Phosphonate products for disease control and putting green quality

How does potassium phosphite stack up against fosetyl-Al in controlling *Pythium* blight and anthracnose basal rot?

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EDITOR'S note:

In their previous article ("Sorting out the phosphonate products," *GCM*, November 2005, pp. 73-77), the authors reviewed phosphonate terminology, how phosphonate compounds control disease, and their role as fertilizers. In this article, they discuss the results of phosphonate fungicide research conducted on *Pythium* blight and anthracnose, as well as putting green quality.

Photos courtesy of P. Landschoot

Figure 1. A *Pythium* chamber (greenhouse frame covered with plastic) was used to produce conditions necessary for *Pythium* blight development (left). An automatic misting system was used to increase humidity levels (right).

Phosphonate products differ in active ingredient, formulation, trade name, label terminology, uses and price. Detailed studies on how these products perform with respect to disease control and improving turf quality should help you make sound choices on the most appropriate product(s) for your specific needs. The objectives of our research were to determine whether products made with potassium phosphite or fosetyl-Al provide similar control of *Pythium* blight and anthracnose basal rot when applied at equivalent rates of phosphorous acid, the active compound for controlling diseases. We also wanted to determine whether product formulation influences disease control. Our second objective was to evaluate the effects of active ingredient and formulation on putting green quality when applied at equivalent rates of phosphorous acid.

Treatments

Phosphonate fungicides are made up of salts or esters of phosphorous acid. Salts of phosphorous acid are referred to as phosphites, and phosphite products typically contain a mixture of phosphorous acid and potassium hydroxide (KOH). Phosphite fungicides (Alude, Magellan, Vital, Resyst and others) usually list potassium phosphite or mono- and di-potassium salts of phosphorous acid as the active ingredient on the product label. Esters of phosphorous acid are referred to as fosetyl-Al or aluminum tris (O-ethyl phosphonate), the active ingredient in Aliette and Chipco Signature fungicides.

All phosphonate fungicides, whether phosphites or fosetyl-Al, are broken down into phosphorous acid following plant uptake. Because phosphorous acid is the compound that controls disease, we compared products based on equivalent rates of phosphorous acid. We did this by determining the molecular weight of phosphorous

TREATMENT RATES

Treatment	Rate/1,000 square feet	Rate/hectare
Potassium phosphate	4.0 ounces	12.2 kilograms
Potassium phosphite standard	43.6 fluid ounces	138.8 liters
Alude	7.4 fluid ounces	23.6 liters
Aliette	5.7 fluid ounces	17.4 kilograms
Chipco Signature	5.7 fluid ounces	17.4 kilograms
Subdue Maxx	1.0 fluid ounce	3.2 liters

Table 1. Treatments and rates used in the *Pythium* blight, anthracnose and putting green-quality phosphonate fungicide studies.

acid in each product and adjusting the product rates accordingly. The rates of all of the phosphonate fungicide treatments fell within the range given for *Pythium* blight control on the fungicide labels and for anthracnose control on the Chipco Signature label (Table 1).

