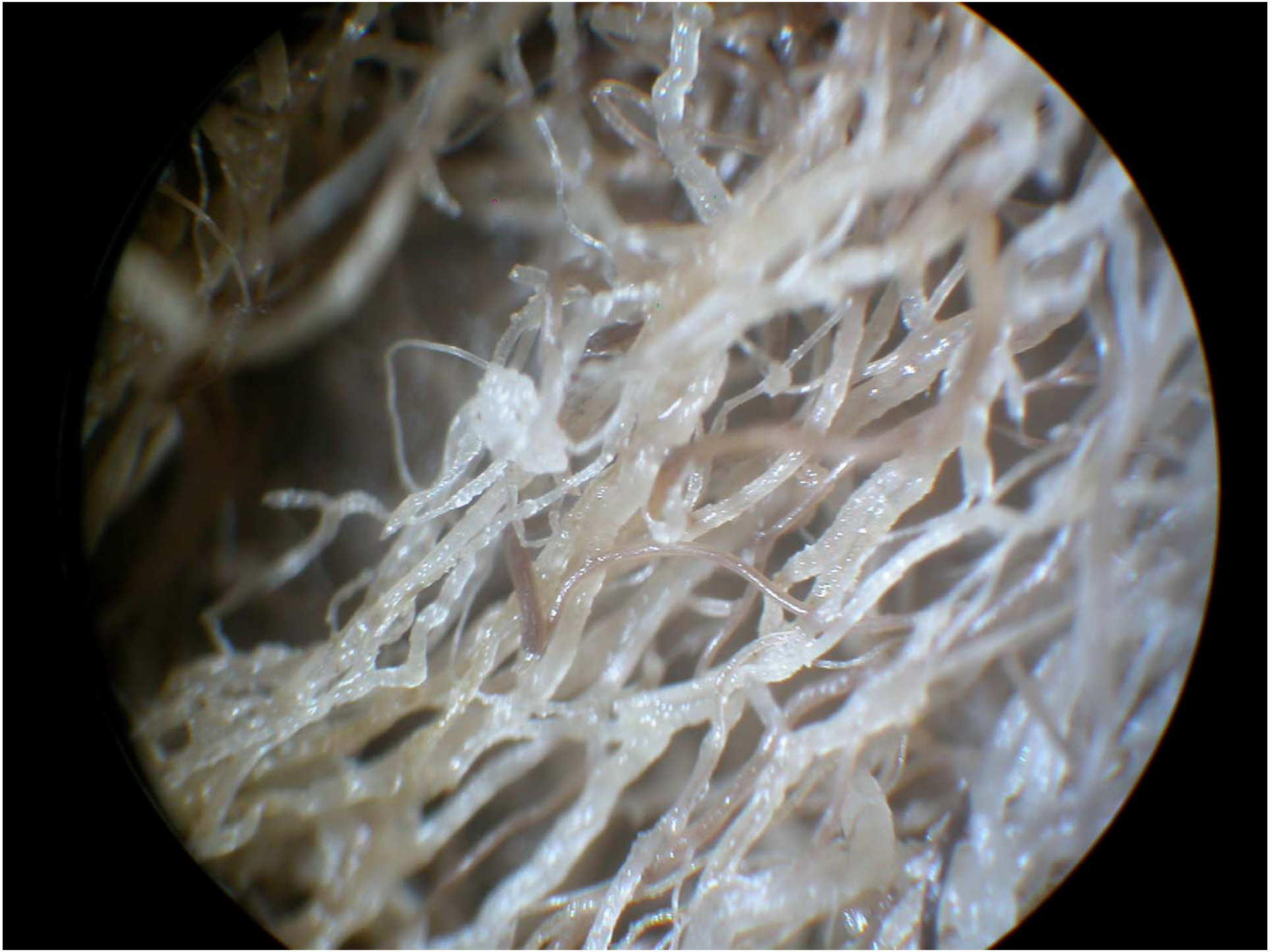
TYPICAL SITES/CONDITIONS FOR TAKE-ALL

- **SITES – *Agrostis spp. Only***
  - New Golf Courses/Virgin Woodland
  - Methyl Bromide & Other Fumigants/Renovation
  - Rebuilt Greens , Tees/Sand Rootzones
  - Imported In Sod
  - Disease May Be More Severe in Wet, Shady, and Thatchy Areas
- **CHRONOLOGY**
  - First Year Following Seeding—Few If Any Patches
  - Second-Third Year—Severe/Esp. Summer
  - Third-Sixth Year—Decline Often Begins*

*Decline dependant greatly on soil and irrigation water pH.

