Determination of the Growing Degree Day Reapplication Threshold for the Anuew PGR

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Plant growth regulators are widely applied to cool season putting green turf to reduce leaf elongation, increase ball roll distance, reduce nutrient requirements, and increase overall plant health. Growth regulators that inhibit synthesis of the hormone gibberellic acid (GA) are most frequently used on fine turf because these products are safer than other PGR classes. All GA inhibitors affect growth in two distinct phases. Immediately following PGR application, leaf elongation slows during the suppression phase. Then leaf elongation rate increases to a level greater than non-treated turf. This phase of growth enhancement, hereafter called the rebound phase, is typically similar in magnitude to the amount of growth suppression in the suppression phase.

The duration of the suppression and rebound phases are a function of air temperature. At high temperatures, breakdown (metabolism) of PGRs within the plant is accelerated. As a result, PGRs need to be reapplied more frequently to sustain season-long growth suppression and benefits associated with PGR use. Kreuser and Soldat (2011) found a growing degree day (GDD) model successfully predicted the duration and magnitude of both the suppression and rebound phase of the PGR trinexapac-ethyl (TE). Further work demonstrated that application of TE every 200 GDD (degrees Celsius with base temperature of 0°C) sustained season-long growth suppression on cool-season putting greens, regardless of TE application rate.

Like TE, prohexadione-Ca (PC) is a late-GA inhibitor that is currently being developed by Nufarm for use on putting green turfgrass under the trade name Anuew. Little is known about the performance of this chemistry on turfgrass including the magnitude and duration of growth suppression.

OBJECTIVES

The main objectives of this research were to:

i) determine the effect of PC and paclobutrazol on putting green clipping yield,
ii) model relative growth rate as a function of GDD,
iii) estimate an ideal re-application interval to sustain season-long growth suppression, and
iv) compare the effect of PC with TE and paclobutrazol, another GA-inhibitor.

METHODS

This study was conducted on a mature 'L-93' creeping bentgrass putting green at the John Seaton Anderson Turf Facility in Mead, NE during the 2014 growing season. The research green was constructed to USGA specification, mowed five days per week at 0.125 inches with at Toro 1000 walking greensmower and irrigated to 80% of potential reference evapotranspiration. The green was fertilized with 0.2 lbs N/M as urea every 14 days and heavily sand topdressed in spring. Disease was controlled with non-DMI fungicides as needed.

Individual plots measured four 5 x 5 feet and were arrayed in a randomized complete block design with four replications. Treatments consisted of PC (Anuew from Nefarm) applied at 8 fl oz/acre and paclobutrazol (Trimmit SC from Syngenta) applied at 11 oz/acre every 1000 GDD and a non-treated control. Temperature data used to calculate GDD was measured by an on-site weather station. Treatments were applied using a CO_2 powered backpack prayer equipped with two TeeJet AI 8005 nozzles at 40 PSI and delivery spray volume of 2.0 gallons per 1000 ft^2. Treatments were initiated on 15 May 2014. The final application were made on 7 Oct 2014.

Clippings were collected from all plots approximately three days during summer and less frequently during Sept and Oct. Clippings were collected by mowing one pass down the center of each plot with a walking greensmower 24h after the previous mowing. Clippings from each plot were then brushed into paper bag, dried in an oven at 170°F, cleaned of sand debris, and weighed. The first clipping collection event occurred on 16 May 2014 and the final event occurred on 15 Oct 2014. A total of 42 clipping collections were taken during the course of the 2014 growing season.

Relative clipping yield was determined by dividing the clipping yield of each PGR treatment by the clipping yield of the non-treated control within each plot. Relative clipping yield values from the four replicates were averaged and plotted as a function of GDD after the most recent PGR application. Finally, sinewave regression was used to create a growth model for PC and paclobutrazol in Excel using the solver function in the data analysis add-on.

RESULTS

The daily average air temperature during 2014 was quite variable (Fig. 1). Daily average air temperatures ranged from 6 to 29°C (43-85°F) with the warmest weather in late June. July was colder than average and late September was warmer than average. The diversity of daily average air temperature was favorable for creation of GDD models. It insures the response is not just a function of number of days following application of the PGR. Paclobutrazol was applied four times and PC was applied three times during 2014. The first application of PC occurred in June because we did not receive the product until June.

