HERBICIDE AND PLANT GROWTH REGULATOR UPDATE

Ronald Calhoun
Department of Crop and Soil Sciences
Michigan State University

As the Turfgrass Turns: This reports summarizes the Turfgrass Physiology and Herbicide (TuPH) research conducted in 2000. The past year was a year of profound change for the project. Since the 2000 conference we have seen the departure of four graduate students and their advisor. In March, Dr. James Baird accepted a job with the USGA Green Section. He left MSU in May to begin his duties with the USGA's Turfgrass Advisory Service in the eastern U.S. The Michigan turfgrass industry will miss Dr. Baird's enthusiasm and philosophy of excellence. We wish Jim all the best in his new career. Beau McSparin and Geoff Rinehart completed their respective site-specific management projects in the fall of 1999. After successfully defending last winter Beau moved on to take a job in industry and Geoff accepted a position as research technician for Dr. Eric Miltner (MSU, 1994) at Washington State University. Ryan Goss came to MSU from Ohio State University. Ryan's project looked at the effects of nitrogen fertilization and Primo applications on the performance of shaded creeping bentgrass putting greens. Ryan has changed his loyalties from scarlet to green to red, as in Big Red. He is now pursuing a Ph.D. at the University of Nebraska. Ryan's advisor at Nebraska is Dr. Roch Gaussoin (MSU, 1989). Susan Redwine continued her research through the winter and defended her thesis in June. Susan moved on, but not very far. She is now working as a technician for Dr. Clayton Rugh in the Department of Crop and Soil Sciences at MSU. Collectively, their departure was one of the most dramatic changes in 2000. These students were not only responsible for their own research projects, but carried additional responsibilities for specific non-thesis research. Fortunately, we had a very experienced summer crew this year and they were definitely up to the challenge. Stephanie Dysinger, Daniel Lamb and Aaron Hathaway spent many long days at the turf center in 2000. Their exemplary efforts have made this report possible.

Natural Shade Green: In 1998, a 25,000 ft^2 putting green was developed. Twenty maple trees (8-inch caliper) were transplanted onto the site to serve as the boundaries for six research greens. These plots were designed to examine the effect of shade [time of day] on putting surfaces. Four creeping bentgrass cultivars (G-2, Penncross, A-4, L-93) have been maintained at greens height (0.135") under the reduced light conditions (RLC). The irrigation system for the green was completed in 2000 and the surrounding turf areas were established. The preliminary data indicate that G-2 has a greater tolerance of RLC under the non-trafficked conditions of this study. Unfortunately three of the transplanted trees have failed and need to be replaced. Future studies to identify superior management techniques for moss control are now in the planning stages.

Weed Garden: In 1998 a weed garden was established at the south end of the turf center property. This display has been very useful for learning the identification of broadleaf and grassy weeds of turf. Proper identification is the first step to control. Although very labor intensive, the garden has been very useful during training sessions with extension agents, and visits from lawncare operators (LCO's). The garden is a major component of the Weed ID workshop held on the afternoon of field day and has served as a ready source of plant material for the Turfgrass Pest Management class and Turfgrass Short Course, which are taught each fall.

Best Management Practices for Weed Control: Common recommendations to LCO's and homeowners include mowing high and providing adequate fertility. Without proper management weed control will be at best, temporary. This study is examining mowing height, fertility, and postemergence herbicide treatment. Plots were maintained at two or four inches, and received either no fertility or 3 lb of nitrogen per 1000 ft^2 per year. In October of 1998 postemergence broadleaf herbicides were applied to half of the plots. Broadleaf weed populations have been monitored since the beginning of the experiment. The re-infestation of white clover and dandelion has been slowest in the fertilized plots and those treated with Confront. Unfertilized plots maintained at four inches have proven to be an excellent environment for clover. The taller height of cut in conjunction with the 'holiday' fertility program has not eliminated existing weeds. However, these management practices have proven to create a more competitive turfgrass stand that better resists re-infestation after a postemergence broadleaf herbicide application.

Bentgrass Cultivars for Northern Michigan: The NTEP system is a valuable tool to help determine which cultivars will perform well in our region. The NTEP green at the HTRC is always a popular stop for turfgrass superintendents. Courses in northern Michigan experience a much different growing season than that of E. Lansing. In the fall of 1999, six [6] of the top performing cultivars in the E. Lansing trial were seeding at Crystal Downs C.C. in Frankfort, MI. These plots are now being maintained at greens height. With the help of the Crystal Downs staff, turfgrass performance characteristics will be evaluated in 2001-02. Data to be collected includes: turfgrass quality, spring green-up, and disease resistance.