TAKE-ALL PATCH SYMPTOMS

- Circular Patches 3.0 in. (8 cm) to 3.0 ft. (1 m) In Diam. Appearing In Spring or Summer
- Occasionally Frog-Eyes, Small Crescents, and Diffuse Areas
- Affected Plants Initially Reddish Brown (Bronzed), Wilt Quickly and Fade to a Bleached Tan
  - Yellow Patches May Develop During The Decline Phase



Managing Take-all Patch in Creeping Bentgrass

Many cases of take-all patch in bentgrass greens have been observed throughout the United States. The pathogen has likely been here for quite some time, but unusual weather conditions this year may have caused the symptoms to become noticeable.

Symptoms

Take-all patch symptoms began to appear this year around late June/early July. The symptoms are circular areas, from 6 inches to 3 feet in diameter, which are yellow to orange in color (Figures 1 and 2). The plants within the patches are stunted, and close examination reveals that the leaves are dying from the tip to the base, starting with the older leaves and progressing to the youngest leaves. During the day, the patches may become severely wilted. The symptoms may appear worse after a heavy rainfall, most likely because the surrounding turf improves in quality, making the symptoms more noticeable.

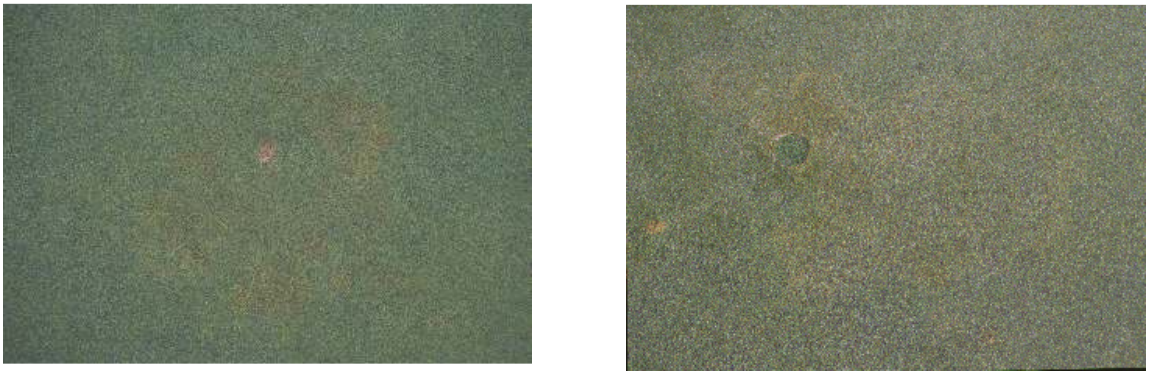


Figure 1. Take-all patch in Penn A-4 (left) and Penn A-1 (right) creeping bentgrass.

The only way to positively diagnose take-all patch is to look at the roots under a microscope. If you suspect that you have take-all patch, submit a sample to your local University.

Disease Development Take-all patch is a root disease, caused by the fungus *Gaeumannomyces graminis*. The take-all fungus kills bentgrass roots in the fall, winter, and spring, when soil temperatures are between 40ºF and 60ºF in the upper 1" to 2" of the soil profile. The symptoms of take-all patch do not appear until late spring or early summer, when heat or drought stress cause the infected plants to decline in quality or die.

Take-all patch is most severe in newly constructed greens, or old greens that were recently fumigated. Most of the cases we have seen are in USGA-spec greens built within the last 5 years. However, those of you with older greens are not immune. Take-all patch severity will decrease as greens mature, but it may not go away completely.

Manganese (Mn) plays an important role in take-all patch development. This pathogen binds up Mn surrounding the root, which weakens the root and allows the fungus to infect and cause disease. Optimal to high levels of Mn in the soil can reduce take-all development, because the pathogen is less capable of starving the roots of this essential element. Take-all patch is most severe in greens with a pH above 6.5, probably due to reduced Mn availability at these high soil pHs.

Any factor that inhibits root growth increases problems with take-all patch. Turf with a deep, dense root system is able to withstand a greater amount of damage from the take-all fungus. Soils that are compacted, excessively wet, or excessively dry will impede root growth and increase take-all severity. Inadequate or imbalanced soil fertility also reduces root growth and increase take-all patch problems.

