TURFGRASS TRENDS

BRIDGING THE GAP

Daconil Action: Bringing a Fungicide and Plant Activator Together

How much control does the new fungicide bring?

By Michael Agnew, Ph.D.

Daconil Action is a new fungicide that builds on the attributes of one of the most utilized active ingredients in turf — chlorothalonil — and the unique attributes of a novel plant activator, acibenzolar-S-methyl.

Chlorothalonil was first registered in the United States in 1966 for use on turfgrass under the trade name Daconil 2787 fungicide. Chlorothalonil is a contact fungicide that exhibits a multi-site mode of action that provides excellent disease protection on the plant surface. Once sprayed onto the plant surface, chlorothalonil deposits are bound by the plant leaf's cuticular wax, where it is then released into the leaf surface water film and redistributed over the leaf. Chlorothalonil protects the plant by inhibiting spore germination by means of attacking the disease-causing pathogen at several biochemical sites.

Furthermore, chlorothalonil is an important fungicide that does not exhibit any signs of resistance developing and can help delay or prevent resistance to single-site fungicides. The Fungicide Resistance Action Committee (FRAC) classifies chlorothalonil as belonging to the M5 FRAC GROUP.

Acibenzolar-S-methyl (ASM) is unlike any traditional methods of disease control. ASM is a plant activator, not a fungicide. ASM belongs to a product category called Host Plant Defense Induction (FRAC GROUP P). The Host Plant Defense Induction group has no direct toxic effect against pathogenic fungi and bacteria; instead, ASM triggers the natural defense response or the Systemic Acquired Resistance of the turfgrass by activating the production of pathogenesis-related (PR) proteins. This internal response within the plant enhances its own defense system against the attack of fungal and bacterial diseases. Thus, ASM bridges the gap between genetic resistance and conventional disease control by activating the plant's own natural defenses against fungi, bacteria and viruses.

The effects of ASM applications on the progression of pathogen development

Continued on page 32

Continued from page 31

on monocots were studied by Görlach, et. al. [1] Plants treated with ASM had no effect on the pathogen germination or appressorium formation on the leaf surface. However, in plants treated with ASM, penetration of the appressorium was reduced to 30 percent when compared to an untreated plant, and the further disease progression at successful penetration sites was reduced significantly.

Systemic acquired resistance

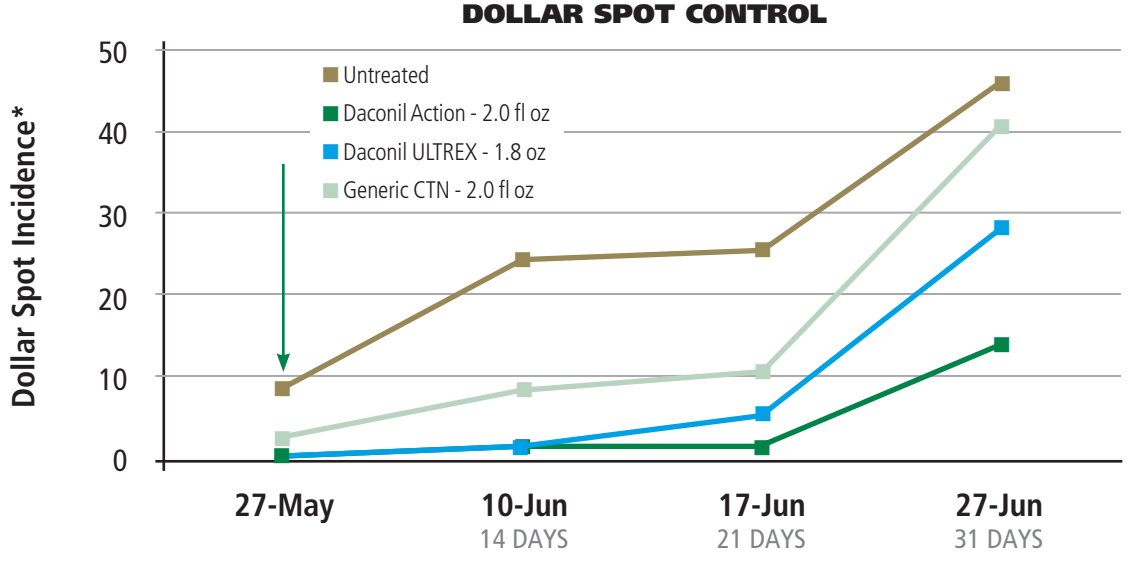
The ability of a plant to trigger biochemical responses to protect itself has been observed and researched for many years. In 1961, A. F. Ross coined the term Systemic Acquired Resistance (SAR) to describe the resistance that developed in the distal, untreated portions of Tobacco Mosaic Virus-inoculated plants.[3] Research conducted in the last 25-plus years demonstrates that the Salicylic Acid Pathway is involved in the SAR effect and that this pathway plays an important role in the ability of plants to defend themselves against pathogens. The Salicylic Acid Pathway can be triggered after the formation of a lesion by a pathogen, microbe or plant activator.

