Maintaining Constant Growth Regulation with Primo Maxx

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Trinexapac-ethyl, the active ingredient in Primo Maxx, has been extensively researched by turfgrass scientists nationwide. Among other benefits, researchers have shown Primo application increases turf color and density (e.g. Fagerness and Yelverton, 2000; Lickfeldt et al., 2001), heat and drought tolerance (McCann and Huang, 2007), and shade tolerance (Stier and Rogers, 2001 Stienke and Stier, 2003). However, these secondary benefits can often overshadow the most obvious benefit of Primo: reduced clipping production. The Primo Maxx label states the product will provide a 50% reduction in clipping production for 4 weeks when used according to directions. However, our experiences indicate that many superintendents perceive a reduction of Primo's efficacy during summer months.

Research published in Golf Course Management by Drs. Branham and Beasley in July 2007 showed that Primo is metabolized by the plant faster at higher air temperatures. More specifically, they reported that the half-life of Primo in the plant is 6 days at 64°F, but only 3 days at 86°F. In this case, a half-life is defined as the amount of time required for 50% of the material to be metabolized. That means Primo was disappearing (being metabolized) in the plant twice as fast at 86°F compared to 64°F. Branham and Beasley correctly conclude that understanding these physiological aspects of Primo will help superintendents more effectively utilize the product. We thought that it might be interesting to take this concept one step further and investigate whether or not more specific re-application recommendations could be developed based on air temperatures.

Growing degree day (GDD) systems are used to predict various naturally occurring events such as the bloom of various plants or the emergence or insects. In turf, GDD systems are widely used to predict the optimum timing for herbicides and Primo/Proxy mixtures to suppress seedheads (for other examples, please visit www.gddtracker.net).

A daily GDD is simply the average air temperature minus a predetermined base temperature. Commonly used base temperatures are either 32 or 50°F. For example, if the maximum air temperature yesterday was 90 and the minimum was 66, the average air temperature was 78. This would be 28 base 50°F GDD, or 48 base 32°F GDD (78 - 50, or 78 - 32, respectively). We would then add the daily GDD to the accumulated GDD from all the other days during the year. If a GDD is negative, that number is treated as zero. As you'll see below, in our study we opted to use a Celsius growing degree day system with a base of zero. This was the simplest system for us to use, and it can be easily converted to base 32°F GDD.

Our hypothesis was that a GDD system can be used to estimate Primo metabolism and provide a tool for turfgrass managers to schedule Primo re-application. Establishing such a system would provide superintendents a method to more effectively maintain consistent growth regulation throughout the growing season. To test our hypothesis we designed an experiment that had five Primo re-application intervals along with a control that received no Primo.

Materials and Methods

This experiment is being conducted on a sand-based L-93 creeping bentgrass putting green. The plots are watered daily to prevent water stress from interfering with the growth regulation. The study is a randomized complete block design with 4 replicates of five re-application intervals along with a zero Primo control. Four of the re-application intervals are based on a growing degree day system (GDD) and the fifth interval is re-applied every 4 weeks as per the label.

Growing degree days are calculated by adding the mean daily air temperature, in degrees Celsius

from our weather station, daily until the desired re-application threshold has been surpassed. The four re-application thresholds in this study are 100, 200, 400, and 800 GDD. Once the appropriate GDD has been achieved, Primo is applied and the growing degree days are reset. Primo is applied at the labeled rate of 0.125 fl oz of product/M in 2 gallons of water with a CO2 power backpack sprayer.

Grass clippings are collected daily, washed, dried, and weighed. Then we calculate the clipping production in comparison to the control. This is done by dividing the treatment clipping mass by the clipping mass of the control. Values less than one, represent a reduction in clipping production while values greater than one represent increased clipping production compared to the control. Overall visual quality and chlorophyll readings are recorded weekly.

Results and Discussion

Both the 100 and 200 GDD re-application treatments maintained constant growth regulation during the summer (200 GDD results shown in Fig. 1). Compare the 200 GDD re-application interval (Fig. 1) to the 4-week interval shown in Fig. 2. You'll notice that on most dates, the 4-week interval is actually producing more clippings than the untreated control. This can be attributed to the "rebound effect" often reported in other studies where turf coming out of growth reduction will show enhanced growth. However, by re-applying Primo every 200 GDD, this rebound effect was minimized and growth suppression was fairly constant throughout the summer of 2008. However, for all re-application treatments, the 0.125 application rate reduced clipping production by only 20 to 30% at peak suppression, significantly lower than