Preemergence Crabgrass: The general preemergence trial was initiated on April 17, 2000. The plots were again located at the Evergreen Cemetery in Lansing, MI. A warm spring and frequent rains throughout the growing season contributed to moderately heavy crabgrass pressure in 2000. The high levels of crabgrass present in the control plots illustrate this. Standard and experimental products were included in this trial. See Table 1 for a complete list of treatments. Percent crabgrass cover was determined at 56, 82, 111, and 129 days after treatment (DAT). All treatments demonstrated excellent control through 111 DAT with the exception of the fertilizer blank, AND 445 at the 2.5 lb/M rate, and Weedz Stop treatments. A rain-free period of two weeks at the end of July followed by significant rains in August led to an explosion of crabgrass late in the summer. Most treatments were showing a significant loss of control by the 129 DAT rating.

Table 1. 2000 Preemergence Crabgrass Trial.

Treatment	Rate	Percent Crabgrass Cover			
		Jun-09-00 56 DAT	Jul-05-00 82 DAT	Aug-03-00 111 DAT	Aug-21-00 129 DAT
Untreated		14 ab[1]	50 abc	72 ab	92 a
Untreated		19 a	74 a	67 abc	78 a
Blank 39-0-0	4 lb/M	5 b	25 cd	43 cd	74 a
Barricade	0.5 lb ai/A	2 c	1 d	0 e	2 b
Pendulum (Low Odor)	2 lb ai/A	1 c	0 d	0 e	6 b
Pendulum EC	2 lb ai/A	0 c	0 d	0 e	7 b
Pendulum 2 G	2.0 lb ai/A	3 c	3 d	2 e	11 b
Pendulum 60 WG	2.0 lb ai/A	0 c	2 d	4 e	11 b
Flumioxazin	0.34 lb ai/A	1 c	2 d	2 e	14 b
AND 445 (Dimension)	2.5 lb/M	3 c	14 d	22 de	21 b
AND 445 (Dimension)	3.5 lb/M	0 c	0 d	3 e	22 b
AND 442 (Dimension)	5.76 lb/M	1 c	2 d	1 e	25 b
Weedz Stop	200 lb/A	10 abc	54 ab	80 a	83 a

[1]Treatments followed by the same letter are not statistically different at the P=0.05 level using Student Newman-Keuls. Comparisons should not be made between columns.

Treatments were applied on April 17, 2000 using a shaker bottle or pressurized spraying system calibrated at 44.6 gal/A. TeeJet 8002VS

Late Preemergence: Preemergence applications are only effective when the herbicide has been applied prior to the germination of the target weed. Soil temperature is the most accurate predictor of crabgrass germination. Calendar-timed preemergence applications for crabgrass can be unreliable. However, for most years in Michigan, treatments made before April 15th have demonstrated a reasonable success rate. Moderate temperatures in the spring of 2000 extended the window for application in some areas. A trial was initiated on May 7, 2000 to compare the performance of late-timed preemergence applications. Treatments included Barricade (prodiamine), Dimension (dithiopyr), Flumioxazin, and Pendulum (pendimethalin). All treatments performed very well through July (Table 2). By 108 DAT, the granular Dimension treatments were no longer providing an acceptable level of control.

Table 2. Late-Timed Preemergence Crabgrass Trial.

Treatment	Rate	Percent Crabgrass Cover		
		Jun-21-00 47 DAT	Jul-17-00 73 DAT	Aug-21-00 108 DAT
Untreated		18 a[1]	37 a	32 a
Pendulum (Low Odor) 3.0 EC	2 lb ai/A	2 bc	0 b	2 b
Pendulum 3.3 EC	2 lb ai/A	2 bc	4 b	5 b
Barricade 65 WG	0.5 lb ai/A	1 c	2 b	4 b
Pendulum 2 G	2 lb ai/A	7 bc	13 b	6 b
Flumioxazin 0.17 G	0.34 lb ai/A	2 bc	5 b	5 b
Dimension 1 EC	0.18 lb ai/A	2 bc	6 b	7 b
AND 442	5.76 lb/M	9 b	4 b	18 ab
AND 445	2.5 lb/M	8 bc	12 b	19 ab
AND 445	3.5 lb/M	7 bc	11 b	21 ab

[1]Treatments followed by the same letter are not statistically different at the P=0.05 level using Student Newman-Keuls. Comparisons should not be made between columns.

