ENHANCING THE DROUGHT TOLERANCE OF TURF PRODUCTION IN NOVA SCOTIA THROUGH THE USE OF ANTI-TRANSPIRANTS

Final Report

INTRODUCTION

One of the most important issues facing the turfgrass sector involves the management and conservation of water. The challenge is that in most municipalities water costs and environmental expectations have increased the need for the development of sustainable and effective water management strategies.

The turf industry has been progressive in identifying water management solutions in an attempt to reduce water use, improve water quality and become less reliant on conventional supplies. For example the industry has promoted: (*i*) the use of new turf varieties with high water use efficiencies; (*ii*) new technologies that improve irrigation system efficiency; and (*iii*) the development of "best management practices" that result in improved water use and water quality.

The movement of water through a plant system can be simplified to consider the water entering the roots and moving up through the trunk or stem to the leaves, as a continuum of a liquid solution (Taiz and Zeiger, 2002). Within the leaf, the liquid changes to a vapour and the liquid is released to the atmosphere. This process is termed evaporation. When it refers specifically to the evaporation of water from within the foliage to the environment, it is called transpiration. The combination of transpiration from the leaf and evaporation from the soil surface is termed evapotranspiration (ET).

The vast amount of transpiration in plants can become a major problem during drought situations. The plant will remove all the water from soil due to the difference in pressure, which will cause one of two things to occur: the plant itself will either die due to transpiring all the water out of the leaves, causing the plant to dry out; or any bit of rain that might come down will immediately be absorbed by the roots, not allowing the water levels to recuperate. Anti-transpirants are flexible, colourless and long-lasting, and once they dry, they will not harm the plant in any way (Ash, 2003). Most often they are used on ornamental plants prior to being removed at nurseries, as this helps to reduce transplant shock. They are often sprayed on evergreen trees and shrubs, as well as turf, prior to winter to prevent desiccation. Products such as CloudCover, Leafshield, and VaporGard, are liquid-wax type products that coat the leaves to help plants retain moisture, protecting them against cold damage. Most anti-transpirants do this by clogging up the stoma and reducing the amount of water that can escape. In a study with sweet corn (*Zea mays*) the rate of photosynthesis was not affected by the application of anti-transpirants to the leaves (Krohn, 1999).

Although anti-transpirants have been used for turf to control winter kill, to date no research has examined the benefits of applying an anti-transpirant throughout the growing season. Anti-transpirants can potentially reduce impacts during dry spells and this research will provide a better tool for the turf industry in Atlantic Canada and results will be applicable across the country.

OBJECTIVES

The objectives of this project were to determine: (*i*) which commercial anti-transpirant is best suited for commercial turf production in Nova Scotia and (*ii*) if applying an anti-transpirant to turf is beneficial

MATERIALS & METHODS

Site Location. A greenhouse at the Nova Scotia Agricultural College was used for this study. Daily temperatures were set to accommodate a maximum of 21°C and a minimum of 15°C.

Plant Material. Creeping bentgrass (*Agrostis* spp.) seed was planted in 20 cm (8in) diameter by 20cm (8in) tall pots. Seeding rate was 0.45 kg per 93m^2 (1lb per 1000ft^2). The medium within the pots was 80:20 sand/peat mix, based upon the United States Golf Association's recommendations. These seeds were established using the mist bench in the greenhouse four weeks prior to the onset of the data collection.

Experimental Design. The experiment was arranged in a complete randomized block design. Five treatments were used as blocks to evaluate the presence or absence of anti-transpirant. In particular, LeafShield (LS; Aquatrols, Cherry Hill, NJ), VaporGard (V; Miller Chemical & Fertlizer Corp., Hanover, PA), CloudCover (CC; Easy Gardener Products, Ltd., Waco, TX), and Anti-dessicant (AD; Total Solutions, Milwaukee, WI) were evaluated in conjunction with an untreated control (C). The mixing ratios (product:water) for the anti-transpirants were as follows: LS (premixed), V (1:40), CC (1:20), AD (1:4).

