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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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). Phosphate 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

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

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

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 phosphorus 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.

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![Pythium blight trials](image)

**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.
Figure 4. Plots showing the effects of potassium phosphite standard or H3PO4 (left), Chipco Signature (center), and potassium phosphate or H2PO4 (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 phosphate 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 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 phosphate 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 phosphate 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...
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 Aluite, 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.

Funding

The Pennsylvania Turfgrass Council, Clery Chemical Corp. and Bayer Environmental Science provided funding for this study.

Acknowledgments

We thank Wakaar Uddin, Ph.D., and Michael Soika for advice, isolates and equipment used in conducting the Pythium blight trials.

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