

Turfgrass Seedling Height and Quality in Paclobutrazol- Treated Seeds of *Lolium perenne* L. Barrage and *Festuca arundinacea* L. Master

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ABSTRACT

Paclobutrazol affects height and quality of seedlings of turfgrass species. To determine the effect of paclobutrazol on seedling height and visual quality, seeds of *Lolium perenne* L. Barrage and *Festuca arundinacea* L. Master were soaked with 0, 20, 30 and 40 mgL⁻¹ paclobutrazol for 24 h on shaker during imbibitions stage of seed germination. Treated seeds were sowed in the soil mixtures containing 70 percent gardening soil (with clay loam texture) and 30 percent sand (V/V). Pots had 41 cm height and 23 cm wide. Lower height at three stages of measured vegetative growth was resulted in *Festuca arundinacea* L. Master. Paclobutrazol resulted in lower height in three stage of vegetative growth. The interaction between cultivar and paclobutrazol concentrations was significant at 30 days after planting (DAP). Treatment of *Festuca arundinacea* L. Master with paclobutrazol 30 and 40 mgL⁻¹ showed lower height at stage tree (30 DAP) while there were no significant difference in *Lolium perenne* L. Barrage. All of paclobutrazol treatment resulted lower wide of blade in *Lolium perenne* L. Barrage. *Festuca arundinacea* L. Master treated with 40 mgL⁻¹ paclobutrazol had higher visual quality. It can be concluded that different cultivar could show different response to paclobutrazol treated on seed before planting. *Festuca arundinacea* L. Master treated with 40 mgL⁻¹ may be more suitable to be used in this regard.

Key Words: Growth retardant, mowing perennial ryegrass, tall fescue, turfgrass

INTRODUCTION

High vegetative growth of turfgrasses has been resulted in studying the chemical mowing agents. Such compounds are of interest because of their potential to reduce labor, fuel, and equipment costs for turfgrass maintenance (Elkins, 1982; Johnson and Faulkner, 1985; Taylor, 1985). The use of the plant growth regulators (PGRs) as “chemical mowing agents” was envisioned many years ago because of the tremendous economic benefits (Davis and Curry, 1991) and additional potential benefits including: improved color, fewer clipping, deeper roots, fewer seedheads, less time spent in trimming (Johnson, 1992). Two types of PGRs have been identified for use in turf. Type 1 PGRs such as MH-30 inhibits and suppresses turfgrass growth by rapidly stopping cell division. Type 2 PGRs such as triazoles mainly reduces cell elongation through the interference of GA-biosynthesis (Johnson, 1992). Triazoles inhibit monooxygenases, which oxidase in three steps ent-kaurene to ent-kaurenoic acid, an early reaction in GA biosynthesis (Hedden and Kamiya, 1997; Rademacher, 2000). The primary action of triazole-type growth regulators consists of lowering plant content of GA through inhibition of GA biosynthesis (Rademacher, 2000). Inhibition of GA biosynthesis makes applications of growth retardants to plants effective in height control of various ornamental crops. Triazole compounds regulate plant growth affecting growth of the main and lateral shoots, internode length and leaf area (Setia et al., 1996; Gent, 1997; Klock, 1998; Million et al., 1999).

Application of PGRs directly to the soil will result in retention of growth regulators by growth medium (Jacuna and Dodds, 1995) and may lead to field contamination (Davis et al., 1988) and increased the cost of applications. Spraying plants is also associated with drift of growth regulators (Cramer and Bridgen, 1998). Another disadvantage of foliar applications is low mobility of growth regulators in certain parts of the plant (Fletcher et al., 2000). Soil and foliar application of PGRs lead to the production of crops with high residue levels of growth regulators which can be hazardous to human (Davis et al., 1988). Advantages of seed treatment with growth regulators include less usage and drift of the product, and simplicity of application (Fletcher et al., 2000; Pombo et al., 1985).