Within each block, three watering regimes were also included; (*i*) full recharge (FR), (*iii*) half recharge (HR), and (*iii*) moisture stressed (D). Within the FR, water was added until the weight of the pot returned to the previous day's mass. Half recharge received half of what was lost. The D was only watered on the initial day of the experiment. This entire experiment was replicated twice during the 2007 growing season. The anti-transpirants were applied weekly. For clarity purpose, the 15 applied treatments were as follows:

LeafShield	Full Recharge	LS-FR
	Half Recharge	LS-HR
	Moisture Stressed	LS-D
CloudCover	Full Recharge	CC-FR
	Half Recharge	CC-HR
	Moisture Stressed	CC-D
VaporGard	Full Recharge	V-FR
	Half Recharge	V-HR
	Moisture Stressed	V-D
Anti-dessicant	Full Recharge	AD-FR
	Half Recharge	AD-HR
	Moisture Stressed	AD-D
Untreated Control	Full Recharge	C-FR
	Half Recharge	C-HR
	Moisture Stressed	C-D

Gravimetric Determination of Transpiration. A Sartorius model LC 12000 P (Sartorius GMBH, Göttingen, Germany) scale with a readability of 0.1g was used to determine the pot weights. Transpiration was calculated by the difference in weight on a daily basis per pot.

Colour Determination. The Field Scout TCM Turf Colour Meter (Spectrum Technologies, Inc., Plainfield, IL) was utilized for colour determination. This instrument measures reflected light from the turfgrass in the red, green, and blue spectral areas and provides a non-subjective colour index value. Colour readings were taken in conjunction with transpiration rate estimates.

Height Determination & Visual Observations. Weekly measurements of height (cm) were manually obtained. Due to the lack of overall growth within the pots, this data will not be discussed in this report. Visual observations were recorded daily. This consisted of noting any colour change or dieback and was collected to verify any anomalies.

Statistical Analysis. ANOVA was completed using the Proc GLM procedure of SAS (SAS Institute, Cary, N.C.) for all data. The ANOVA assumptions of normality and constant variance were verified using the Proc Univariate procedure of SAS (SAS Institute, Cary, N.C.). If significance occurred at the $\alpha = 0.05$ level of significance, means separation using the LSMeans procedure was performed. All statistical analyses compared anti-transpirants to the untreated control, only, and not each other. In addition, for statistical purposes, the three watering regimes (FR, HR, and D) were individually compared.

RESULTS & DISCUSSION

The Nova Scotia turf industry is important to the provincial economy. The sod component is valued at $6.5 million in direct sales; taking into account landscape projects this would increase to $20 million annually. On average, the golf course sector generates $55,000,000 yearly to the economy.

Ample water is essential for turf to grow adequately (Beard, 1973). If water is not available under demanding conditions, the turf will experience stress, potentially leading to death. This research was to provide preliminary data on the effectiveness and feasibility of incorporating anti-transpirants within a turf management program. It was hypothesized that using anti-transpirants would limit water loss while at the same time, showing no harmful effects to the turf.

As the summer progressed, the temperatures of the greenhouse exceeded the posted amount and the air exchange had to be adjusted accordingly. In general, the root systems ran deep but were within all the treatments. This may have been attributed to the age and developmental stage of the turf. During the second run of the experiment, the scale was being shared with another project and accounts for some missing data.

The AD did not spray very well and came out more as a foam. Also, when initially sprayed, it coated the turf in a white covering. When dried, AD became stiff and shiny. While unpleasing to the eye, it did aid with application as it was easier to where it was applied. LeafShield, V, and CC all applied as a milky coating and as a more of a liquid than foam.

Overall, transpiration rates were not affected in the fully recharged (FR) treatments (Table 1). Regardless of the application, there were no significant differences among the anti-transpirant treatments and the untreated control (C). It should be noted that C-FR was significantly different from LS-FR on one day of the second run of the experiment (Table 2). However, C-FR was not significantly different from the remaining anti-transpirants.