Both PGRs reduced relative clipping yield following application. Growth suppression lasted for 19, 13, 28 days with paclobutrazol and 10, 14, and >7 days for the PC. The range days of growth suppression suggests that a GDD model may be useful to model turfgrass response to PC and paclobutrazol. Sinewave regression of relative clipping yield as a function of GDD was highly significant ($p<0.001$). The pseudo r^2 values for the paclobutrazol and PC were 0.773 and 0.696,

respectively. These value was greater than the pseudo r^2 for the original TE model of 0.520 (Kreuser and Soldat, 2011) which likely occurred because of a refined method to clean sand debris from the samples.

Maximum yield suppression and rebound occurred approximately 190 and 710 GDD after application with an average magnitude of clipping yield suppression/rebound of 21% for PC. Maximum growth suppression and rebound occurred at 220 and 670 GDD with 45% suppression/rebound with paclobutrazol. For comparison, TE reduced maximum clipping yield suppression approximately 150 GDD and maximum rebound approximately 550 GDD after application. The magnitude of the clipping yield suppression/rebound following TE application was 18% which is similar to PC. It would be inappropriate to conduct a statistical test to compare the growth suppression of TE to PC because the models were generated at a different location and year. These results do suggest that PC does last longer in the plant than TE but not as long as paclobutrazol applied at 11 oz/acre.

Based on previous work with PGR GDD intervals, we recommend that a PGR be reapplied half way between the point of peak growth suppression and the transition from the suppression to rebound phase. The ideal GDD interval to sustain growth suppression with TE was determined to be roughly 200 GDD. The PC and paclobutrazol models suggest the ideal intervals would be roughly 300 and 350 GDD, respectively. During an average May in the Midwest (59°F or 15°C) 200, 300, and 350 GDD would be equivalent to 13, 20, 23 days. During the summer (90°F or 32°C) those interval would occur in 6, 9, 11 days.

Other research with PC at the University of Wisconsin-Madison determined that application rate did not affect the performance of PC on bentgrass putting greens (Doug Soldat, email correspondence, November 2014). This is similar to TE and might be a function of PGR mode of action. Both products produced similar clipping yield suppression while PC lasted 50% longer than TE. This difference is likely the result of different rates of product metabolism within the plant. Our latest research with paclobutrazol suggests the duration and magnitude of clipping yield suppression is a function of application rate.

CONCLUSIONS

GDD models successfully predicted the duration and magnitude of clipping yield suppression/rebound following application of PC and paclobutrazol. Prohexadione-Ca provided similar magnitude of growth suppression as TE (~20%), another late GA inhibitor, but it lasted approximately 50% longer (300 vs 200 GDD). Paclobutrazol sustained greater levels of growth suppression (45%) for a longer duration than either TE or PC (350 GDD). While all three PGRs are GA inhibitors, paclobutrazol affects metabolism earlier in the pathway.

Reference:

Kreuser, W. C. and D. J. Soldat. 2011. A growing degree day model to schedule trinexapac-ethyl applications on Agrostis stolonifera golf putting greens. Crop Sci. 51:2228-2236

