.

Statistics

Data were subjected to one-way analysis of variance (ANOVA) and means were compared using the LSD test at P≤0.05 level of significance.

3. Results

TE induced a statistically significant shortening of stolons compared to the control one and two weeks after application at the rates 0.2, 0.4 and 0.8 kg a.i. ha^{-1} (Fig. 1). Three weeks after treatment, the effect of TE treatments on stolon length began to wane (Fig. 1).

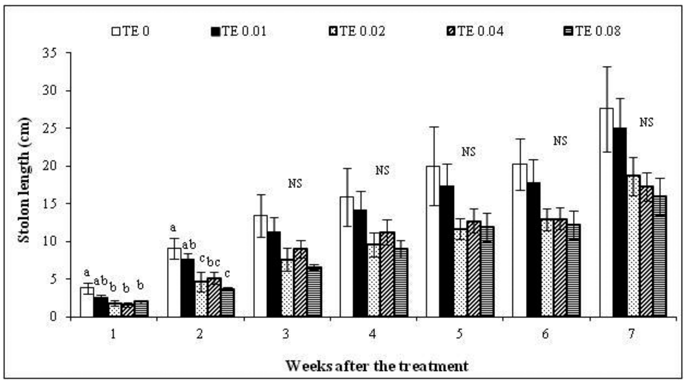

Fig. 1 - Stolon length in Patriot bermudagrass treated with different rates of TE (kg a.i. ha^{-1}). Within the same week, different letters show significantly different values for P≤0.05 (LSD test). Vertical bars show SE of the means (n=5); NS= not significant.

During the entire monitoring period (seven weeks), no statistically significant differences were observed between TE-treated plants and control plants in the number of nodes per stolon (Fig. 2).

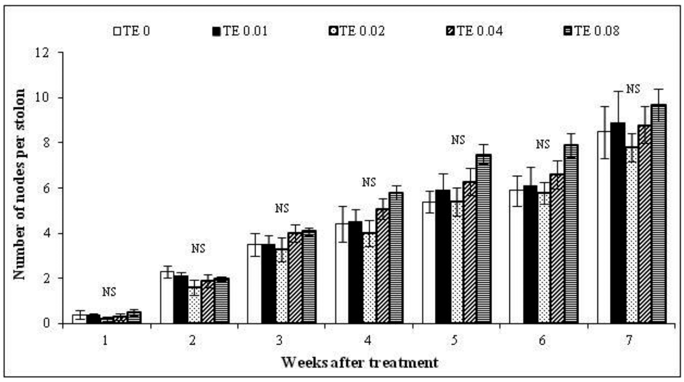

Fig. 2 - Number of nodes per stolon in Patriot bermudagrass treated with different rates of TE (kg a.i. ha^{-1}). Within the same week, different letters show significantly different values for P≤0.05 (LSD test). Vertical bars show SE of the means (n=5); NS= not significant.

TE-treated plants showed a decrease in the average length of internodes (Fig. 3). In control plants internode length varied between 2.7 and 3.0 cm; in TE-treated plants stolons showed an average internode length varying from 1.8 (first week) to 2.5 cm (seventh week) at the rate 0.1 kg a.i. ha^{-1}, from 1.4 (first week) to 2.1 cm (seventh week) at the rate 0.2 kg a.i. ha^{-1}, from 1.2 (first week) to 1.8 cm (seventh week) at 0.4 kg a.i. ha^{-1}, and from 1.2 (third week) to 1.5 cm (seventh week) at 0.8 kg a.i. ha^{-1} (Fig. 3). The differences between control and TE-plants were statistically significant at all the applied rates one week after treatment and afterwards at the rates 0.2, 0.4 and 0.8 kg a.i. ha^{-1}.

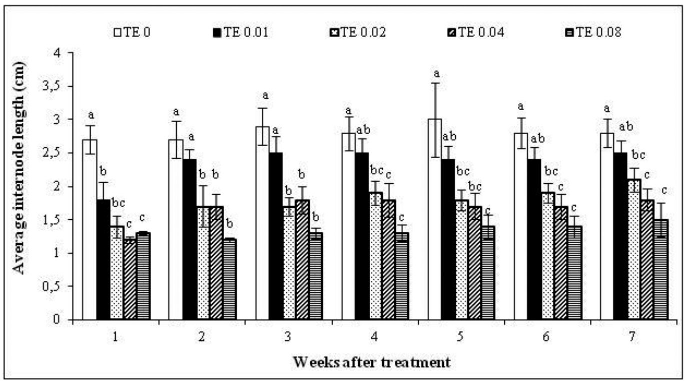

Fig. 3 - Average internode length in Patriot bermudagrass treated with different rates of TE (kg a.i. ha^{-1}). Within the same week, different letters show significantly different values for P≤0.05 (LSD test). Vertical bars show SE of the means (n=5); NS= not significant.