Growth regulators reduce the contents of GA in seeds, which regulates cell elongation and division during radicle and shoot growth (Bewley and Black, 1994). Histological studies demonstrated that cell elongation in the plumule is suppressed at a lower concentration of growth regulator than cell division (Grossman, 1990). During germination, GA reduces the physical restraint imposed by the endosperm and testa, which allows radicle protrusion (Olszewski et al., 2002). Gibberellin has been also implicated in the induction of hydrolytic enzymes that degrade the endosperm (Bewley and Black, 1994; Olszewski et al.,

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2002). Therefore, growth of embryonic axis and hydrolase activities are likely to be the main processes affected by growth regulators in germinating seeds (Olszewski et al., 2002).

The aim of this study was to assess the effect of paclobutrazol-treated seeds on two cultivars of turfgrass for turf growth and quality.

MATERIALS AND METHODS

Perennial ryegrass (*Lolium perenne* L. 'Barrage') and Tall fescue (*Festuca arundinacea* L. Master) seeds from local market were soaked in paclobutrazol solution at concentrations of 20, 30 and 40 mg·L⁻¹ for 24 hr in a flask on a shaker device (Model 75, Burrell Co., Pittsburgh, PA, USA). After soaking, seeds were sown in the soil mixtures containing 70 percent gardening soil (with clay loam texture) and 30 percent sand (V/V) in Jan 18, 2008. Pots had 41 cm height and 23 cm wide. Pots were transferred in research greenhouse of Ferdowsi University of Mashhad. Pots were irrigated before sowing of seeds so that soil mixture becomes completely wet in soil column at pots. Height of seedlings before and after mowing, clipping dry weight and visual quality in regard to turf texture, color and density, were measured. In March 10, first cutting was done for all of treatments. 10 days after first cutting height of seedling is measured. For visual quality, a ranking scale of 0 to 9, 0=no live turf; 9=Best (Salehi and Khosh-Khui, 2004), were used. This research was carried out using factorial experiment with in a completely randomized design with 4 replications by 32 pots and treatments were applied in Jan 2008. Statistical analysis was done with MSTATC software. Means compared with Duncan's multiple range tests (DMRT) at 5 % level.

RESULTS AND DISCUSSION

Height of seedling before moving

Data presented in fig.1 and fig.2 shows that application of paclobutrazol at all concentrations at 10 and 20 days after planting (DAP) caused significant reduction in the plant height as compared to the control. However interaction of paclobutrazol and cultivars had no significant differences on plant height at 10 and 20 DAP. Interaction effect of cultivars × paclobutrazol at 30 DAP on height of seedling was significant. After 30 DAP there were no significant difference between control and paclobutrazol treated seeds in *Lolium perenne* L. Barrage. However *Festuca arundinacea* L. Master showed reduction in height with increasing paclobutrazol concentration (Fig.3). Magnitskiy (2004) reported that a reduction in height of shoot of pansy by increasing the concentration from 2- 30 mg·L⁻¹ of paclobutrazol but it was not significant. It suggested that after sowing paclobutrazol-soaked seeds in plugs, coat-associated growth regulator might further diffuse into seeds or growth media and then be absorbed by root (Passion and Bennett, 2001). The paclobutrazol treatment reduced plant height of Maize (*Zea mays*) at 14 DAP, but had no effect on shoot weight, plant height, or leaf number at 55 DAP (Batlang, 2006). Cucumber (*Cucumis sativus* L.) seeds soaked in 250, 500, 1000 or 2000 mg·L⁻¹ paclobutrazol for 6, 12 or 24 hr produced seedlings with reduced stem elongation and hypocotyls length (Cho et al., 2002). Soaking the seeds of marigold, pelargonium and tomato in paclobutrazol decreased height of seedlings (Pasian and Bennett, 2001). Seedling height decreased in *Lolium perenne* L. Barbal by effect of paclobutrazol seed treatment in compare to control (Shahrokhi et al., 2008).