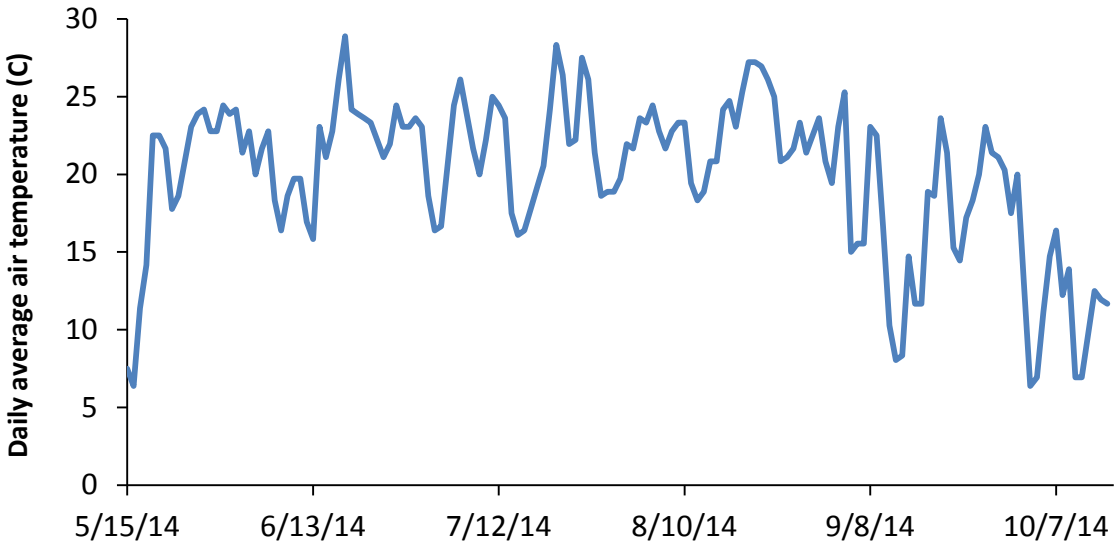

Figure 1. Daily average air temperature at the JSA Turf Center in Mead, NE.

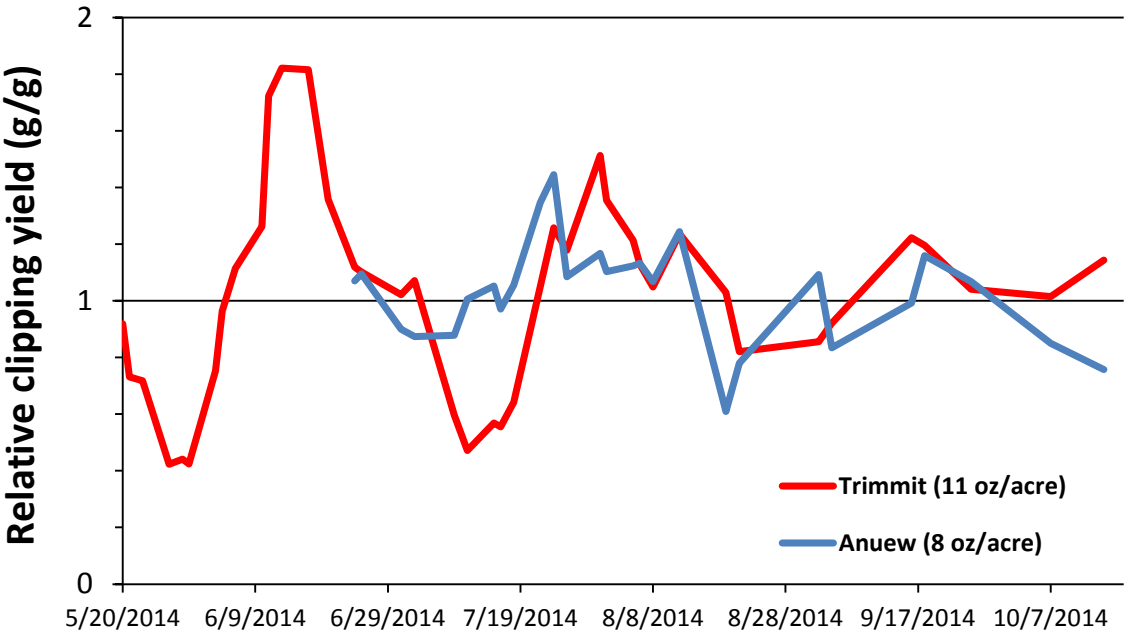

Figure 2. Relative clipping yield of creeping bentgrass putting green turf following application of paclobutrazol (Trimmit) and prohexadione-Ca (Anuew) every 1000 GDD (°C with base 0°C).