At the end of the monitoring period, no statistically significant differences were observed between TE-treated plants and control plants in fresh matter production, while dry matter decreased significantly compared to control at 0.2 and 0.8 kg a.i. ha^{-1} but, surprisingly, not at 0.4 kg a.i. ha^{-1} (Table 1).

Table 1 - Aerial biomass production in Patriot bermudagrass treated with different doses of TE (kg a.i. ha-^{1}) seven weeks after treatment

Treatment TE (kg a.i. ha^{-1})	Fresh matter (g per pot)	Dry matter (g per pot)	Number of stolons per pot	Number of sprigs per pot
0	128.5±5.1 ab (z)	38.3± 4.6 a	110±7.4 a	915±83.3 a
0.1	136.7±5.8 a	37.9±1.3 a	104±6.4 ab	912±138.3 a
0.2	113.2±5.2 b	31.8±1.5 b	86±2.6 b	673±48.0 ab
0.4	121.0±4.7 b	34.5±2.6 ab	89±6.3 b	786±80.6 ab
0.8	115.0±6.6 b	31.3±2.0 b	62±5.6 c	597±72.9 b

(z) Values in the same column followed by different letters are significantly different for P≤0.05 (LSD Test).
Values are means (± SE) of five replicates.

TE treatment had a detrimental effect on stolon number per pot starting from the rate 0.2 kg a.i. ha^{-1} upwards, but the average number of nodes derived from one pot decreased significantly only at the highest rate applied (0.8 kg a.i. ha^{-1}) (Table 1).

4. Discussion and Conclusions

The effect of TE on the number of bermudagrass stolons was previously investigated by Fagerness *et al*. (2002). These authors found that TE (0.11 kg a.i. ha^{-1}) did not affect the number of stolons in Tifway bermudagrass when plants were grown in a 22/17°C day/night temperature regime, while at 36/31°C TE-treated plants showed about twice as many stolons as control plants four weeks after TE application. In our experiment, temperature ranged between 20 to 35°C and 0.1 kg TE ha^{-1} did not cause any effect on stolon number in Patriot bermudagrass seven weeks after its application. On the contrary, higher rates of TE (0.2, 0.4 and 0.8 kg a.i. ha^{-1}) reduced significantly the number of stolons compared to control.

An indirect evaluation of the effect of TE on stolon lengthening in turfgrass species may come from percentage lateral regrowth, a parameter used to estimate the horizontal growth or recovery of turfs as described by Bunnell *et al*. (2005). These authors applied TE at 0.039 kg a.i. ha^{-1} to TifEagle bermudagrass every three weeks and measured percentage lateral regrowth weekly for eight weeks. Averaged weekly data of TE-treated plants did not show any differences compared to untreated plants. Totten *et al*. (2006) reported that TE did not affect the percentage lateral regrowth in Tifway bermudagrass when used at the rate 0.052 kg a.i. ha^{-1}, while at 0.104 kg a.i. ha^{-1} percentage lateral regrowth was significantly reduced compared to control two weeks after TE application. In our experiment, a TE rate of at least 0.2 kg a.i. ha^{-1} was needed for a significant decrease of stolon length in Patriot bermudagrass (Fig. 1). That effect lasted for two weeks after TE treatment.

Internode length after one, two or three TE applications at 0.153 kg a.i. ha^{-1} to a mature Tifway bermudagrass turf was measured by Richardson (2002). The measurements were taken ten weeks after the last TE application and no effect of the PGR was detected. In our experiment internode length was significantly shortened in TE-treated plants at any applied TE rate one week after one application; from two to seven weeks after treatment stolon showed average internode length with statistically significant differences between control and TE-treated plants at the rate 0.2 kg a.i. ha^{-1} and higher.

In conclusion, our results suggest that TE may be advantageously used to control stolon development of Patriot bermudagrass for nursery purposes (shortening of the internodes in plants grown in pot to facilitate stolon division practice). In order to obtain prolonged effect, higher rates than those normally adopted in bermudagrass turf management seemed to be required (at least 0.2 kg a.i. ha^{-1}). The highest rate applied (0.8 kg a.i. ha^{-1}) was not advisable as it caused also almost a halving in the number of stolons per pot and a statistically significant decrease in the yield of sprigs. Under the conditions in which we operated, the best result was achieved at the rates 0.2 and 0.4 kg a.i. ha^{-1}. With such rates, although the number of stolons per pot was significantly reduced compared to control, the yield in nodes remained unvaried.

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