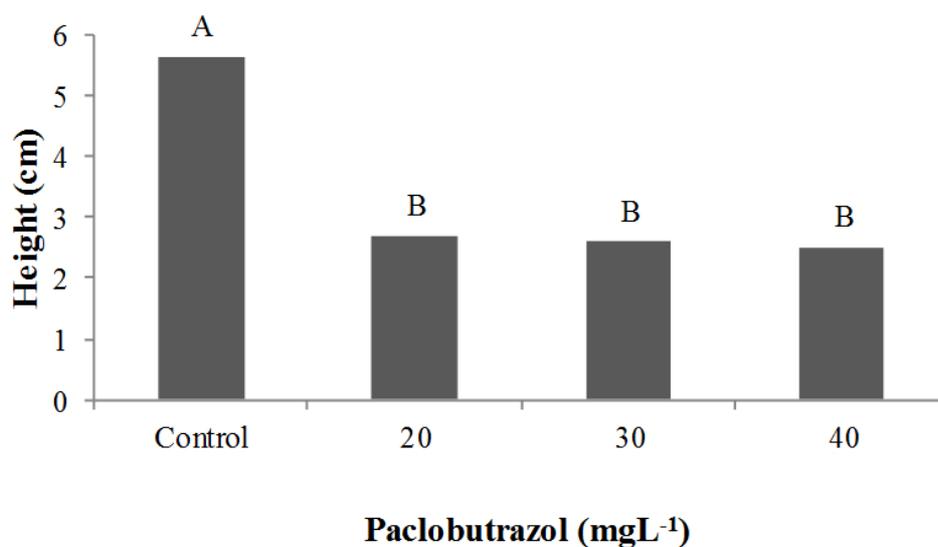


Figure 1. Effect of paclobutrazol on height of seedlings before mowing (10 DAP). In each column, the same letters are not significantly different using DMRT at 5% probability level

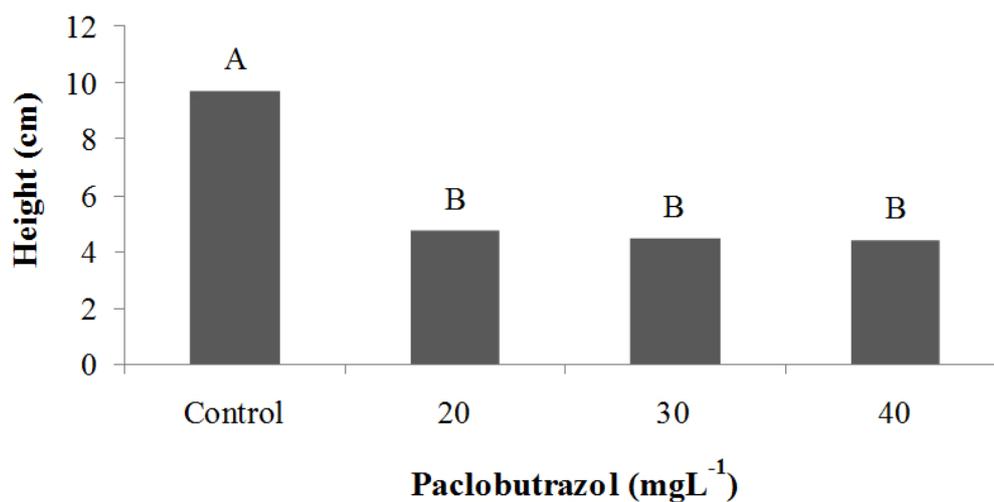


Figure 2. Effect of paclobutrazol on height of seedlings before mowing (20 DAP). In each column, the same letters are not significantly different using DMRT at 5% probability level