After the formation of a disease-induced necrotic lesion, several responses can occur at the infection site. The initial response is a programmed cell death that is believed to restrict pathogen spread. This is referred to as a hypersensitive response. The cell death compartmentalizes the pathogen; salicylic acid accumulates in the infected tissue that triggers the salicylic acid pathway in the infected tissue; and this results in the accumulation of PR proteins and SAR defense response gene expression near the site of infection.[4] The infection also induces a PR protein production and SAR defense response gene production in non-infected tissue. This naturally occurring phenomenon cannot be relied on for commercial use because it may not happen in a timely manner or be uniform over an entire field.

A plant treated with the plant activator ASM does not result in elevated levels of salicylic acid in the plant; however, ASM does

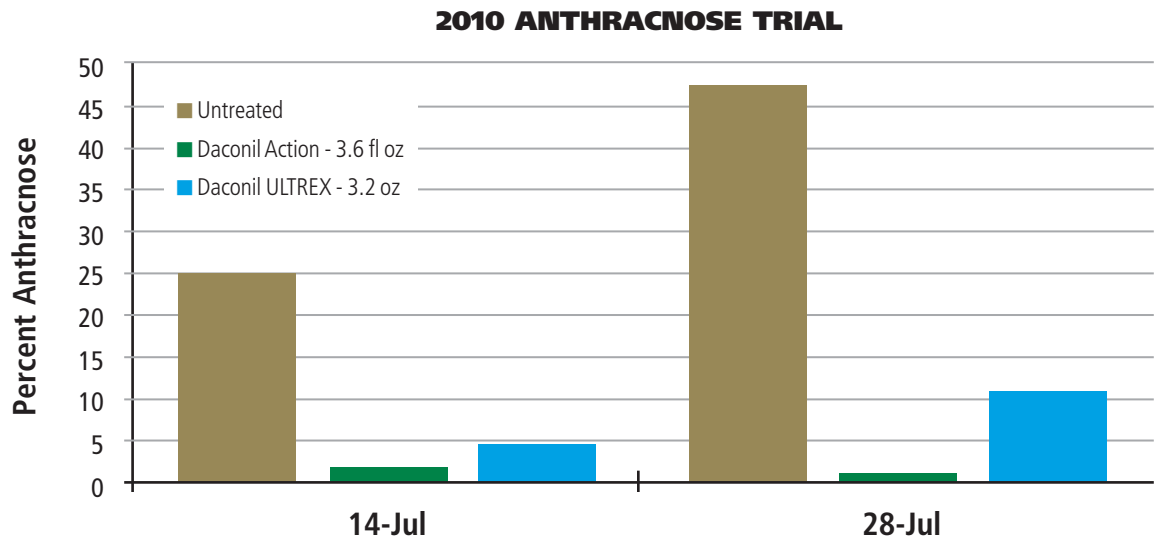
Continued on page 34

FIGURE 1: THE RESIDUAL EFFECT OF DACONIL ACTION FOLLOWING TWO APPLICATIONS



*Number of infection centers per 5 'X 5' plot area. Applications made on May 12 and 27, 2011.
Trial conducted by Steve McDonald, Turfgrass Disease Solutions - 2011