Treatments were applied on May 05, 2000 using a shaker bottle or pressurized spraying system calibrated at 62.3 gal/A. TeeJet 8002VS

Postemergence Crabgrass: An early postemergence crabgrass trial was conducted which included granular consumer products containing dithiopyr and traditional liquid treatments. Pendulum was also included in order to evaluate reports of very-early postemergence activity. Remarkably, the Pendulum treatment resulted in an 80 percent reduction in 1-3 leaf crabgrass. The Drive DF (quinclorac) had the greatest efficacy in this postemergence trial (Table 3). This treatment also yielded excellent postemergence control of dandelion. The granular consumer products did not provide acceptable postemergence control.

Table 3. Early Postemergence Crabgrass Control (1-3 leaf stage).

Treatment	Rate	Crabgrass 18 DAT	Crabgrass 33 DAT	Dandelion 33 DAT
	lb ai/A	*percent control* [1]		
Untreated		0 d[2]	0 f	0 c
Drive DF	0.75	75.9 a	99.1 a	98.5 a
Pendulum (Low Odor)	1.5	40.5 b	79.7 ab	30.5 b
Dimension EC	0.25	26.6 bc	64.1 bc	2.27 bc
Weed B Gon Crab.Con.	1.5	21.1 bcd	57.34 c	15.3 bc
Pursell Vigoro	0.25	14.2 cd	48.3 cd	0 c
Scott's Halts	1.5	20.6 bcd	33.5 de	15.2 bc
Pursell Sta-Green	0.25	9.8 cd	23.1 e	0 c

[1]Percent control determined by pre-count, post-count using Henderson-Tilton.

[2]Treatments followed by the same letter are not statistically different at the P=0.05 level using Student-Newman-Keuls. Comparisons should not be made between columns.

Treatments were applied on June 3, 2000 using a shaker bottle or pressurized spraying system calibrated at 44.6 gal/A. TeeJet 8002VS

TuPH Weed Protocols: The TuPH weed program started in 1997. Through surveys and extension calls a handful of difficult to control weeds in Michigan has been identified. Fall applications of postemergence herbicides generally yield adequate to excellent control of many of these weeds. However, acceptable control in late spring or summer can be more elusive. Studies conducted over the last four summers have helped to develop or confirm recommendations for ground ivy, wild violet, white clover, sedum and several speedwell species. Products containing triclopyr (Table 4) continue to be the first alternative when 2,4-D or conventional three-way products (2,4-D, MCPP, dicamba) fail to provide acceptable results. The evaluation of tankmixes including postemergence broadleaf products with Drive (quinclorac) continued in 2000. Research with these combinations has shown significant increases in broadleaf herbicide activity. This activity was subtler in summer 2000 than in previous years as moderate summer temperatures and adequate rainfall led to better postemergence weed control from all treatments. Targeted weeds for 2000 included ground ivy and wild violet. These studies included tankmixes with Drive (Tables 5 and 6). A third study examined the use an adjuvant to increase activity on a difficult-to-control bedding plant. Sedum, a perennial ground cover, is commonly planted around headstones and in landscape beds. Sedum has a very thick cuticle (waxy covering) that enables it to thrive during times of extended drought. This ability to survive in harsh conditions allows it to spread into surrounding turf areas. Landscape and cemetery managers often have great difficulty controlling sedum. In this study an organosilicone adjuvant was included with the broadleaf herbicides to encourage spreading and penetration through the cuticle. The results seem to indicate that poor control of sedum might be a function of lack of entry into the plant (Table 7).

Table 4. Postemergence Broadleaf Products Containing Triclopyr.

Product	triclopyr ai/gal	Approximate ai/A
Turflon, Garlon	62%	0.62 lb
Chaser, Chaser 2, Turflon II	34%	0.5-0.6 lb
Cool power, Eliminate, Horsepower	5%	0.15 lb
Confront	33%	0.56 lb
Momentum	3%	0.09
Battleship	4%	0.14 lb

Table 5. Postemergence Control of Ground Ivy (*Glechoma hederacea*).

Treatment	Rate	Percent Control[1] 56 DAT	
Drive Tankmix	**1.0 lb/A**	**-**	**+**
Untreated		0 f[2]	49 de
Trimec Classic	4 pt/A	70 bcd	71 bcd
Turflon	3 pt/A	96 a	93 ab
Eliminate	4 pt/A	63 cd	87 abc
Momentum	2 pt/A	97 a	92 ab
Formula 40	4 pt/A	32 e	90 a

[1]Percent control determined by pre-count, post-count using Henderson-Tilton.