Take-all Patch Management

Soil pH. To minimize take-all development, maintain soil pH between 5.5 and 6.0. These values are well within the range for optimal bentgrass growth. Soil pH should be reduced gradually. Avoid applications of sulfur, which will cause a rapid drop in soil pH. Ammonium forms of nitrogen, such as ammonium thiosulfate, will induce a gradual reduction in soil pH.

Manganese. Reducing soil pH will increase the availability of manganese, but additional Mn applications have been shown to further reduce take-all development. Manganese should be applied every 4 weeks when soil temperatures are between 40ºF and 60ºF. This is when the take-all patch fungus is actively killing roots and the most benefit will be obtained from the Mn applications. **Apply at least a total of 2 lbs Mn per acre per growing season.**

The following program gradually decreases soil pH due to the Ammonium Thio-sulfate, while the Techmangam 32% efficiently supplies manganese to the plant. The FloThru moves the products evenly and effectively into the soil profile. Apply every three weeks. Irrigate immediately and thoroughly after application

Rate per Acre (Plant Food Program)	
3.67 oz/M or 10 lbs/A	**Techmangam 32% (Monohydrated Manganese Sulfate Soluble)**
3 oz/M or 1 gal/A	**Green-T Manganese 5% Liquid**
12 oz/M or 4 gal/A	**Ammonium Thio-Sulfate 12-0-0, 26% Sulfur (Acidifier)**
3 oz/M or 1 gal/A	**FlowThru Penetrant**

Grow Good Roots. Reduce soil compaction with a regular aerification program. Top dress with sand after aerification to improve soil drainage and aeration. Encourage root growth with deep and infrequent irrigation, especially in the fall and spring when bentgrass roots are actively growing. Use granular fertilizers in the fall and spring to provide adequate levels of nitrogen, phosphorous, and potassium such as Plant Food 12-3-12 organic fertilizer. Additional nutrients should be applied as needed based on regular soil test results.

Preventative Control with Fungicides. Fungicides are most effective for take-all patch control when applied on a preventative basis. Complete control can be obtained when the applications are timed properly. Since the take-all fungus kills roots when soil temperatures are between 40ºF and 60ºF, this is when the fungicide protection is needed. Fall applications, when the disease is just beginning to develop, are most important. Initiate applications in the fall when soil temperatures drop to 60ºF, and repeat on 28 day intervals until soil temperatures drop below 40ºF. Resume applications in the spring when soil temperatures reach 40ºF, and continue until soil temperatures exceed 60ºF.

Heritage, Rubigan, Bayleton, and Banner are most effective for preventative control of take-all patch. For best results, these products should be applied at the high label rates. Since take-all patch is a root disease, the fungicide must be moved into the root and crown area in order to protect the turf. Either apply the fungicide in a high volume of water (5 gallons per 1000 ft^2) or water it in with 0.25" of water immediately after application.

Curative Management. Once take-all patch symptoms are observed, very little can be done to alleviate the symptoms. The areas showing symptoms must be watered lightly and frequently because their root system is deteriorated. Maintain your regular schedule for overhead irrigation, and water the areas with take-all patch more frequently by hand. Be sure to leave time for the soil to dry in between hand watering; saturating the soil for extended periods of time will cause more root loss and make matters worse. Light syringing during the day to reduce heat stress may also help alleviate take-all patch symptoms. The turf should also be spoon-fed with foliar fertilizer (1/8 to 1/10 lb N every 2 weeks) during the summer to provide adequate nutrients.

Curative Control of Take-all Patch in an *Agrostis stolonifera* fairway, 2006

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Material and Methods: This study was conducted on the seventh fairway at Bellewood Golf Club located in North Coventry, Pennsylvania. This site is annually damaged by take-all patch (*Gaeumannomyces graminis var. avenae*) and should be considered thatchy and wet. The fairways were originally seeded to PennTrio creeping bentgrass in 1998, however, low-to-moderate amounts of roughstalk bluegrass (*Poa trivialis*) and annual bluegrass (*Poa annua*) have invaded these areas. Soil at the site had a pH of 6.3 with 5.4% organic matter. The plots were mowed three times per week at 0.525 inches. Generally, 2 lbs N per 1000ft^2 is supplied to the fairways annually and 1 lb N was supplied from 5-4-5 Earth Works Replenish this spring. One pound of K from 0-0-50 was applied in April 2006. The fairways had been treated with Trinexapac-ethyl (Primo MAXX) + Paclobutrazol (Trimmit 2SC) on 20 April. Paclobutrazol (Trimmit 2 SC, 12 oz product/A) was re-applied with Boscalid (Emerald) on 25 May 2006.