FIGURE 2: THE EFFECT OF DACONIL ACTION ON ANTHRACNOSE CONTROL



Application dates: May 28; June 11 and 24; July 8 and 22; August 8, 2010

Trial conducted by Dr. John Kaminski, Penn State University

Continued from page 32

activate the SAR response. ASM bypasses the accumulation of salicylic acid by acting downstream of salicylic acid production in the SAR signaling. This results in the activation of the SAR response throughout the plant, and the production of PR proteins and SAR gene expression throughout the plant.

The effect of ASM on the control of dollar spot was published by Lee, et al. [2] and Zhang, et al.[5] These two studies demonstrated that ASM-treated plants had significantly less dollar spot than untreated plants; and plants treated with the combination of ASM and Daconil had significantly less dollar spot than either Daconil-treated plants or ASM-treated plants.

No fungicide, not even multi-site fungicides, can give continual control of dollar spot and anthracnose when used alone.

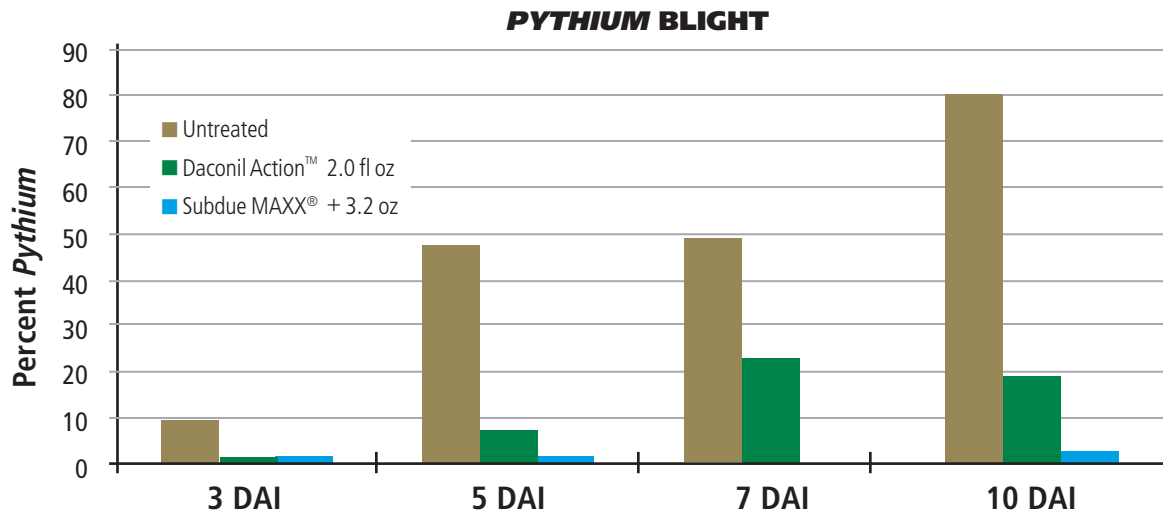
Disease control in turf

Plants treated with Daconil Action exhibit enhanced control of both dollar spot and anthracnose when compared to plants treated with chlorothalonil alone. This enhancement is demonstrated in extended dollar spot control, lower use rates for fairway dollar spot control and improved anthracnose control.