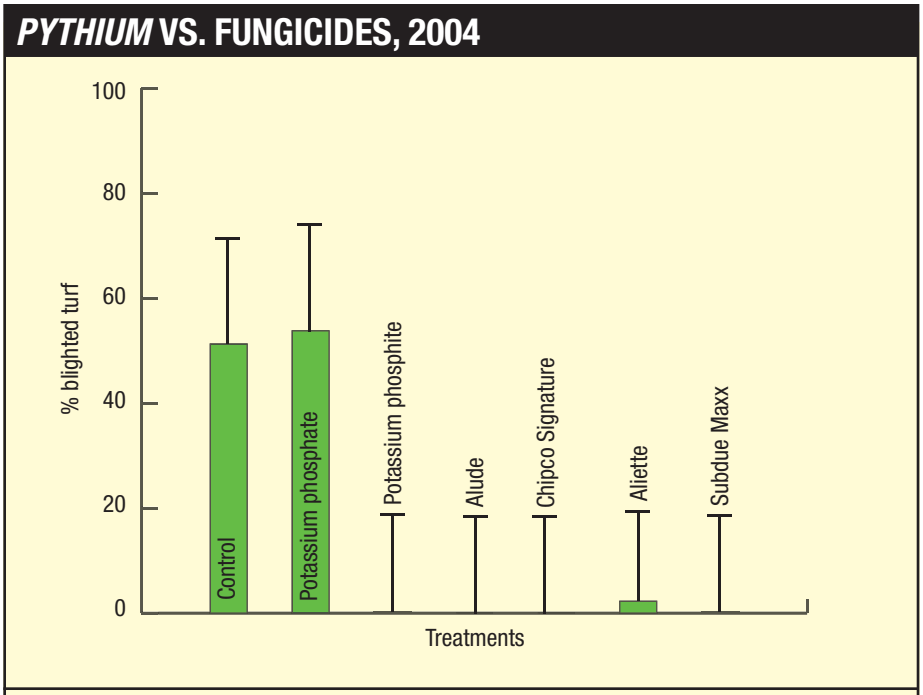

Figure 2. The effect of phosphonate fungicides on *Pythium* blight development of Penncross creeping bentgrass in 2004. Disease is expressed as the percentage of blighted turf. Bars above columns indicate the level of statistical significance.

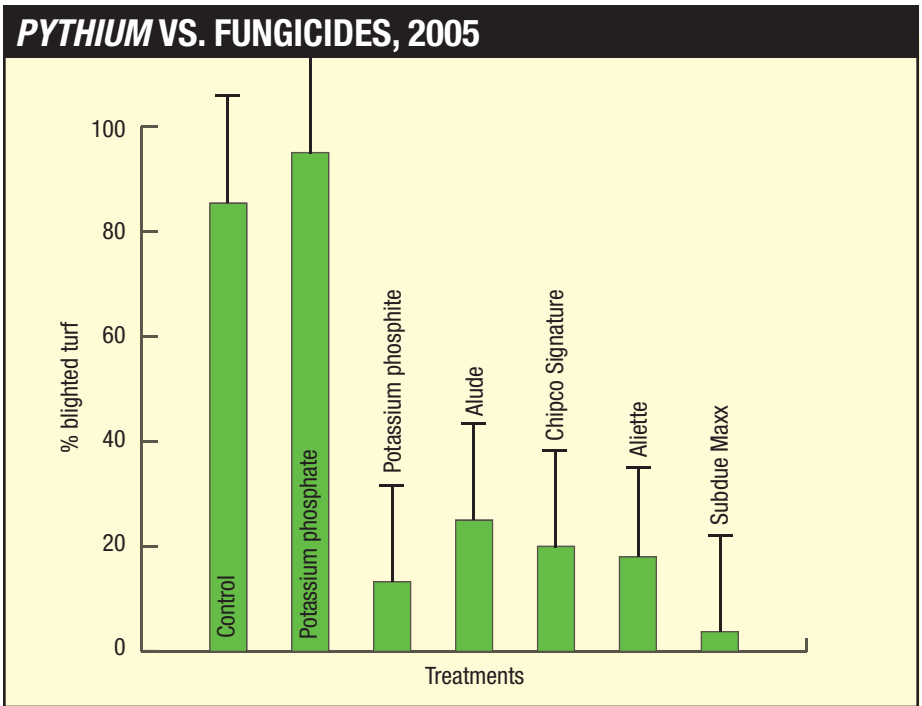

Figure 3. Effect of phosphonate fungicides on *Pythium* blight development of Penncross creeping bentgrass in 2005. Disease is expressed as the percentage of blighted turf. Bars above columns indicate the level of statistical significance.