Gaeumannomyces graminis var. avenae had been macroscopically identified on the roots of infected *Agrostis* within the site two weeks before initiation of study. The site had an average of 15-20% blighted turf. All treatments were applied on 14 and 29 June, and 13 July 2006. Treatments were applied in 4 gallons of water per 1000ft^2 using an 8010 EVS flat fan nozzle. Plots were 5 ft x 5 ft and arranged in a randomized complete block design with three replications. Due to the difficulty of working with this disease, two untreated control plots per replications were included and since different levels of disease was observed within them, averages of all untreated plots was not used. They were analyzed as separate treatments.

Percent of plot area blighted by take-all patch was rated on linear 0 to 100 scale with 0= no disease and 100= entire plot area blighted with take-all patch. Turf quality was rated on a 0 to 10 scale with 7.5 being the minimal acceptable level for a creeping bentgrass

fairway and 10.0= optimal density and quality. Color was rated on a 0 to 10 scale with 7.5 being the minimal acceptable level for a creeping bentgrass fairway and 10.0= optimal greenness.

Results: On 21 and 28 June, no differences were observed in the percent of plot area blighted by take-all patch (TAP; Table 1). The disease activity, however, seem to be slowing and the reddish-orange color that had originally dominated affected plants was not as prevalent. All plots were re-treated on 29 June. By 12 July, differences among treatments were observed. Plots treated with Heritage TL at 2.0 fl oz (2.3 % TAP), Headway + Plant Food Mn + Plant Food Flow thru wetting agent (0.3 % TAP), Lynx Green (2.3 %TAP) and the Plant Food Program (supplied 0.09 lb N and 0.06 lb Mn per application), had less TAP, when compared to both of the untreated controls (7.6 and 13.3 %TAP). By 19 July, take-all patch seemed to slow in even the untreated plots, however, reduced levels were generally observed in all treated plots. At that point, plots that were TAP-free included; Heritage TL, Headway + Plant Food Mn + Plant Food Flow thru wetting agent, Lynx Green, Tartan, and SP102000014874 exp. It is important to note, however, that when the study was again rated on 2 August, no take-all patch was visible within any of the study area.

Overall turfgrass quality was rated a total of three times. On 22 June, no differences were observed in the treated-plots and the untreated control (Table 2.) However, by 28 June, all treated plots generally provided a higher level of quality when compared to both untreated controls. Again on 12 July, no significant differences were observed in the level of turfgrass quality in the trial.

Bentgrass color also was rated three times over the course of the study, on 22 June, all treated plots, increased color when compared to one of the untreated controls. The highest color level was observed in plots treated with Lynx and the Plant Food Program. The plant food program would be expected to increase overall color due the nutrients it supplied. On 13 July, all treatments increased color, when compared to the untreated control, except for Insignia and SP102000014874 exp. The highest level of color was observed in plots treated with Headway + Plant Food Mn + Plant Food Flow thru wetting agent, Lynx and Tartan. On 13 August, the color differences were still apparent and all fungicide treated plots (8.0-8.3) exhibited better color, when compared to the untreated controls (7.6 and 7.7).

Conclusions: Throughout the mid-Atlantic, many newer courses battled take-all patch during the 2006 season. Little information is available on the use of fungicides and micronutrients on take-all patch when it is visually damaging turfgrass. The purpose of the study was to examine various fungicides and micronutrient sources applied alone and tank-mixed for their level of curative take-all patch control. Although, it is recommended that many of these materials are applied preventatively, it is extremely difficult for golf course superintendents to do this financially, especially to 22 to 30 acres of fairway turf. Furthermore, few fungicide labels provide information about rates to use curatively as compared to preventatively for take-all patch. Also, it is difficult to forecast the possibilities of take-all patch causing problems, especially on a course that is more than five years old, since this disease typically damages younger stands. Therefore, these results begin to provide some information regarding the best management of this disease, curatively. Also, on golf courses were take-all patch becomes problematic in isolated areas, spot-treating with one of these treatments may be practical.

Other researchers (Heckman, Clarke and Murphy, 2003) have shown that Manganese (Mn) fertilization in the autumn and spring reduces take-all patch severity in bentgrass. Little information, however, is available on the impact of tank-mixing foliar Mn sources with fungicides for curative take-all patch control. Although only Headway was mixed with Mn in this trial, that treatment provided the most agronomically significant knockdown of the disease and more research is warranted to determine if better control could be achieved with other fungicides for take all patch control when they are tank-mixed with Mn.