Within the half recharged (HR) treatments, the untreated control (C-HR) was only significantly different once (on June 21; Table 1), from LS-HR. During the second run, C-HR was significantly different from LS-HR, V-HR, and AD-HR on one day only (July 11; Table 2). Overall, within the HR watering regime, there was no clear distinction among treatments.

As expected, the moisture stressed pots were the most susceptible to dieback. In general, the untreated moisture stressed treatment (C-D) was significantly different from the anti-transpirant treatments. With the exception of June 16 and July 3 (during the first run) VaporGard showed consistently lower transpiration than (C-D). CloudCover was the next best anti-transpirant compared to (C-D). However, it was not as consistent as VaporGard for significance from the untreated control. While there was a significant difference in transpiration rates for the untreated control pots within the moisture stressed treatment, it was not realistic to conclude that incorporating this product into management practices was a feasible option based upon these results alone. Additional data were required to further evaluate their incorporation into a turf management program. In particular, colour needed to be assessed.

While the colour readings changed very little from day to day, there was a significant difference among the treatments. These colour readings were especially important when assessing the feasibility of anti-transpirant use. It is the lush green colour of turf that is the selling feature for consumers. Within the first run of the experiment, the untreated control pots consistently had better colour values than the anti-transpirant treatments (Table 3). During the second run, LS, CC, and AD each had higher colour values scattered throughout the data collection period (Table 4). Regardless, none of these readings were significantly different from the untreated control. While, the VaporGard treatment showed the most promise for conserving moisture under extreme moisture stressed conditions, it consistently had the loweest colour undex value. This can be clearly seen in Figure 1, where the VaporGard pot had a strong yellow tinge to its colour.

Conclusion

Although the anti-transpirants did minimize the amount of water lost (on a daily basis), the preparation time as well as their effects on the turf colour limited their effectiveness and potential inclusion into a turf management program. It was because of this that the field component was not executed. The application of the each anti-transpirant was time consuming and left an unpleasing visible covering on the surface.

Ash, R.J. 2003. Anti-transpirants: winter sprays to protect broadleaf evergreens. Plant & Pest Advisory. Rutgers Cooperative Extension at the New Jersey Agricultural Experiment Station. 7 pp.

Beard, J. 1973. Turfgrass: Science and Culture. Prentice Hall, Upper Saddle River, NJ. 658 pp.

Taiz, L. and E. Zeiger. 2002. Plant Physiology, 2nd Edition. Sinauer Associates, Inc., Sunderland. MA. 690 pp.

