



How Phosphonate Fungicides Affect Bentgrass Stress

By Lane Tredway, Lee Butler and Brad Franklin, Department of Plant Pathology, North Carolina State University

Editor's Note: Now that Dr. Geunhwa Jung has moved to the University of Massachusetts/Amherst, we are asking plant pathologists from across the country to pinch hit for him until the UW - Madison fills his position. Frankly, seldom does a day go by that I don't think about Dr. Jung and all the excellent work he did for us.

Phosphonates are still a hot topic of discussion around the country, and this excellent article appeared in the July/August 2006 issue of CAROLINAS Green and appears here with permission of Chuck Borman, executive director of the Carolinas GCSA.

The phosphonate fungicides are a group of products that contain phosphite (PO_3^{2-}) as the active ingredient. These products are very different from phosphate (PO_4^{3-}), which is applied to plants in various forms as a phosphorous fertilizer. In fact, the phosphite ion provides no nutritional benefit to plants whatsoever. Instead, this molecule has fungicidal activities against certain pathogens and also stimulates the plant's natural defense responses against disease.

The phosphonates have been available in the turf market since the early 80's, but first gained widespread attention in the mid-90's when Dr. Leon Lucas and co-workers at North Carolina State University demonstrated their beneficial effects on the summer stress tolerance of creeping bentgrass. In their studies, combinations of Aliette (fosetyl-Al) and Fore (mancozeb) significantly increased the quality of creeping bentgrass, even in the absence of true disease activity. The exact cause of this quality increase remains unknown, but physiological effects on the plant and control of secondary pathogens are likely involved.

NOT ALL PHOSPHONATES ARE CREATED EQUAL

Since the work by Dr. Lucas, several changes have occurred in the phosphonate group. First, the Aliette formulation of fosetyl-Al was modified to include a green pigment similar to that in Fore, giving rise to a new product call Signature. In addition, several new phosphonate fungicides have been released to the turf market. These products, such as Alude, Magellan, Magnum, Resyst, and Vital, contain potassium and/or ammonium salts of phosphate. Even though some of these products are advertised as 'generic' versions of Signature, they are very different in two respects

First, the new phosphonates contain the phosphite ion in a different form. In fosetyl-Al products, the

phosphite ion is bound within a complex molecule. After application, the molecule is broken down in the plant to release the phosphite ion. In contrast, phosphite salts contain the phosphite ion in solution and do not require processing by the plant.

The second difference is that Signature contains a high concentration of a green pigment, which is not present in the other phosphonate products. Independent research has shown that this pigment has beneficial effects on turfgrass health, which persists well after the 'painting' effect wears off. This pigment technology is now being referred to as 'StressGard' by patent-holder Bayer Environmental Science to emphasize its beneficial effects on turfgrass health.

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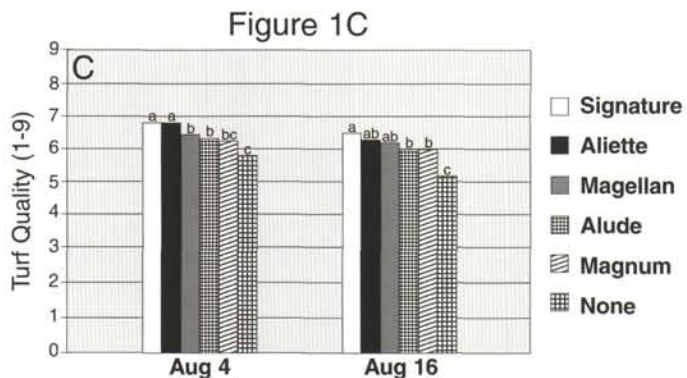
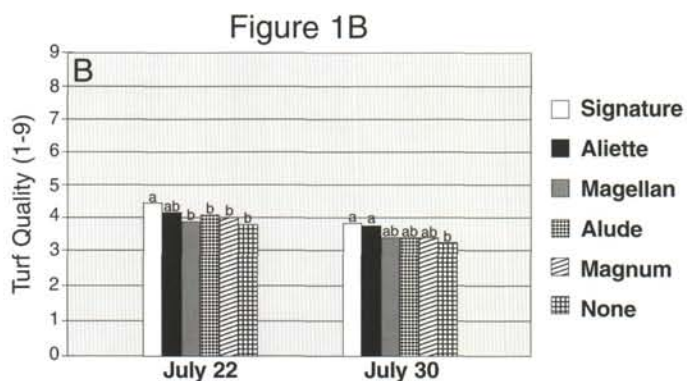
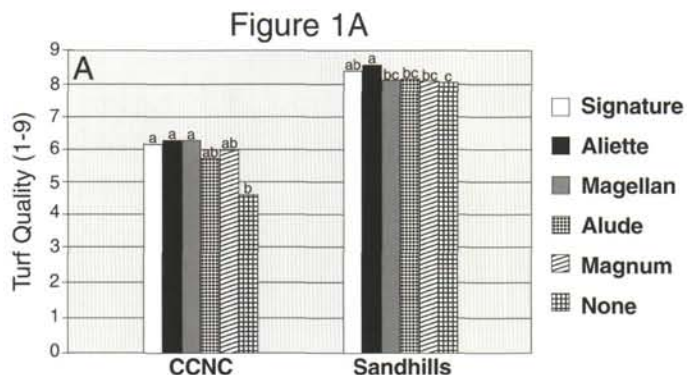