Reference: Heckman, J. R., B. B. Clarke, and J. A. Murphy. 2003. Optimizing manganese fertilization for the suppression of take-all patch disease on creeping bentgrass. Crop Sci. 43:1395-1398.

Acknowledgements: I wish to express thanks to Derek Hudson for allowing me to use the area for this trials, Bayer Environmental Science and Plant Food Company for grant-in-aid and product(s), and Syngenta Crop Protection for supplying product.

Table 1. Percent of plot area visually blighted by take-all patch as influenced by fungicide and/or fertilizer application in a creeping bentgrass fairway at Bellewood Golf Club, North Coventry PA.; 2006.

Treatment [x]	Rate (1000 ft^2 unless noted)	Percent of plot area blighted [y] 0-100			
		21 June	28 June	12 July	19 July
Heritage TL	2.0 fl oz	13.7 a [z]	8.3 a	2.3 d	0.0 c
Headway	3.0 fl oz	16.3 a	7.7 a	4.6 bcd	1.0 bc
Headway + Plant Food Mn + WA	3.0 + * same as below	16.7 a	5.3 a	0.3 d	0.0 c
Lynx Green	1.5 fl oz	19.0 a	8.0 a	2.3 d	0.0 c
Tartan	2.0 fl oz	21.0 a	11.3 a	3.3 cd	0.0 c
SP102000014874 exp	2.0 fl oz	16.7 a	10.0 a	3.6 bcd	0.0 c
Insignia	0.9 oz	16.7 a	6.0 a	8.6 ab	2.0 bc
Plant Food Program		10.4 a	5.0 a	1.7 d	1.0 bc
Techmangum	10 lbs/A				
0-0-0-5 (Mn)*	3.0 fl oz				
12-0-0-26	12 fl oz				
Flow thru wetting agent (WA)*	3.0 fl oz				
Untreated Control	-	17.3 a	10.7 a	7.6 bc	3.3 b
Untreated Control	-	22.3 a	10.7 a	13.3 a	8.0 a
P<F		0.7819	0.7879	0.0013	0.0007

[x] All treatments were applied on 14 and 29 June, and 13 July 2006. Treatments were applied in 4 gallons of water per 1000ft^2 using an 8010 EVS flat fan nozzle.

[y] Percent of plot area blighted was rated on a 0 to 100 scale with 0= no disease and 100= entire plot area blighted with take-all patch.

[z] Means in each column followed by different letters are significantly different ($P \leq 0.05$) according to the Fischer's Protected least significant difference test.

Table 2. Overall turfgrass quality as influenced by fungicide and/or fertilizer applications in a creeping bentgrass fairway at Bellewood Golf Club, North Coventry PA.; 2006.

Treatment [x]	Rate (1000 ft^2 unless noted)	Turf Quality [y]		
		----------0-10----------		
		22 June	28 June	12 July
Heritage TL	2.0 fl oz	8.1 a [z]	8.7 ab	8.4 a
Headway	3.0 fl oz	7.3 a	8.9 a	8.3 a
Headway + Plant Food Mn + WA	3.0 + * same as below	7.7 a	8.5 a	8.7 a
Lynx Green	1.5 fl oz	8.0 a	8.5 ab	8.2 a
Tartan	2.0 fl oz	7.9 a	8.2 ab	7.8 a
SP102000014874	2.0 fl oz	7.7 a	8.2 ab	7.7 a
Insignia	0.9 oz	8.2 a	8.5 ab	7.6 a
Plant Food Program		8.1 a	8.5 ab	7.7 a
Techmangum	10 lbs/A			
0-0-0-5 (Mn)*	3.0 fl oz			
12-0-0-26	12 fl oz			
Flow thru wetting agent (WA)*	3.0 fl oz			
Untreated Control	-	7.3 a	7.2 c	7.7 a
Untreated Control	-	7.0 a	7.6 bc	7.0 a
P<F		0.08	0.0318	0.30

[x] All treatments were applied on 14 and 29 June, 2006.

[y] Turf quality was rated on a 0 to 10 scale with 7.5 being the minimal acceptable level for a creeping bentgrass fairway and 10.0= optimal density and quality.

[z] Means in each column followed by different letters are significantly different ($P \leq 0.05$) according to the Fischer's Protected least significant difference test.

Table 3. Turfgrass color as influenced by fungicide and/or fertilizer applications in a creeping bentgrass fairway at Bellewood Golf Club, North Coventry PA.; 2006.