Treatments

Treatments for *Pythium* blight, anthracnose and turf quality trials included a commercial phosphite product (Alude); two fosetyl-Al products (Aliette WDG and Chipco Signature); a potassium phosphite standard (made by mixing reagent-grade phosphorous acid with water and adjusting the solution to a pH of 6.2 with KOH); and reagent-grade potassium phosphate (made by mixing reagent-grade phosphoric acid with KOH to raise the solution to a pH of 6.2). The potassium phosphite standard was included as a treatment because we knew nothing was added to the mixture that would enhance the efficacy of the phosphite. Thus, we could evaluate the efficacy of the potassium phosphite without interference from formulation effects.

Potassium phosphate (essentially fertilizer phosphorus) was applied at about the same rate of phosphorus as the potassium phosphite treatment. This treatment was added to ensure that disease suppression was not due to a phosphorus nutrition effect.

Subdue Maxx was applied at the label-recommended rate for *Pythium* blight control (1.0 fluid ounce/1,000 square feet or 3.2 liters/hectare) for comparison with phosphonate. This rate of Subdue Maxx has provided excellent control of *Pythium* blight in our *Pythium* chambers during previous studies.

Pythium blight trials

In 2004 and 2005, we conducted field trials to determine whether the active ingredients and formulations of different phosphonate fungicides influence the degree of control of *Pythium* blight on creeping bentgrass (*Agrostis palustris*). We began the trials by seeding Penncross creeping bentgrass within a greenhouse frame one year before treatment application. The turf was mowed three times each week at a height of 1.0 inch (25.4 millimeters), and the area was fertilized and watered to maintain a dense turf. Just before treatment application, the greenhouse frame was covered with clear polyethylene plastic.

This trial was conducted in the plastic-covered greenhouse frame equipped with an automatic misting system (referred to as a *Pythium* chamber) to ensure warm, humid conditions necessary for *Pythium* blight development in central Pennsylvania (Figure 1). Treatments included the phosphonate fungicides and other treatments listed in Table 1.

Figure 4. Plots showing the effects of potassium phosphite standard or H_3PO_3 (left), Chipco Signature (center), and potassium phosphate or H_3PO_4 (right) on symptom development of *Pythium* blight of creeping bentgrass.

Treatments were applied once on Aug. 30, 2004, and again on July 18, 2005. Following treatment application, the open ends of the *Pythium* chamber were closed, and inoculum of *Pythium aphanidermatum* was applied to the test area. Temperature and humidity were controlled with vents that could be opened and closed and an automatic misting system. At the end of each trial, all plots were evaluated for the percentage of area exhibiting blighted turf.

Results

Results showed that *Pythium* blight disease was more severe in 2005 than in 2004, probably as a result of higher chamber temperatures in 2005 (Figures 2, 3). In 2004, phosphonate fungicides (including the potassium phosphite standard) provided good (>95%) control, whereas in 2005, the same treatments showed only 70% to 84% control. Despite seasonal differences in overall *Pythium* blight control, no statistically significant differences occurred among the phosphonate fungicides in either year of the study. This indicates that products with phosphites and fosetyl-Al as active ingredients provide similar *Pythium* blight control (Figure 4). Results also suggest that the formulation of individual products do not appear to have any advantage with respect to *Pythium* blight control.

The potassium phosphate treatment and the untreated control had no effect on disease, indicating that phosphorus nutrition was not responsible for *Pythium* blight control. Subdue Maxx provided significantly better control than all treatments on creeping bentgrass in 2005, but did not differ from the phosphonate fungicides in 2004.

Trials conducted in the *Pythium* chamber represent a severe test for fungicide performance, and are better for measuring relative differences among fungicides than for measuring the actual degree of control in the field.