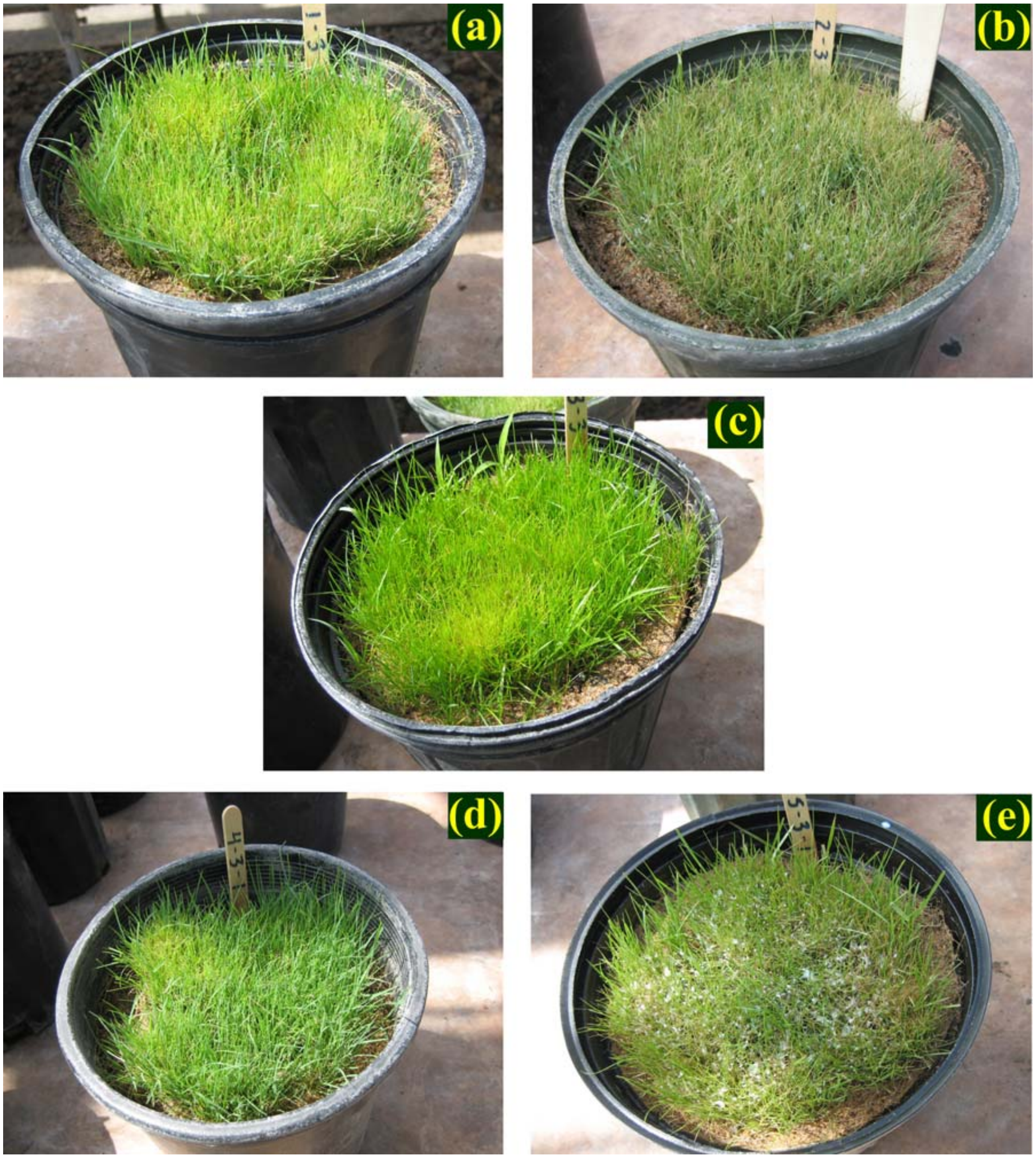

Figure 1. Overhead photos (21 June 2006) of the five treatments, LeafShield (*a*), CloudCover (*b*), VaporGard (*c*), control (*d*), and Anti-Dessicant (*e*).

Table 1. Daily transpiration rates ($g\ day^{-1}$) for the first run. Data collection began June 14 and concluded July 3. Differing letters within each watering regime indicate significance from the untreated control ($\alpha = 0.05$ level of significance, using LSMeans analysis).