[2]Treatments followed by the same letter are not statistically different at the P=0.05 level using Student Newman-Keuls. Comparisons may be made between columns.

Treatments were applied on June 17, 2000 using a CO_2 pressurized spraying system calibrated to deliver 62.3 gal/A. TeeJet 8002VS

Table 6. Postemergence Control of Wild Violet (*Viola spp.*).

Treatment	Rate	Percent Control[1] 56 DAT	
Drive Tankmix	**1.0 lb/A**	**-**	**+**
Untreated		0 g[2]	0 g
Trimec Classic	4 pt/A	44 ef	47 ef
Turflon	2 pt/A	71 bcd	99 a
Eliminate	3 pt/A	27 f	91 ab
Momentum	4 pt/A	62 cde	87 abc
Millennium Ultra	3 pt/A	70 bcd	90 ab

[1]Percent control determined by pre-count, post-count using Henderson-Tilton.

[2]Treatments followed by the same letter are not statistically different at the P=0.05 level using Student Newman-Keuls. Comparisons may be made between columns.

Treatments were applied on June 21, 2000 using a CO_2 pressurized spraying system calibrated to deliver 32.6 gal/A. TeeJet 8002VS

Table 7. Selective Postemergence Control of Sedum Ground Cover.

Treatment	Rate	Percent Control[1] 21 DAT	
Sylgard 309	**0.35%**	**-**	**+**
Untreated		0 c[2]	45 b
Trimec Classic	4 pt/A	10 c	97 a
Turflon	2 pt/A	23 bc	100 a
Momentum	4 pt/A	12 c	96 a
Millennium Ultra	3 pt/A	18 bc	100 a

[1]Percent control determined by pre-count, post-count using Henderson-Tilton.

[2]Treatments followed by the same letter are not statistically different at the P=0.05 level using Student Newman-Keuls. Comparisons may be made between columns.

Treatments were applied on July 10, 2000 using a CO_2 pressurized spraying system calibrated to deliver 32.6 gal/A. TeeJet 8002VS

Herbicide Safety: Selective postemergence herbicides are designed to remove grassy or broadleaf weeds without damaging the desired turf. However, these products do not have the same level of safety on all species. Traditional control of white clover included making multiple applications of postemergence herbicides on 3-4 week intervals. Products like Confront (triclopyr + clopyralid) allow for a single application for control of clover and other legumes. This activity comes from the clopyralid component of Confront. Unfortunately, fairway height creeping bentgrass is particularly sensitive and can be injured by applications of triclopyr. Clopyralid has a large window of safety on creeping bentgrass but has been unavailable as a stand-alone product for turf. This has changed with the introduction of Lontrel. This product should provide the clover and thistle control of Confront without injury to bentgrass. A study was done to ascertain the amount of injury, if any, to creeping bentgrass from applications of broadleaf herbicides. Plots were rated for injury at 7, 14, 21, and 28 DAT. Results from this study are shown in Table 8 where; E=excellent, F=fair, and U=unacceptable. A similar study was done to evaluate postemergence crabgrass products on a creeping bentgrass fairway (Table 9).

Table 8. Tolerance of Bentgrass to Postemergence Herbicides.

Treatment	Rate	7 days	14 days	21 days	28 days
Untreated		E	E	E	E
Lontrel	½-1 pt/A	E	E	E	E
Drive	½ lb/A	E	E	E	E
Drive	1 lb/A	E	F	F	F
Mecomec 4	3¼ pt/A	F	F	E	E
Trimec Bent	3 pt/A	F	F	F	F
Trimec Bent	4 pt/A	F	U	F	F
Trimec Classic	3 pt/A	F	U	F	F
Mecomec 4	4 pt/A	U	U	F	E
Trimec Classic	4 pt/A	F	U	U	F
Confront	1-2 pt/A	U	U	U	F

Plots established on a creeping bentgrass 'Penncross' fairway maintained at 0.5".

Treatments were applied on June 17, 2000 using a CO_2 pressurized spraying system calibrated to deliver 62.3 gal/A. TeeJet 8002VS

Table 9. Tolerance of Bentgrass to Postemergence Crabgrass Herbicides.