Figure 1. 200 GDD Re-application Clipping Production

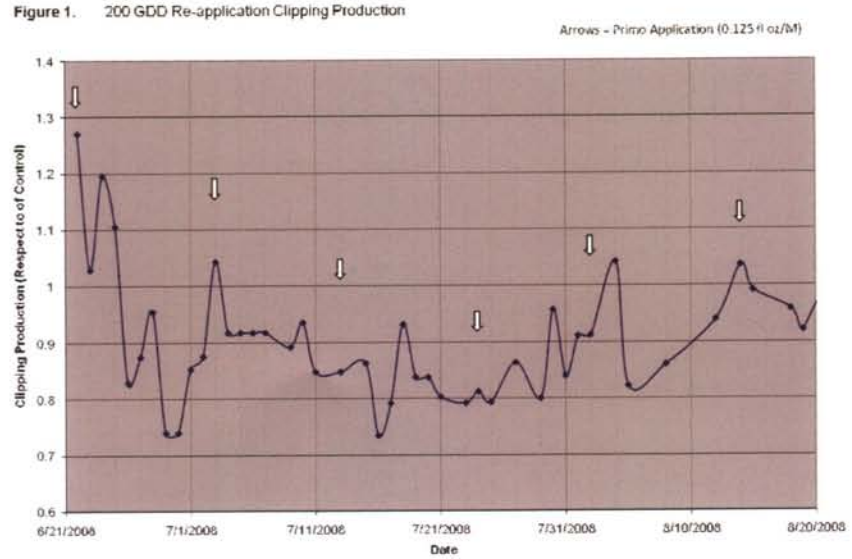


Figure 2. 4 Week Re-application Clipping Production

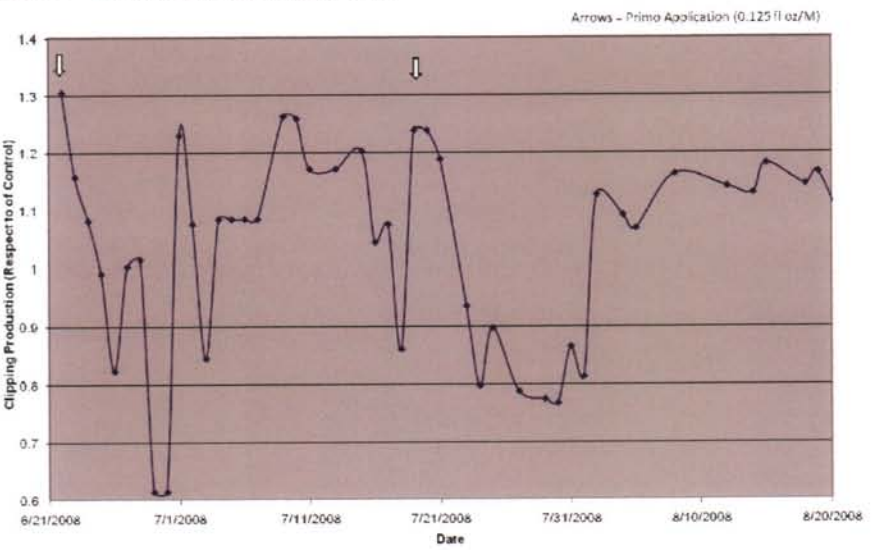
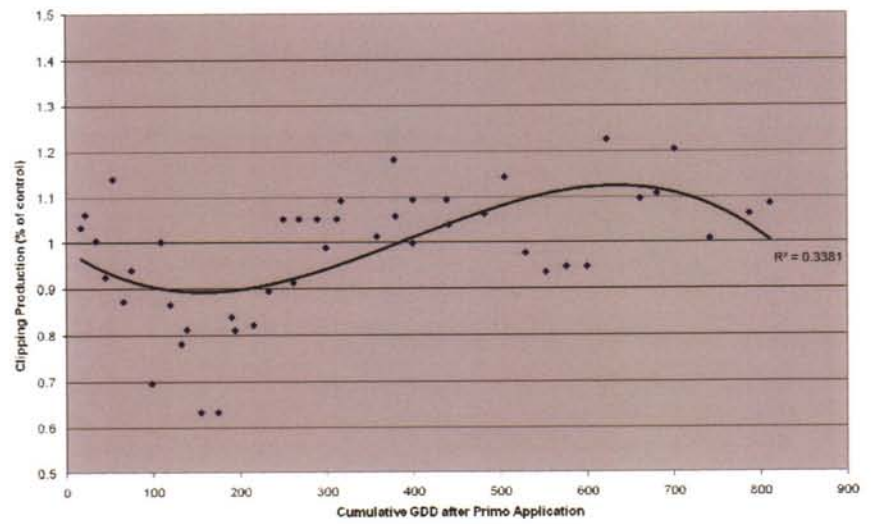


Figure 3. Dry Clipping Production After Primo Application



the 50% reduction claimed on the label (Table 1). This is likely related to the rate of application, as we have seen growth reductions up to 80% in Kentucky bluegrass plots at much higher application rates (data not shown).

As you can see in Figure 3, following a Primo application at GDD=0, the maximum reduction in clipping production occurs around 150 GDD, and then growth rates increase until the are approximately equal to that of the untreated control around 300 growing degree day units. During July, 300 GDD can occur in as little as twelve days. However, in the May or September 300 GDD may occur after 21-28 days. Between 300 and 500 GDD units following Primo application, the turfgrass will enter a rebound phase (Fig. 3). During this phase clipping reduction is greater than the control. Typically the duration and magnitude of this rebound phase is similar to the suppression phase. At the labeled application rate the rebound is 300-500 GDD units long and with a 15 to 35% increase in clipping production in comparison to the control treatments.