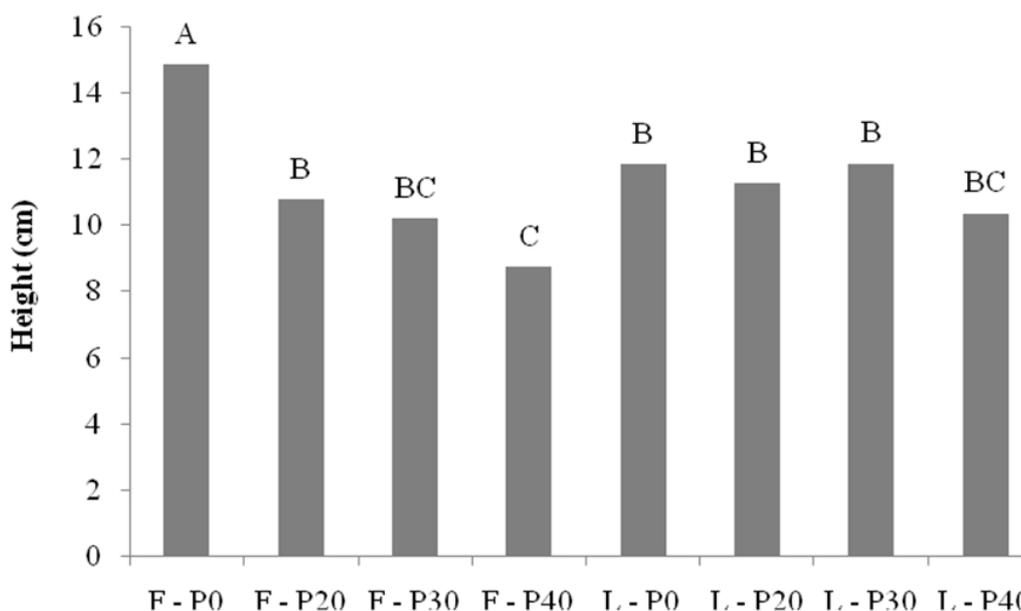


Figure 3. Effect of paclobutrazol on height of *Lolium perenne*(L) and *Festuca arundinacea* (F) seedlings before mowing (30 DAP). In each column, the same letters are not significantly different using DMRT at 5% probability level

Height of seedlings after first mowing

After 10 days of first mowing, paclobutrazol and interaction of paclobutrazol * cultivar had no significant effects on height of seedling. However the effect of cultivar was significant (Table.1). The results reported by Batlang (2006) also showed that the paclobutrazol effect on plant height of Maize was short lived. Plants that were shortened by paclobutrazol at 14 DAP were as tall as the no-PGR controls by 40 to 50 DAP (Batlang, 2006). Paclobutrazol lasts for 2 to 3 weeks in wheat tissues but becomes undetectable thereafter (Fletcher et al., 2000). PGRs may have long lasting effects. For example, two months after treatment with various growth regulators, the starch content of brown boronia (*Boronia megastigma* Nees.) was still different from the control plants. Paclobutrazol may be used initially to retard plant height of brown boronia (Day et al., 1994).

Clipping dry weight

There was no significant interaction between paclobutrazol and cultivar on clipping dry weight (Table.1). Deyton et al. (1991) found that total and shoot dry weights of strawberry (*Fragaria x ananassa* Duch.) cultivar 'Cardinal' decreased by foliar application with 75-1200 mgL⁻¹ paclobutrazol. Paclobutrazol increased partitioning of assimilates to roots, therefore, increased root growth instead of shoots (Davis et al., 1988).

Leaf width

Festuca arundinacea L. Master with Paclobutrazol 40 mgL⁻¹ showed higher wide of leaf but lower wide was resulted in all of paclobutrazol treatments of *Lolium perenne* L. Barrage, although the lowest wide was manifested in 20 mgL⁻¹ paclobutrazol (Table.1). PB resulted reduction of leaf growth by changing in partitioning of assimilates, reduction of transparent of assimilate to leaf and determination of leaf growth. It decreased leaf area by inhibition of gibberellin biosynthesis (Yelenosky et al., 1995).