Figure 1. Impact of phosphonate fungicides on creeping bentgrass quality in: A) 2003 at CCNC and Sandhills Research Station; B) 2004 at the Sandhills Research Station; and C) 2005 at Lake Wheeler Turfgrass Field Laboratory. Data are averaged across all mixtures with contact fungicides. Bars containing the same letter are not significantly different according to the Waller Duncan k-ratio t-test.

Several questions arise from these changes in the phosphonate fungicides. Do the new phosphite salts provide the same turf quality benefits as fosetyl-Al? Does the green pigment play a significant role? Which fungicide serves as the best tank-mix partner with the phosphonates for summer management of creeping bentgrass? We initiated a research project at NC State University in 2003 to address these questions.

METHODS AND RESULTS

This research was conducted at the Country Club of North Carolina in Southern Pines, NC, on an A-1/A-4 blend (2003), the Sandhills Research Station in Jackson Springs, NC, on A-1 (2003 and 2004) and the Lake Wheeler Turfgrass Field Laboratory in Raleigh, NC, on Penncross (2005). In each year, treatments were applied on a 14-day interval from early June to late August using a CO₂-powered backpack sprayer. TeeJet 8004 nozzles were used to deliver two gallons of water per 1000 sq. ft. at 40 psi. Each plot was 3.33 x six feet in size and treatments were replicated four times.

Treatments included two fosetyl-Al products, Signature and Aliette, each applied at four oz/1000 sq.ft. and three phosphate salt products, Alude, Magellan, and Nutri-grow Magnum, each applied at six fl oz/1000 sq. ft. The phosphonates were applied along or tank-mixed with the contact fungicides Daconil Ultrex 82.5 WDG (3.2 oz/1000 sq.ft.) or Fore 80WP (four or eight oz/1000 sq.ft.).

The visual quality of each plot was rated 14 days after treatment, based on color, texture density, and uniformity using a scale of zero to nine (nine = best, five = acceptable). Data analysis indicated no statistical interaction among the phosphonates and contacts, meaning that these two types of fungicides behave independently. Therefore, data will represent an average across all tank-mixtures including that product.

RESULTS: PHOSPHONATE FUNGICIDES

At the CCNC location in 2003, the phosphonates did not affect bentgrass quality on June 19, July 1, or July 15. Significant differences were detected on July 29, after four applications of each treatment. On this date, Aliette, Signature, and Magellan significantly increased turfgrass quality as compared to the untreated control (Figure 1A).

At the Sandhills Research Station in 2003, benefits from phosphonate applications became evident more quickly, but no effects were observed later in the season. Aliette significantly increased turf quality ratings on June 19 and July 15, and Signature improved bentgrass quality on July 15 (Figure 1A).

In 2004 at the Sandhills location, the phosphonates again had no apparent effect early in the season, but certain products did increase turf quality in late July

after four applications of each treatment. Signature increased bentgrass quality on July 22, while both Signature and Aliette improved turf quality on July 30 (Figure 1B).