Treatment	June 16	June 19	June 21	June 23	June 26	June 28	July 3
LS-FR	63.46^{a}	83.37^{a}	37.86^{a}	75.71^{a}	ND*	77.99^{a}	101.21^{a}
CC-FR	67.19^{a}	84.61^{a}	40.66^{a}	84.99^{a}	ND	87.94^{a}	106.67^{a}
V-FR	63.25^{a}	82.37^{a}	40.71^{a}	76.04^{a}	ND	89.20^{a}	118.28^{a}
C-FR	67.88^{a}	81.01^{a}	42.25^{a}	89.11^{a}	ND	91.61^{a}	106.97^{a}
AD-FR	61.26^{a}	82.30^{a}	39.68^{a}	80.74^{a}	ND	88.11^{a}	108.20^{a}
LS-HR	60.44^{a}	83.60^{a}	53.62^{b}	58.93^{a}	13.24^{a}	32.15^{a}	72.73^{a}
CC-HR	60.50^{a}	88.14^{a}	55.64^{a}	70.29^{a}	15.50^{a}	48.99^{a}	78.29^{a}
V-HR	63.29^{a}	83.75^{a}	54.60^{a}	58.78^{a}	12.44^{a}	34.16^{a}	77.67^{a}
C-FR	68.35^{a}	82.37^{a}	60.30^{a}	67.01^{a}	15.50^{a}	39.59^{a}	74.82^{a}
AD-FR	64.91^{a}	85.73^{a}	55.28^{a}	68.79^{a}	14.04^{a}	41.08^{a}	76.74^{a}
LS-D	69.38^{a}	111.32^{a}	82.54^{a}	ND	64.41^{a}	90.73^{a}	81.17^{a}
CC-D	61.70^{b}	109.03^{a}	79.99^{b}	ND	59.78^{a}	98.19^{a}	88.48^{a}
V-D	58.78^{a}	96.86^{b}	71.79^{b}	ND	54.30^{b}	81.04^{b}	91.63^{a}
C-FR	73.31^{a}	117.91^{a}	88.45^{a}	ND	68.95^{a}	109.96^{a}	82.40^{a}
AD-FR	67.99^{a}	112.25^{a}	82.48^{a}	ND	63.03^{a}	99.08^{a}	83.64^{a}

*ND denotes no data.

Table 2. Daily transpiration rates (g day^{-1}) for the second run. Data collection began July 5 and concluded July 17. Differing letters within each watering regime indicate significance from the untreated control ($\alpha = 0.05$ level of significance, using LSMeans analysis).

TREATMENT	**JULY 7**	**JULY 11**	**JULY 12**	**JULY 14**	**JULY 17**
LS-FR	58.35[a]	50.76[b]	ND	ND	32.46[a]
CC-FR	63.60[a]	66.16[a]	ND	ND	46.66[a]
V-FR	55.39[a]	58.24[a]	ND	ND	37.12[a]
C-FR	60.81[a]	65.68[a]	ND	ND	41.75[a]
AD-FR	59.20[a]	59.53[a]	ND	ND	40.21[a]
LS-HR	59.62[a]	58.00[b]	ND	ND	42.74[a]
CC-HR	59.66[a]	73.42[a]	ND	ND	28.16[a]
V-HR	53.18[a]	57.73[b]	ND	ND	32.34[a]
C-FR	61.74[a]	77.73[a]	ND	ND	34.00[a]
AD-FR	56.34[a]	65.00[b]	ND	ND	28.00[a]
LS-D	55.76[a]	63.00[b]	ND	ND	64.64[b]
CC-D	60.12[a]	71.81[b]	ND	ND	56.14[b]
V-D	50.42[b]	66.10[b]	ND	ND	57.34[b]
C-FR	60.61[a]	82.74[a]	ND	ND	89.85[a]
AD-FR	58.92[a]	75.71[a]	ND	ND	57.11[b]

*ND denotes no data.

Table 3. Colour index values for the first run. Data collection began June 14 and concluded July 3. Differing letters within each watering regime indicate significance from the untreated control (α = 0.05 level of significance, using LSMeans analysis).