Anthracnose and putting green quality trials

In 2004 and 2005, we conducted field trials on a putting green to determine whether active ingredient and formulation of different phosphonate fungicides influence control of anthracnose basal rot and putting green quality. The trials were conducted on an 8-year-old mixed stand of Providence creeping bentgrass and annual bluegrass (*Poa annua*) growing in an 80:20 root-zone mix and maintained as a putting green. A minimal amount of nitrogen was applied to the trial area to encourage development of anthracnose. Treatments (Table 2) were similar to those in the *Pythium* blight trial, except that there was no Subdue Maxx treatment. All treatments were applied every two weeks beginning on May 21 and ending Aug. 13 in 2004; and beginning May 4 and ending July 29, 2005, for a total of seven applications in each year. Anthracnose disease ratings were assessed visually using a 0 to 10 scale, with 10 indicating severe disease and 0 indicating no disease. Because very little disease was evident on the test area in 2004, only results from 2005 are discussed in this article. Putting green quality was rated every two weeks, just before treatment application, on a scale of 0 to 10, with 10 indicating excellent turf quality and 0 indicating very poor quality.

Results

Anthracnose symptoms developed rapidly on the test site during early July 2005, and the test was evaluated on July 5 after five treatment applications had been made. None of the phosphonate fungicides completely controlled anthracnose, but the Chipco Signature and potassium phosphite standard treatments had significantly less disease than the untreated control. Chipco Signature performed better than Aliette (both were applied at the same rate of fosetyl-Al), indicating that the formulation of Chipco Signature may be enhancing disease control. The potassium phosphite standard showed significantly less disease than the untreated control, indicating that this compound *may* have some benefit in suppressing anthracnose under certain conditions. With respect to anthracnose, none of the other treatments differed significantly from the untreated control. Although these results are interesting, we would like to point out that data from anthracnose trials often vary from region to region and from year to year. Nevertheless, we now have justification for conducting more extensive anthracnose trials with phosphonate fungicides.

The results for putting green quality were similar to the anthracnose results, with the Chipco Signature treatment providing slightly better quality than other treatments on most rating dates during 2004 and 2005 (Figure 5). The other phosphonate treatments usually provided better putting green quality than the potassium phosphate treatment and

ANTHRACNOSE VS. PHOSPHONATE

Treatment	Rate/1,000 square feet	Rate/hectare	Disease severity (0-10)† July 5, 2005
Control	—	—	5.5 ab‡
Potassium phosphate	4.0 ounces	12.2 kilograms	6.3 a
Alude	7.4 fluid ounces	23.6 liters	4.5 bc
Aliette	5.7 ounces	17.4 kilograms	4.5 bc
Potassium phosphite standard	43.6 fluid ounces	138.8 liters	3.5 cd
Chipco Signature	5.7 ounces	17.4 kilograms	2.0 d

†Anthracnose basal rot disease severity ratings based on a 0-10 scale, where 0 = no disease and 10 = severe disease symptoms.
‡Data means within the same column that are followed by the same letter are not significantly different from one another.

Table 2. Treatment, application rate and anthracnose basal rot disease-severity ratings for the 2005 anthracnose phosphonate fungicide trial. Five treatment applications were made at two-week intervals before the July 5 rating date.

the untreated control during both years, but the response was not as strong as the response to Chipco Signature.

Conclusions

The objectives of our study were to determine whether products made with potassium phosphite or fosetyl-Al provide similar control of *Pythium* blight and anthracnose basal rot, as well as enhanced putting green quality, when applied at equivalent rates of phosphorous acid. Although levels of overall *Pythium* blight control varied between 2004 and 2005, no differences were found among phosphonate treatments in either year, regardless of active ingredient or formulation. Chipco Signature and the potassium phosphite standard provided some control of anthracnose, but complete control was not achieved.

Chipco Signature performed better than Aliette, a product containing fosetyl-Al, which was applied at the same rate of active ingredient as Chipco Signature. Based on this observation, we concluded that the formulation of Chipco Signature played an important role in suppressing this disease. It is not surprising that most phosphonate products did not have a pronounced effect on anthracnose, given that our laboratory studies (not discussed in this article) show that the phosphorous acid does not have a strong inhibitory effect on the causal pathogen, *Colletotrichum graminicola*.