Treatment	Rate	7 days	14 days	21 days	28 days
Untreated		E	E	E	E
Dimension	4 pt/A	E	E	E	E
Acclaim Extra	1.75 fl oz/A	E	F	E	E
Acclaim Extra	3.5 fl oz/A	E	E	E	E
Drive	0.375 lb/A	F	F	E	E
Drive	0.5 lb/A	F	F	E	E
Drive	1 lb/A	F	U	F	F
Acclaim Extra	7 fl oz/A	F	U	F	F

Plots established on a creeping bentgrass 'Penncross' fairway maintained at 0.5".

Treatments were applied on June 17, 2000 using a CO_2 pressurized spraying system calibrated to deliver 62.3 gal/A. TeeJet 8002VS

Plant Growth Regulators: The project continues to research lawncare, sports field, and golf course applications for PGRs. Several studies were done in 2000. These studies included making more frequent sub-label applications of currently available products for greens and fairway management and *Poa* control. Additional research focused on two experimental PGRs, which were screened for turf tolerance on Kentucky bluegrass, perennial ryegrass, and creeping bentgrass.

Primo Maxx in a Reduced Nitrogen Greens Management Program: Golf course superintendents have increased the frequency of nitrogen applications made to greens while reducing the annual amount of nitrogen applied. One of the goals of this change in management practices is to maintain faster green speeds by minimizing growth flushes that normally correspond to nitrogen applications. Possible ramifications of these reduced nitrogen rates:

- Reduced turfgrass vigor
- Increased dollar spot pressure
- Diminished recuperative potential
- Increased greens speed.

Many superintendents are additionally conditioning the turf with frequent sub-label applications of Primo Maxx (trinexapac-ethyl [TE]). The Primo program is not primarily being used for clipping reduction but for secondary benefits, which could include:

- Traffic tolerance
- Increased turf density
- Disease resistance
- Surface uniformity (ball roll)

Traditionally TE has been applied on a monthly basis as reflected by the label recommendation of 0.125 fl. Oz./ M. Controlled research of sub-label Primo treatments is limited or at least not well published. The objectives of this study were to determine the effects of reduced nitrogen and sub-label Primo Maxx applications to a creeping bentgrass green when applied as 0.1 lb N/M with TE @ 0.04 fl. Oz./M on 10-d intervals as compared to 1 lb N/M with TE @ 0.125 fl. Oz./M applied on 30-d intervals. TE applications did not improve green speed. However, these applications did increase quality and color ratings for the duration of the study. These differences were most evident between foliar applied 0.1 lb N/M treatment with and without TE. The quality ratings of the 0.1 lb N/M with TE @ 0.04 fl Oz./M on 10-d intervals was nearly equivalent to that of the 1 lb N/M on 30-d intervals. For additional information on this study please see Frank's Turfgrass Soils and Fertility Research Report 2000 in the proceedings.

Proxy vs. Primo for KBG Clipping Reduction: Proxy (ethephon) was introduced in 1999. It has been reported that Proxy reduces clipping production for up to 10 weeks after treatment. However, studies at MSU indicate that it may take as long as 14 days before the effects of a Proxy application can been seen. In this study PGR treatments were made after the third mowing in the spring on May 9. Clipping production was measured weekly for the entire season. The objectives of this research were to compare the degree and duration of Kentucky bluegrass clipping reduction for Primo and Proxy. For the five-week period immediately following application Primo Maxx and Proxy reduced clipping production by 38 and 31 percent, respectively (Table 10). Proxy did not reduce clippings as dramatically as Primo during the first month of the experiment. However, the clipping reduction period of Proxy lasted 8 weeks, which was 4 weeks longer than the Primo treatment.

Table 10. Clipping Reduction of KBG from PGRs.

Treatment	Rate	1 WAT	2 WAT	3 WAT	4 WAT	5 WAT
	Fl Oz/M	*weekly reduction / cumulative reduction*				
Primo Maxx	0.6	27 / 27	59 / 41	58 / 49	26 / 44	9 / 38
Proxy	5.0	16 / 16	16 / 26	52 / 35	25 / 32	28 / 31

Treatments were applied on May 9, 2000 using a pressurized spraying system calibrated to deliver 44.6 gal/A. TeeJet 8002VS

Conclusions and Future Directions

It is impossible to include results from every study. Only a portion of the research conducted in 2000 has been presented here. It is difficult to make conclusions from only one or two seasons. It is important to remember that many of these studies are preliminary and that future research will help to form our recommendations for herbicide and plant growth regulator use in turf. I appreciate the opportunity I was given to serve the Michigan turfgrass industry in 2000 and look forward to another exciting year of killing weeds in 2001.