In a study conducted on a golf course in the Philadelphia area by Steve McDonald (Turfgrass Disease Solutions) during the summer of 2011, a summer rain event prevented the application of scheduled fungicide treatments to his research plots. Instead of making the scheduled treatment on Day 14, the spray had to be delayed to Day 17. Only the Daconil Action-treated creeping bentgrass provided acceptable dollar spot control on Day 17. In an adjacent study, only two fungicide applications were made to the creeping bentgrass, and then the turf was evaluated over a 31-day period to determine the residual effect of Daconil Action (Fig. 1, page 32). Daconil Action-treated turf not only maintained acceptable dollar spot control for 21 days, the turf also had significantly less dollar spot than other fungicides on Day 31 after the application.

Continued on page 36

FIGURE 3: IMPACT OF DACONIL ACTION ON *PYTHIUM* BLIGHT CONTROL



Treatments applied once. Inoculated with *Pythium aphanidermatum* the next day and rated for disease at 3, 5, 7 and 10 days post inoculation.

Trial conducted by Dr. Jim Kerns, University of Wisconsin, 2011

*Syngenta supports a FIFRA Section 2(ee) recommendation for use of Daconil Action™ for suppression of *Pythium* Blight and Bacterial Wilt on both Group A and Group B Turf as listed on the federal label. Please see the Section 2(ee) recommendation to confirm that the recommendation is applicable in your state.

Continued from page 34

Daconil Action was also evaluated in 2011 for the use of lower rates under moderate to low disease pressure. Daconil Action was tested at rates as low as 1.6 fl. oz. per 1,000 ft² and compared to a 2.0 fl. oz. rate of straight chlorothalonil*. In multiple trials on fairway height turfgrass, dollar spot control on turfgrass treated with Daconil Action applied at 1.6 fl. oz. was equal to straight chlorothalonil applied at 2.0 fl. oz.

This is significant, as the EPA limits for the 2.0 fl. oz. rate of straight chlorothalonil is 6 applications on a 7- to 14-day interval. The use of the 1.6 fl. oz. rate of Daconil Action allows for up to 8 applications on a 14-day spray interval. The two extra applications at the 1.6 fl. oz. rate can be important in your resistance management strategy when tank mixing a multi-site fungicide with single-site fungicides for dollar spot control.

Dr. John Kaminski of Penn State University conducted a study to demonstrate the enhanced control of anthracnose on annual bluegrass. Daconil Action-treated annual bluegrass had anthracnose levels of less than 3 percent, better than any other fungicide (Fig. 2, page 34). In addition, plant quality and percent creeping bentgrass encroachment were measured. Daconil Action-treated turf had better plant health as measured by visual plant quality, and the encroachment of creeping bentgrass was 45 percent less than Daconil ULTREX.

Daconil Action also demonstrated the suppression of *Pythium* blight and bacterial diseases. In a study conducted by Dr. Jim Kerns of the University of Wisconsin, *Pythium* blight was significantly reduced by a single application of Daconil Action** at the 2.0 fl. oz. rate (Fig. 3). This suppression of *Pythium* may allow for a subsequent application of a *Pythium* fungicide before the disease progressed too far. In greenhouse trials, Dr. Nathanial Mitkowski of the University of Rhode Island tested Daconil Action for the control of *Xanthomonas translucens pv. poae* and *Acidovorax avenae*. Turfgrass treated with Daconil Action had 73 percent fewer symptoms of *Xanthomonas* on annual

Continued on page 38

**Syngenta supports a FIFRA Section 2(ee) recommendation for the use of Daconil Action fungicide to control dollar spot at the use rate of 1.6 - 2.0 fl. oz. per 1,000 sq. ft. Please see the Section 2(ee) recommendation to confirm that the recommendation is applicable in your state.*

***Syngenta supports a FIFRA Section 2(ee) recommendation for use of Daconil Action for suppression of* Pythium *blight and bacterial wilt on both Group A and Group B turf as listed on the federal label. Please see the Section 2(ee) recommendation to confirm that the recommendation is applicable in your state.*

Continued from page 36
bluegrass and 77 percent fewer symptoms of *Acidovorax* on creeping bentgrass.