TREATMENT	**JUNE 21**	**JUNE 23**	**JUNE 26**	**JUNE 28**	**JUNE 30**	**JULY 3**
LS-FR	5.8^{a}	4.9^{a}	5.9^{b}	4.7^{b}	4.1^{b}	3.5^{b}
CC-FR	6.1^{a}	5.1^{a}	6.2^{b}	5.0^{b}	4.1^{b}	4.5^{b}
V-FR	4.4^{b}	3.1^{b}	3.9^{b}	3.8^{b}	3.0^{b}	2.9^{b}
C-FR	7.0^{a}	6.5^{a}	7.6^{a}	7.1^{a}	5.7^{a}	5.9^{a}
AD-FR	4.6^{b}	4.4^{b}	4.8^{b}	4.2^{b}	3.5^{b}	3.8^{b}
LS-HR	4.5^{b}	3.5^{b}	4.0^{b}	3.2^{b}	2.8^{b}	2.7^{b}
CC-HR	6.2^{a}	5.4^{a}	5.4^{a}	5.0^{b}	4.2^{b}	4.1^{a}
V-HR	3.8^{b}	2.8^{b}	3.1^{b}	3.1^{b}	2.8^{b}	2.7^{b}
C-FR	6.2^{a}	5.9^{a}	6.2^{a}	6.5^{a}	5.4^{a}	4.8^{a}
AD-FR	5.2^{a}	4.4^{a}	4.7^{b}	4.5^{b}	3.9^{b}	3.6^{b}
LS-D	5.1^{b}	4.1^{a}	5.0^{a}	4.0^{b}	3.2^{b}	3.1^{b}
CC-D	5.4^{a}	4.8^{a}	5.5^{a}	4.4^{b}	4.1^{b}	4.5^{b}
V-D	4.0^{b}	2.8^{b}	3.5^{b}	3.4^{b}	2.7^{b}	2.6^{b}
C-FR	5.8^{a}	6.1^{a}	6.3^{a}	6.1^{a}	6.2^{a}	5.4^{a}
AD-FR	4.8^{b}	4.1^{b}	5.1^{a}	4.6^{b}	4.0^{b}	4.2^{b}

Table 4. Colour index values for the second run. Data collection began July 5 and concluded July 17. Differing letters within each watering regime indicate significance from the untreated control (α = 0.05 level of significance, using LSMeans analysis).

TREATMENT	**JULY 5**	**JULY 7**	**JULY 11**	**JULY 12**	**JULY 14**	**JULY 17**
LS-FR	6.4^{a}	5.3^{b}	5.0^{a}	4.9^{a}	4.2^{b}	3.3^{b}
CC-FR	6.8^{a}	5.7^{b}	5.1^{a}	5.2^{a}	4.8^{b}	4.6^{b}
V-FR	3.9^{b}	3.8^{b}	3.5^{b}	3.6^{b}	3.1^{b}	3.3^{b}
C-FR	6.5^{a}	6.5^{a}	5.4^{a}	5.3^{a}	5.6^{a}	6.1^{a}
AD-FR	6.0^{a}	5.7^{b}	4.8^{a}	4.6^{b}	4.4^{b}	4.4^{b}
LS-HR	6.1^{a}	6.1^{a}	5.1^{a}	4.8^{a}	4.2^{b}	3.4^{b}
CC-HR	6.1^{a}	5.7^{a}	5.0^{a}	4.6^{a}	4.8^{a}	4.9^{a}
V-HR	4.0^{b}	3.4^{b}	3.4^{b}	3.2^{b}	3.1^{b}	3.2^{b}
C-FR	6.6^{a}	6.4^{a}	4.8^{a}	4.8^{a}	5.1^{a}	5.2^{a}
AD-FR	5.9^{a}	5.2^{b}	4.6^{a}	4.8^{a}	4.1^{b}	4.0^{b}
LS-D	6.1^{a}	5.6^{a}	4.9^{a}	4.9^{b}	4.1^{b}	3.7^{b}
CC-D	6.0^{a}	6.0^{a}	5.2^{a}	5.8^{a}	4.8^{a}	4.8^{a}
V-D	4.2^{b}	3.2^{a}	3.6^{b}	3.6^{b}	3.5^{b}	3.2^{b}
C-FR	6.5^{a}	6.1^{a}	5.0^{a}	5.8^{a}	4.8^{a}	5.2^{a}
AD-FR	5.7^{a}	5.4^{a}	5.4^{a}	5.2^{b}	4.4^{a}	4.4^{b}