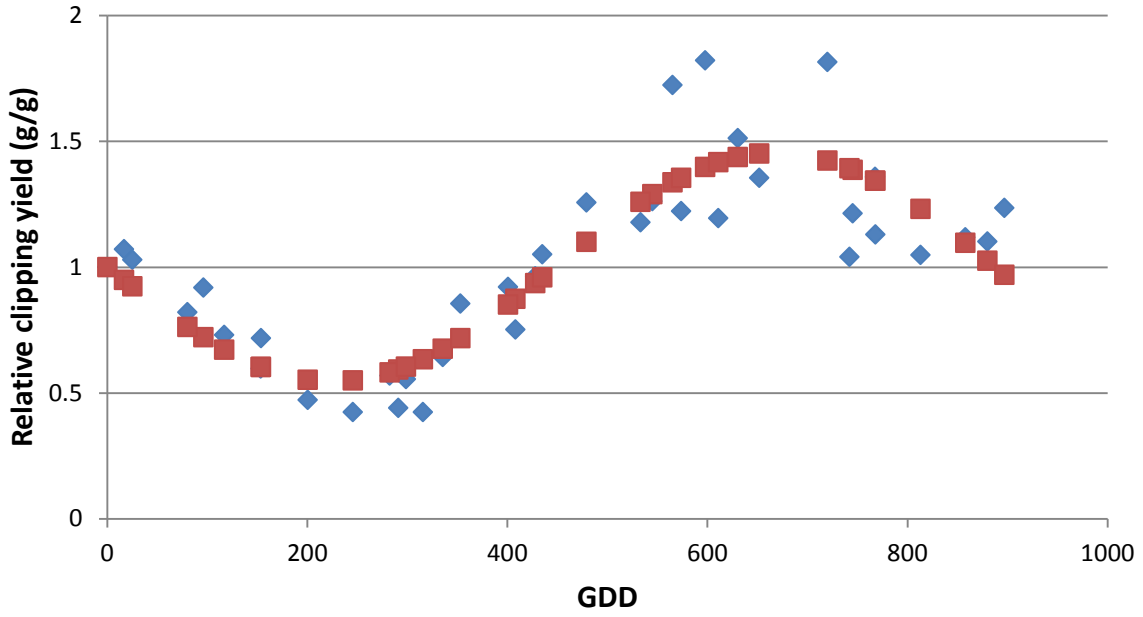

Figure 3. Relative clipping yield of creeping bentgrass putting green turf following application of paclobutrazol (Trimmit) plotted as a function of GDD (°C with base 0°C). The pseudo r^2 of the model is 0.773. Blue triangles are actual and red squares are the model predicted values.