Plant quality

One of the most interesting results during the development of Daconil Action was the discovery of enhanced plant quality and drought avoidance that resulted in improved plant health. Annual bluegrass plant quality is enhanced with multiple applications of Daconil Action that resulted in a healthier putting green surface. This increased plant quality was in spite of one of the most stressful summers, 2010.

In a Penn State researcher's study, Daconil Action-treated annual bluegrass had anthracnose levels of less than 3 percent.

Enhanced plant quality was also seen in trials on creeping bentgrass mowed at fairway height, as evidenced by a trial conducted by Steve McDonald in 2011. Plant quality was not only better than any other chlorothalonil product, but the plant quality steadily improved during the heat of the summer. Interestingly, this research site not only was stressed by high temperature, it also received record rainfall to potentially make a bad situation worse. Yet, Daconil Action-treated creeping bentgrass performed very well.

In trials conducted in Syngenta research facilities, Daconil Action-treated creeping bentgrass showed excellent signs of avoiding drought stress. In a greenhouse trial conducted in Vero Beach, Fla., after two applications of fungicides, watering was stopped. Daconil Action-treated creeping bentgrass maintained green turf vigor 2 to 3 days after Daconil-treated plants wilted. In a corresponding study conducted in Switzerland, creeping bentgrass plants were treated on a 14-day spray interval with Daconil Action, where watering was stopped 14 days after last application. Wilting of the creeping bentgrass was noted on Day 3 for untreated turf; Day 4 for Daconil; and wilt was not seen in Daconil Action-treated turf on Day 5, when turf was watered. Further research to investigate this phenomenon is ongoing.

Conclusion

All protectant fungicides work best if applied preventively. This is also true for plant activators. Applying plant activators prior to disease and stress allows for the full activation of stress genes and proteins. This primes the plant to be fully activated to protect itself the best it can. Research demonstrated that ASM fully activated SAR genes in 48 hours.[1] Multiple, consecutive applications on a 14-day spray interval is optimum for continual gene expression.

Spray coverage is critical for chlorothalonil to be effective. Avoid extremely large spray droplets and water volumes that dilute the fungicide too much. The key is to keep the fungicide on the leaf surface and not move it into the thatch.

Daconil Action is best used in a spray program that uses other classes of fungicides. No fungicide, not even multi-site fungicides, can give continual control of dollar spot and anthracnose when used alone. Instead, use Daconil Action in rotational programs and in a tank mixture with single-site fungicides for best disease protection.

Michael Agnew, Ph.D. is a senior technical manager at Syngenta. Contact him at michael.agnew@syngenta.com.

REFERENCES

1. Görlach, J., S. Volrath, G. Knauf-Beiter, G. Hengy, U. Beckhove, K. H. Kogel, M. Oostendorp, T. Stauub, E. Ward, H. Kessmann, and J. Ryals. 1996. Benzothiadiazole, a novel class of inducers of systemic acquired resistance, activates gene expression and disease resistance in wheat. *Plant Cell* 8, 629–643.

2. Lee, J., J. Fry and N. Tisserat. 2003. Dollar spot and brown patch incidence in creeping bentgrass as affected by acibenzolar-s-methyl and biostimulants. *HortScience.* 38 (6): 1223-1226.

3. Ross A.F. 1961. Systemic acquired resistance induced by localized virus infections in plants. *Virology* 14:340-58

4. Ryals, J.A., U.H. Neuenschwander, M.G. Willits, A. Molina, H.Y. Steiner, and M.D. Hunt. 1996. Systemic acquired resistance. *Plant Cell* 8, 1809–1819.

5. Zhang, Q., J. Fry and N. Tisserat. 2005. Evaluation if plant defense activators for dollar spot and brown patch control on creeping bentgrass putting greens. *Int. Turfgrass Soc. Research Jour.* Vol 10: 180-185