As reported in previous Primo studies turfgrass color/chlorophyll index (CI) and overall visual quality increased with Primo application (Tables 2 & 3). Similarly to the clipping production data the color and quality were consistently greatest for the 100 and 200 GDD treatments. The 400 GDD, 800 GDD, and 4 week re-application treatments varied slightly as the turfgrass experienced the suppression/rebound cycling. Statistical

Table 1. Clipping Production with Respect to Control as Influenced by Primo Re-application

Primo Application		Clipping Production (Percent Growth of Control)									
Re-application Frequency	Rate fl oz/M	6/28/2008	7/9/2008	7/15/2008	7/20/2008	7/25/2008	7/30/2008	8/2/2008	8/8/2008	8/14/2008	8/18/2008
100 GDD	0.125	88 A	79 A	79 A	83 AB	82 A	72 A	68 A	84 A	100 A	93 A
200 GDD	0.125	95 A	89 AB	87 AB	84 AB	79 A	95 BC	91 AB	86 A	104 A	96 A
400 GDD	0.125	100 A	123 B	105 CD	67 AB	101 AB	106 C	86 AB	93 AB	105 A	115 C
800 GDD	0.125	81 A	101 AB	106 CD	95 AB	120 B	109 C	87 AB	84 A	98 A	105 ABC
4 Week	0.125	101 A	127 B	120 D	124 B	90 AB	76 AB	113 B	117 B	113 A	115 BC
Control	0	100 A	100 AB	100 BC	100 AB	100 AB	100 C	100 AB	100 AB	100 A	100 AB

Table 2. Chlorophyll Index as Influenced by Primo Re-application

Primo Application		Chlorophyll Index							
Re-application Frequency	Rate fl oz/M	6/22/2008	7/9/2008	7/23/2008	7/31/2008	8/14/2008	8/21/2008	8/28/2008	9/7/2008
100 GDD	0.125	248 A	310 A	275 A	293 A	325 A	338 A	303 A	384 A
200 GDD	0.125	244 A	299 A	269 A	285 AB	306 AB	315 AB	279 AB	355 AB
400 GDD	0.125	248 A	305 A	267 A	284 AB	303 B	319 AB	277 B	346 B
800 GDD	0.125	243 A	304 A	261 A	269 B	288 BC	310 AB	268 B	339 B
4 Week	0.125	250 A	310 A	271 A	280 AB	306 AB	313 AB	279 AB	350 AB
Control	0	240 A	301 A	262 A	274 AB	283 C	305 B	263 B	324 B

Table 3. Overall Putting Green Quality as Influenced by Primo Re-application

Primo Application		Overall Quality Rating							
Re-application Frequency	Rate fl oz/M	6/22/2008	7/9/2008	7/23/2008	7/31/2008	8/14/2008	8/21/2008	8/28/2008	9/7/2008
		Scale of 1 to 9 (perfect quality)							
100 GDD	0.125	7.5 A	7.9 A	7.6 A	8.3 A	8.6 A	8.3 A	8.5 A	8.5 A
200 GDD	0.125	7.4 A	7.6 A	7.8 A	7.8 A	8.1 AB	7.5 AB	8.1 AB	8.0 ABC
400 GDD	0.125	7.5 A	7.4 A	7.6 A	7.9 A	8.0 A	7.4 AB	7.9 AB	8.4 ABC
800 GDD	0.125	7.5 A	7.4 A	7.6 A	7.5 A	7.8 BC	7.4 AB	7.4 B	7.8 BC
4 Week	0.125	7.5 A	7.9 A	7.6 A	7.8 A	8.1 AB	7.5 AB	7.8 AB	7.9 ABC
Control	0	7.4 A	7.1 A	7.6 A	7.6 A	7.3 C	6.9 B	7.2 B	7.6 C

differences for both color (CI) and quality didn't occur until approximately six weeks after the study. It's unclear if that is due to initial plot variability or if it takes the plant that time to develop those qualities.

Summary and Conclusions

From our preliminary research during this summer, we found that re-applying Primo every 200 GDD or less will provide consistent growth regulation on a creeping bentgrass putting green. Additionally this re-application interval will maintain darker green color and higher turfgrass quality. Re-applying more frequently didn't increase growth suppression measurably, nor did it significantly affect quality or color; even when Primo was being re-applied every 4-5 days in July. It is important to stress that these results occurred on a bentgrass putting in full sun. The green is watered to 100% of estimated potential evapotranspiration and fertilized with 0.6 lb N/M monthly. These factors may be important in rate of Primo metabolism.

To help superintendents keep track of GDD we created an Excel spreadsheet that allows turfgrass managers to enter the daily temperature (°F) along with the date they applied Primo. This program will convert the temperature to Celsius and then tell turfgrass managers when Primo application is need. This program will be available this winter.

We are encouraged by our results and plan to continue this study in coming years. We plan on investigating other plant growth regulators at various application rates on other grass species. Other potential variables include nitrogen fertility levels and different traffic levels. Our ultimate goal is to develop a program that would allow turfgrass managers to obtain accurate re-application interval recommendations for a wide variety of agronomic situations.

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