The Effect of the Plant Growth Regulator Primo on Winter Hardiness Levels

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Summary

Turfgrass growth under winter covers in early winter and spring is thought to be a problem for overwintering putting green turf in cold climates. Considerable growth reduction in the spring under a winter cover was observed following a single fall application of Primo MAXX at an Alberta golf course. As a result, this trail was established in order to determine the effect of the growth regulator, Primo MAXX, on fall hardening and spring dehardening of annual bluegrass (*Poa annua).*

An initial pilot study was conducted during the winter of 2003-04 where a single application of Primo Maxx was applied at three different rates in the late fall to an annual bluegrass (Petersen's creeping bluegrass) putting green located at the Prairie Turfgrass Research Centre in Olds, Alberta. Individual treatments were then subjected to various dehardening temperatures for various periods of time. After a freeze test, plants were re-grown and their relative hardiness levels were assessed. Due to an equipment failure during the secondary hardening stage results of the trial were inconclusive.

In year two of the study there were also no significant treatment differences when evaluating fall relative hardiness levels. Application rates and timing of Primo MAXX were evaluated in this study. For all treatments, the LT_{50} values for the plants were -19^{o}C.

Spring hardiness levels will also be determined in order to evaluate the product for its effect on slowing the loss of hardiness as a result of temperature increases in the spring.

Introduction

Previous work conducted at the Prairie Turfgrass Research Centre attempted to determine the effects of temperature and crown moisture content on the hardening and dehardening of annual bluegrass putting greens throughout winter (2).

Results of the trial showed that plants harden in the fall in response to a decline in temperature. Cool temperatures begin the hardening process while a period of freezing temperatures is necessary to completely harden the turfgrasses. As plants harden, crown moisture content decreases and the plants ability to resist freezing temperatures increases. In this trial, hardiness levels were measured and were recorded as LT_{50} values or the lethal temperature required to kill 50% of the plants.

Generally, the opposite effect occurs in the spring. As temperatures increase, plants begin to break dormancy and initiate growth. It is believed that one of the first plant responses to warmer temperatures is a re-hydrating of the plant tissues which causes an initial loss of hardiness. Further warm temperatures trigger a growth response in the plants with new growth and noticeable greening. The warmer the temperature and the greater the duration of warm temperatures, the greater the loss in hardiness.

Many golf course superintendents use protective winter covers on annual bluegrass putting greens to counter the negative effects of winter. In the past, common thinking has been to warm turfgrasses in the spring so that new growth may be initiated. However, we found that increased temperatures under winter covers created problems of excessive growth which, in turn, resulted in a loss of hardiness (2).

In Alberta, superintendents typically cover greens in either late October or early November. In the past few years, warm Pacific Ocean currents have caused our winters to have long periods of above average temperatures. These warm temperatures have occurred after greens have been covered which stimulates considerable growth and reduces hardiness levels.

A local superintendent attempted to reduce the effects of the warm temperatures by applying the growth regulator, Primo MAXX, prior to the installation of the winter covers in the fall. The thought was that if growth could be reduced, covers would not need to be removed for mowing and the turf would retain its hardiness.

Although this new growth regulator has not been used for this purpose, Gusta et al, (1988) reported foliar application of plant growth regulators inhibited gibberillin biosynthesis and increased the freezing tolerance and winter survival of winter cereals.

In their promotional literature Syngenta states that using Primo MAXX prior to stress periods leads to healthier plants that tolerate stresses such as drought and cold more effectively. In addition, the product reportedly helps plants to recover from stress more quickly. They also mention that Primo MAXX positively affects grass grown in shady areas where abiotic and biotic stresses can be quite prevalent. Reports from superintendents also state that the use of Primo MAXX increases plant density and increases root development.

As a result of these observations, the objective of this study was to determine the effect of Primo MAXX on fall hardening and spring dehardening of annual bluegrass.