Chipco Signature also provided slightly better putting green quality than all other phosphonate treatments in 2004 and 2005. Although the improvement in putting green quality may have been partly due to anthracnose control, Chipco Signature plots were greener and appeared healthier (fewer brown and thin areas) than other treatments on most ratings dates. The enhanced green-up may have been partially a result of residual pigment from the Chipco Signature formulation; however, we attempted to minimize this effect by taking ratings two weeks after treatments were applied.

Other phosphonate fungicides provided improved putting green quality at certain times during the test when compared to the control, but not as much as Chipco Signature. Currently, we are unsure of why phosphonate fungicides improve putting green quality. Quality improvement does not appear to be a phosphorus nutrition effect, but may be partially due to a reduction of minor pathogens present in putting green turf. More-detailed research may shed light on how some phosphonate fungicides improve turf quality, and provide insights into the environmental and management conditions under which this may occur.

THE RESEARCH says . . .

- **We compared products** made with potassium phosphite or fosetyl-Al to determine whether they provide similar control of *Pythium* blight and anthracnose basal rot when applied at equivalent rates of phosphorous acid and to determine whether product formulation influences disease control.
- **Products with phosphites** and fosetyl-Al as active ingredients provided similar control of *Pythium* blight, and formulation of individual products did not appear to have any effect.
- **The potassium phosphate** treatment had no effect on *Pythium* blight control.
- **The Chipco Signature** and potassium phosphite standard treatments had significantly less anthracnose than the untreated control. We concluded that the formulation of Chipco Signature is a factor in anthracnose control.
- **Chipco Signature provided** slightly better putting green quality than all other phosphonate treatments in 2004 and 2005.

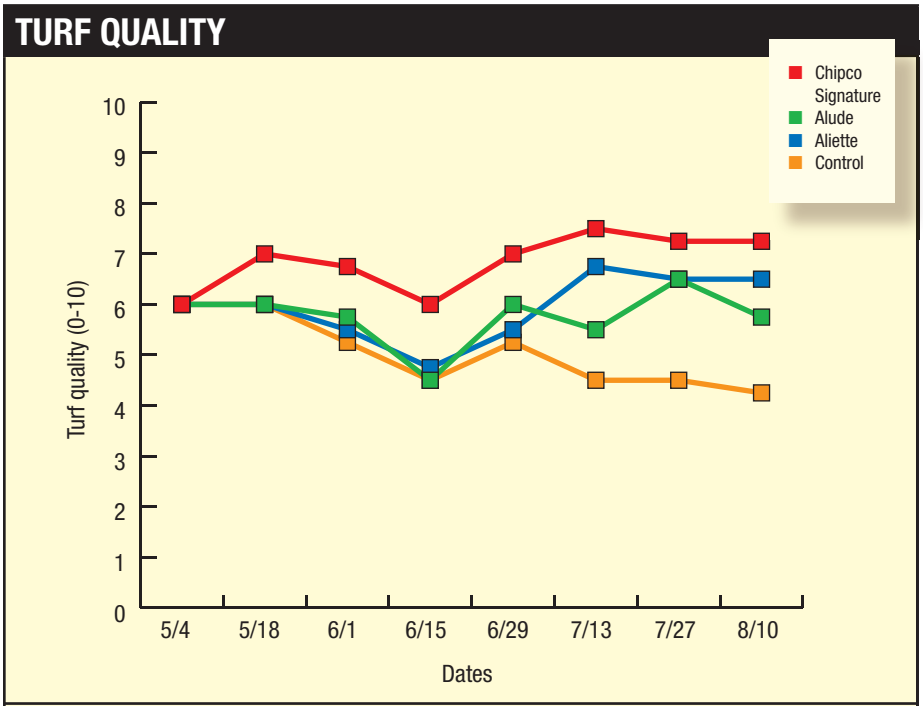

Figure 5. Turf-quality ratings of a creeping bentgrass/annual bluegrass putting green with an untreated control and plots treated with Aliette, Alude and Chipco Signature. Turf quality was rated on a scale of 0-10, where 10 was the highest-quality turf.

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