Treatment [x]	Rate (1000 ft^2 unless noted)	Color [y]		
		----------0-10----------		
		22 June	13 July	13 August
Heritage TL	2.0 fl oz	8.1 ab [z]	8.0 ab	8.0 a
Headway	3.0 fl oz	7.8 abc	7.8 abc	8.0 a
Headway + Plant Food Mn + WA	3.0 + * same as below	7.7 abc	8.5 a	8.1 ab
Lynx	1.5 fl oz	8.3 a	8.3 a	8.0 a
Tartan	2.0 fl oz	8.3 ab	8.2 a	8.0 a
SP102000014874	2.0 fl oz	7.3 bc	7.3 bcd	8.0 b
Insignia	0.9 oz	7.8 abc	7.7 abc	8.0 b
Plant Food Program		8.4 a	8.1 ab	8.3 a
Techmangum	10 lbs/A			
0-0-0-5 (Mn)*	3.0 fl oz			
12-0-0-26	12 fl oz			
Flow thru wetting agent (WA)*	3.0 fl oz			
9. Untreated Control	-	7.6 abc	6.7 d	7.7 c
10. Untreated Control	-	7.1 c	7.1cd	7.6 c
P<F		0.0001	0.0001	0.0001

[x] All treatments were applied on 14 and 29 June, 2006.

[y] Color was rated on a 0 to 10 scale with 7.5 being the minimal acceptable level for a creeping bentgrass fairway and 10.0= optimal greenness.

[z] Means in each column followed by different letters are significantly different ($P \leq 0.05$) according to the Fischer's Protected least significant difference test.

Plant Food Company's

Take All Patch Reduction Program

Apply Fall & Spring

Techmangam 32% MN	**3.67 oz / M**	**or**	**10 lbs/A**
5% Manganese Liquid	**3 oz / M**	**or**	**1 gal/A**
Ammonium Thiosulfate	**12 oz / M**	**or**	**4 gal/A**
FloThru Penetrant	**3 oz / M**	**or**	**1 gal/A**

- Irrigate IMMEDIATELY for 15 minutes after application
- Ammonium Thiosulfate acidifies soil. MUST BE IRRIGATED
- FloThru penetrant moves liquid solution into the soil
- These products are NOT Fungicides, but promotes healthier turf
- Fall and Spring Applications work best as a preventative program

Take All Patch Reduction Program
Irrigate Immediately After Application

Program Site: 3 Acres

Area in Sq. Ft: 130680

Nutrients per 1,000 sq. ft

				Primary Nutrients			Secondary Nutrients			Micronutrients				
Application Date	Product	Oz/1000'	Total Gallons or lbs Required	Nitrogen	Phosphate	Potassium	Calcium (Ca)	Magnesium (Mg)	Sulfur (S)	Boron (B)	Colbalt (Co)	Copper (Cu)	Iron (Fe)	Manganese (Mn)
				0.248					0.538					0.171
Spring	Techmangam 32% MN Water Soluble, 50 LB BAG	3.67	29.97											0.073
	Manganese 5% 2X2.5 GAL	3	3.06											0.012
	Ammoinum Thiosulfate 12-0-0 26% SULFUR 2X2.5 GAL	12	12.25	0.124					0.269					
	Flo Thru 2403 SOIL PENETRANT 2X2.5 GAL	3	3.06											
				0.124					0.269					0.086
Fall	Techmangam 32% MN Water Soluble, 50 LB BAG	3.67	29.97											0.073
	Manganese 5% 2X2.5 GAL	3	3.06											0.012
	Ammoinum Thiosulfate 12-0-0 26% SULFUR 2X2.5 GAL	12	12.25	0.124					0.269					
	Flo Thru 2403 SOIL PENETRANT 2X2.5 GAL	3	3.06											
				0.124					0.269					0.086

Product Summary	Gallons or lbs	Purchasing Qty/Case
Techmangam 32% MN Water Soluble, 50 LB BAG	60 lbs.	2
Manganese 5% 2X2.5 GAL	6 gallons	2
Ammoinum Thiosulfate 12-0-0 26% SULFUR 2X2.5 GAL	25 gallons	5
Flo Thru 2403 SOIL PENETRANT 2X2.5 GAL	6 gallons	2
Total Cases		9

Comments: **Irrigate immedately for approximately 5 -10 minutes to move into the soil and to knock the Ammonium Thiosulfate off of the turf leaves.**