Methodology

Initial Pilot Study 2003-04

In this initial study, the growth regulator, Primo MAXX, active ingredient trinexapac-ethyl, was applied at three different rates to annual bluegrass (Petersen's creeping bluegrass) plots located at the Prairie Turfgrass Research Centre (Olds, Alberta, Canada). Three application rates, 4 ml, 8 ml and 12 ml/100m^2, were made just prior to permanent freeze-up on 28 October 03 with a compressed air sprayer. The sprayer was equipped with TeeJet 8004 nozzles and was calibrated to apply 10.3 litres/100m^2.

Following application the product was left for four hours to dry on the plant surface prior to sample collection with a 2" soil sampling tube. Individual samples were placed in a growth chamber (Conviron PGW 36 Winnipeg, Manitoba) and were maintained for five days at 10^{o}C/2^{o}C day/night temperatures to ensure the complete uptake of the product. Following this the samples were placed in a freezer (Revco Freezer/incubator B0D 30A)

at –2^{o}C for an additional 3 weeks in order to fully harden the plant material. Plants that were left untreated were assessed for relative hardiness prior to the initiation of the dehardening treatments. As annual bluegrass normally can withstand temperatures of –20^{o}C, these baseline relative hardiness levels (LT_{50}'s) would be an indication of full hardiness of annual bluegrass plants.

Treated samples were then placed back in the growth chamber and were subjected to various temperatures for various periods of time in order to create a situation where plants would deharden. These conditions were created to simulate springtime conditions in the field. Plants were subjected to three different temperature regimes in the growth chamber: 4^{o}C/2^{o}C, 8^{o}C/2^{o}C and 12^{o}C/2^{o}C day/night temperatures, with lights on for 12 hours a day. A combination of cool white fluorescent and incandescent lighting (8:1) was used, with an irradiance of 360um and 94w/m2 as determined by a Li-Cor LI-1000 photometer. The various treatments were subjected to these temperatures for various periods of time: 24, 48, 72 and 96 hours. As dehardening is a function of time and temperature, it was expected that those plants that were in the growth chamber for the longest periods of time at the highest temperatures would lose the greatest level of hardiness. Following the time and temperature treatments, plants were subjected to a freeze test.

A low temperature programmable freezer (Forma Model 8270/759M Freezer with a Watlow 982 programmable controller) was used for the freeze test. Turf cores were divided into six individual samples and placed into colour coded cells (2.5 cm) in propagation plug trays. A piece of moist paper towel was placed in the bottom of each cell to act a nucleator for the individual samples. These samples were allowed to acclimatize in the freezer for a minimum of two hours at -2^{0}C. Following this the temperature was decreased in a step-wise fashion by 2^{0}C/hour. When the temperature was in the selected range, individual cells in the propagation trays were removed for each treatment before the temperature was further decreased by 2^{o}C. Following the freeze test, samples were thawed for 24 hours at 4^{o}C in the incubator, divided into individual plants, and transplanted into propagation trays. Plants were then transferred to the greenhouse for four weeks at 18^{o}C/10^{o}C day/night temperatures with supplemental lighting. After four weeks, plant re-growth was rated for survival in order to establish LT_{50} values. LT_{50} values are considered to be the lethal temperature that is required to kill 50% of the plants. Four successive freeze tests were used as replicates.

Field Study 2004-05

Plots that measured 1 by 2 metres were established on the Petersen's creeping bluegrass plots in mid-summer. Plots were arranged in a split plot design with four replications. Main treatments plots included untreated control, summer treatments of Primo MAXX, fall treatments, and treatments that were conducted once in the summer and once in the fall. Sub-plots consisted of two rates of application, 2 and 4 ml 100m^{2} which were applied with a compressed air sprayer with TeeJet 8008 nozzles. Applications dates were as follows (table 1).

Table 1 – Schedule of applications.

Treatment	Application dates
Untreated control	N/A
Summer treatments	July 15, August 1 and 15, September 1
Fall treatments	September 15 and 30, October 15 and 30
Summer and fall treatments	July 15 and October 30

A putting green cup cutter was used to remove individual turf samples from the treated field plots on November 2, 2004. The cores were organized by replication into greenhouse plastic trays lined with a plastic insert (Kord 801). The bottom portion of each insert was filled with snow and the samples were inverted and placed top side down. Additional snow was then loosely packed around each sample to prevent desiccation during the secondary hardening period. Samples were then placed into a low temperature incubator (Revco, BOD 30) set at -2^0C for an additional two weeks to completely harden the plant material.