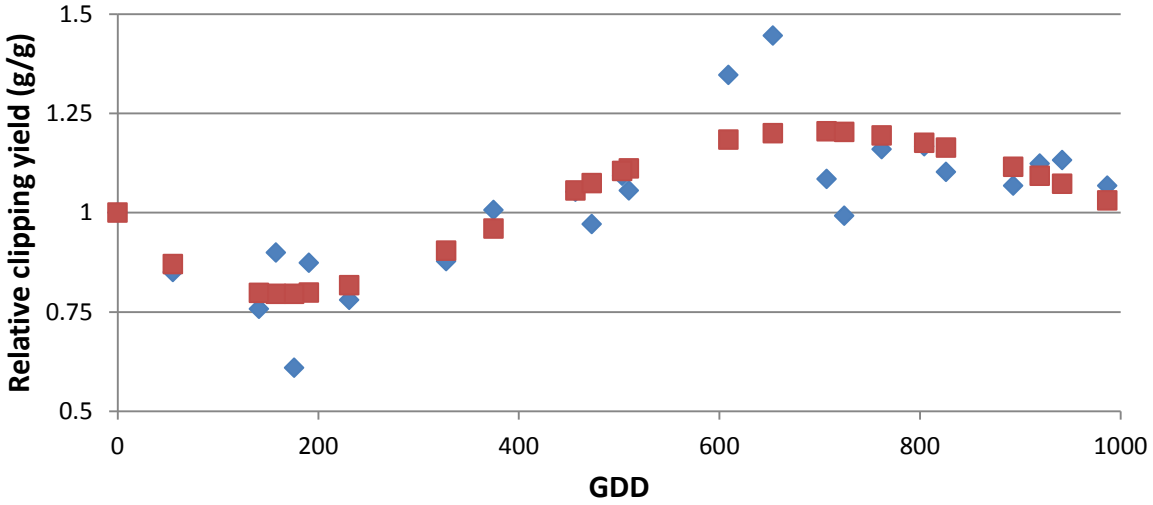

Figure 4. Relative clipping yield of creeping bentgrass putting green turf following application of prohexadione-Ca (Anuew) plotted as a function of GDD (°C with base 0°C). The pseudo r^2 of the model is 0.696. Blue triangles are actual and red squares are the model predicted values.

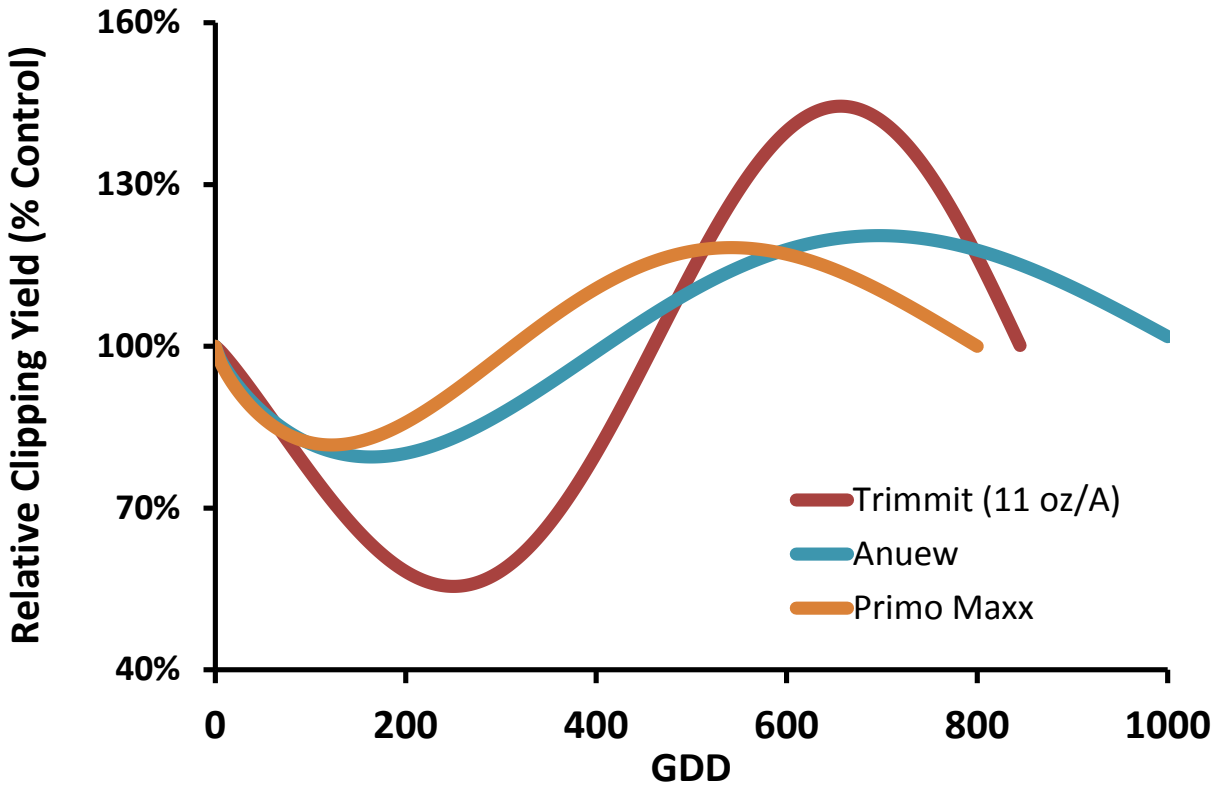

Figure 5. The GDD models of clipping yield following application of three different GA-inhibiting PGRs to creeping bentgrass putting green turf.