In 2005, this trial was conducted on Penncross at the Lake Wheeler Turfgrass Field Lab in Raleigh, NC. As in past years, the phosphonates impacted turf quality late in the season after several applications on 14-day intervals. On August 4, Aliette, Signature, Magellan, and Alude increased creeping bentgrass quality as compared to the untreated. On August 16, all phosphonates increased turf quality, but Signature was superior to Alude and Magnum (Figure 1C).

**RESULTS:
CONTACT FUNGICIDES**

Over the three years of this study, the contact fungicides chlorothalonil (Daconil Ultrex) and mancozeb (Fore) provided the greatest, most rapid, and most consistent increases in creeping bentgrass quality. Quality increases were typically evident after one or two applications of these materials on a 14-day interval, and the benefits persisted throughout the season. Daconil Ultrex (3.2 oz/1000 sq. ft.) and Fore (eight oz/1000 sq. ft.) produced the highest quality turf in general, while the four oz/1000 sq. ft. rate of Fore also increased quality as compared to the untreated control (Figure 2).

THE PHOSPHONATES AS FUNGICIDES

Is there a difference between fosetyl-Al and the phosphite salts from a disease control perspective? The research conducted to date indicates that there is not. For example, a trial conducted at Blowing Rock Country Club in 2005 showed that Signature (four oz/1000 sq. ft.) and Alude (six fl oz/1000 sq. ft.) provided excellent control of anthracnose foliar blight when applied alone or combined with Daconil Ultrex (3.2 oz/1000 sq. ft.) Other researchers have shown that fosetyl-Al and phosphite salts

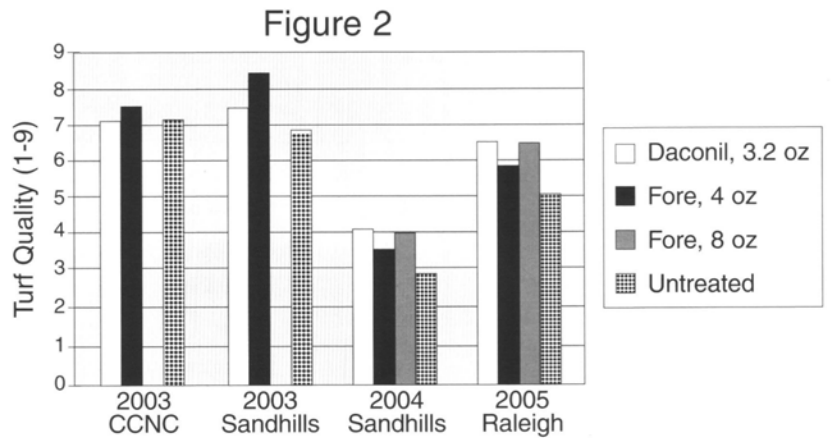


Figure 2. Impact of contact fungicides on creeping bentgrass quality. Data are averaged across all mixtures with phosphonate fungicides. Bars containing the same letter are not significantly different according to the Waller Duncan k-ratio t-test.

provide good control of Pythium foliar blight when applied preventatively. Because they work by enhancing the plant's resistance to disease, the phosphonates must be applied on a preventative basis for best results.

SUMMARY

This research has shown that the phosphonates and contact fungicides work to improve creeping bentgrass quality independently, indicating that they do not need to be tank-mixed to obtain their benefits. The contact fungicides chlorothalonil and mancozeb provide the greatest and most consistent increases in turf quality, likely due to suppression of algae and other secondary pathogens. The phosphonates provided smaller quality increases, typically late in the season during severe stress and after several applications.

Fosetyl-Al formulations increased creeping bentgrass quality in all three years of this study, and on a total of seven rating dates. In contrast, the phosphite salts only improved turf quality in 2003 (CCNC only) and 2005 and on a total of three rating dates. Although fosetyl-Al and phosphite salts provide similar levels of Pythium blight and anthracnose control, fosetyl-Al formulations provide greater and more consistent increases in creeping bentgrass stress tolerance. We did not observe a consistent benefit from the StressGard pigment contained within Signature, as compared to the Aliette formulation of fosetyl-Al. When developing a fungicide that includes the phosphonate fungicides, one should consider the desired effect of each application and select their products accordingly.

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