After the secondary hardening was completed, seven 18mm diameter turf plugs were extracted from each of the frozen samples. The frozen turf plugs were placed into 25mm plug trays. A piece of moist paper towel was placed in the bottom of each cell to act as a nucleator for the individual plugs. The plug tray was then placed into a programmable freezer (Forma Model 8270/759M Programmable Chest Freezer) where the turf plugs were allowed to equilibrate for a minimum of two hours at -2^0C. Following this, the internal temperature of the freezer was programmed to decrease in a step-wise fashion at 1^0C/hour. When the freezer temperature reached -16^0C the first set of turf plugs were removed. The temperature of the freezer was then further decreased at a 1^0C/hour and the remaining turf plugs were removed every two hours until all seven of trial temperatures had been reached.

Following the freeze test, the turf plugs were allowed to thaw in the incubator for 16 hours at 4^oC. The plugs were transplanted back into 25mm plug trays containing general purpose growing media (Premier Promix BX). The tray was transferred to a growth chamber (Conviron E15, Winnipeg, Manitoba) with a growing environment of 20^oC/12^oC day/night. The turf plugs also received 14 hours of supplemental lighting per day.

Plants were allowed to grow on for four weeks, after which the turf plugs were destructively sampled in order to determine whether new emerging plants arose from existing turf crowns or from germinating seed. Only the plants emerging from crowns were counted as surviving plants for each of the trial treatments. LT_{50} values were determined for each of the treatments by determining the temperature that corresponded to 50% plant mortality.

Results

Results of initial pilot study were extremely variable and there were no differences between the various treatments. A malfunction of the incubator where temperatures rose to 18^oC over a weekend period, likely caused the plants to deharden. However, this should have occurred to all plants and it is thought that drought stress may also have been a factor in the loss of hardiness. As the plant material was only intended to be in the incubator for a short period of time, this problem was not anticipated.

In year two of the study there were also no significant treatment differences when evaluating fall relative hardiness levels (table 4). Application rates and timing of Primo MAXX were evaluated in this study. For all treatments, the LT_{50} values for the plants were -19^{o}C.

Spring hardiness levels will also be determined in order to evaluate the product for its effect on slowing the loss of hardiness as a result of temperature increases in the spring.

Table 4 - Percent of re-growth from crowns for various treatments.

Percent of Plant survival	-16 Celsius		-18 Celsius		-20 Celsius	
	2mls	4mls	2mls	4mls	2mls	4mls
Untreated Control	65%	75%	70%	69%	26% A	18% AB
Summer Treatments	66%	72%	66%	61%	25% A	14% B
Fall Treatments	63%	72%	55%	69%	17% AB	26% A
$LSD_{0.05}$ =	N/S		N/S		11.24	

Percent of Plant survival	-22 Celsius		-24 Celsius		-26 Celsius	
	2mls	4mls	2mls	4mls	2mls	4mls
Untreated Control	1%	2%	1%	2%	1%	0%
Summer Treatments	2%	3%	2%	1%	1%	0%
Fall Treatments	3%	2%	0%	1%	1%	1%
$LSD_{0.05}$ =	N/S		N/S		N/S	

References

1. Ross, J.B. 2000. Evaluation of Winter Covers for Prevention of Freezing Injury on Putting Greens. Prairie Turfgrass Research Centre Annual Report. Pg. 28-32.

2. Tompkins, D.K., J.B. Ross and D.L. Moroz. 2000. Dehardening of annual bluegrass and creeping bentgrass during late winter and early spring. Agronomy Journal 92:5-9.

3. Tompkins, D. K., J.B. Ross, and D.L. Moroz. 2000. Hardening of annual bluegrass and creeping bentgrass in fall and early winter. Trial in progress.

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