Turf visual quality

Paclobutrazol significantly influenced turf visual quality. Highest quality was observed with 40 mgL⁻¹ paclobutrazol, while lowest quality was in 30 mgL⁻¹ paclobutrazol but it had no significant difference with control and 20 mgL⁻¹ paclobutrazol. High visual quality resulted in paclobutrazol 40 mgL⁻¹ in *Festuca arundinacea* L. Master. *Lolium perenne* L. Barrage with 30 mgL⁻¹ paclobutrazol and control had lower visual quality (Table.1).

Table 1: The effect of paclobutrazol and different cultivar of turfgrass on seedling height after first mowing (cm), wide of leaf (mm), clipping dry weight (g) and visual quality (ranking scale: 0 to 9, 0=no live turf; 9=best) of turfgrass.

Cultivar	Treatment		Seedling height after first mowing	Leaf width	Clipping dry weight	Visual quality
	Paclobutrazol (mgL ⁻¹)					
Master	0		8.620 a†	3.067 ab	1.692 a	7.875 ab
	20		8.827 a	2.725 ab	1.467 a	6.875 bc
	30		8.38 a	2.628 ab	1.472 a	7.000 bc
	40		7.525 a	3.410 a	1.418 a	8.375 a
Barrage	0		8.735 a	2.115 b	1.81 a	5.125 e
	20		8.712a	2.095 b	1.680 a	6.500 cd
	30		8.212a	2.233 b	1.753 a	4.625 e
	40		8.795a	2.142 b	1.462 a	5.500 de
Means						
PP ₃₃₃ 0 mg/L			8.677 A	2.591 A	1.754 A	6.500 AB
PP ₃₃₃ 20 mg/L			8.770 A	2.410 A	1.574 A	6.688 AB
PP ₃₃₃ 30 mg/L			8.300 A	2.430 A	1.612 A	5.813 B
PP ₃₃₃ 40 mg/L			8.160 A	2.776 A	1.440 A	6.938 A
Master			8.340 B	2.957 A	1.513 B	7.531 A
Barrage			8.614 A	2.146 B	1.678 A	5.438 B
Significance						
PP ₃₃₃			NS	NS	NS	**
Cultivar			**	**	**	**
PP ₃₃₃ x Cultivar			NS	**	NS	**

†Mean followed by the same letter (small letters for interaction means and capital letters for main effects) is not significantly different at 5% level of probability using DMRT.

** Significant, NS: Non-significant at P= 0.05

In agreement with our results, several studies reported the increase in chlorophyll content in triazole-treated plants (Berova and Zlatev, 2003; Fletcher et al., 2000). Paclobutrazol without zeolite in all concentrations significantly influenced turf visual quality. Highest quality was observed with 45 mg L⁻¹ paclobutrazol without zeolite, while the lowest quality was found in control (Shahrokhi et al., 2008).

Taking everything into account, seed-treatments with paclobutraol may have some promising effects on control of growth of seedling and better quality. So that less frequently cut may be needed. At this study, interaction of paclobutrazol with two cultivars had significant effect on height of seedling at 30 DAP. Although two cultivars were responsive to paclobutrazol treatment up to 20 DAP, however after 30 DAP only *Festuca arundinacea* L. *Master* was responsive (Fig 3). In a word, although it took different times for different cultivars or species to show significant effect when seeds treated with paclobutrazol but the results from this work showed that seed soaking of turfgrass with paclobutrazol effect on plant quality was short lived. After first cutting, results showed that effect of paclobutrazol on plant growth reduction is paclobutrazol discarded but in another study by Shahrokhi et al. (2008) after second cutting effect of on plant growth was still clear. This may be happen due to different concentration of paclobutrazol, cultivar and pretreatment of seeds by Sulfuric acid that conducted in that experiment. Finally, these findings suggest some good avenues of approach for continuing studies.

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