

DON'T PANIC WITH EMERALD

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Emerald is a new fungicide from BASF launched in 2003 and widely available this past year. It has been an outstanding performer in dollar-spot trials beginning in 2001 at the Hancock Turfgrass Research Center and elsewhere. The product is sold as a 70 WDG formulation with the active ingredient boscalid. It is a carboximide and as such is the sole representative of the newest class of fungicides to be used on dollar-spot. Boscalid is a systemic fungicide that has upward movement within the plant as well as penetration through the leaves. Its novel action-site is specifically within the mitochondria where it inhibits respiration thereby depriving energy needed by the fungal cells. The other carboximide used on turf is flutolanil sold by Bayer as ProStar; and, it is not labeled for dollar spot.

Dollar spot can be suppressed with Emerald applied at very low rates of 0.13 to 0.18 ounces per 1,000 square feet in two to four gallons of water. The label recommends application prior to or at the onset of disease development. The reapplication interval is 14 to 28 days with the shorter interval being recommended under prolonged conditions favoring the dollar-spot pathogen. Emerald is for use solely on golf-courses. It is also labeled to control bentgrass-dead spot when 0.18 ounces per 1,000 square feet is applied at 14-day intervals.

Because its punitive action affects a particular process of the fungal cell's metabolism, Emerald is categorized as a single-site fungicide. Over time the dollar-spot pathogen, *Rutstroemia floccosum*, has developed some degree of resistance to all previously introduced single-site fungicides.

Class	Fungicide	First Published Report	Authors
benzimidazole	benomyl thiabendazole thiophanate-ethyl thiophanate-methyl	1973	Goldberg & Cole
dicarboximide	iprodione	1983	Detweiler, Vargas & Danneberger
DMI	triadimefon fenarimol propiconazole	1995	Golembiewski, Vargas, Jones & Detweiler

Under the section titled “Resistance Management” the label warns that a “reduction of disease control” may occur “if boscalid is used predominantly and repeatedly in the same turfgrass area in successive years as the primary method of control for the targeted pathogen species.” The label also states,

“If Emerald appears to be less effective against a pathogen that it previously controlled or suppressed, contact a BASF representative or local turfgrass expert for further investigation. Do not apply more than two (2) sequential applications of Emerald. Then alternate with another effective fungicide before reapplying Emerald.”

In late July, we were contacted by the superintendents of Lochmoor Golf Club and Red Run Golf Club, both in southeast Michigan. Each of them reported unsatisfactory suppression of dollar spot following a mid-July application of Emerald fungicide to their fairways. The circumstances surrounding these incidents and resulting actions by the superintendents were very similar. They were as follow:

- 1) The fairways had been treated with Daconil Ultrex (chlorothalonil) within a week prior to a first-time application of Emerald in late July.
- 2) Dollar spots began to appear four days after Emerald application.
- 3) A “rescue treatment” of Daconil Ultrex was applied six days after Emerald application. On the Lochmoor Golf Club course a small area of a fairway was not sprayed with Daconil Ultrex and left as a check area (see below).
- 4) Emerald was not used again.

These courses were within five miles of each other and had both been diagnosed in the early 1990s as being two of the first courses with DMI-resistant populations of *R. floccosum*. Mike Jones, the superintendent at Lochmoor Golf Club, commented that in his check area he had casually observed that the spots disappeared after a few days even though he had not applied Daconil Ultrex to that area. From there and other parts of the course, we collected symptomatic leaves from twenty dollar spots in early August of this year and isolated the pathogen into pure cultures. Most of them grew equally well on potato-dextrose agar (PDA) only and PDA amended with 10 ppm boscalid. This concentration was used because a 10 ppm concentration of thiophanate-methyl and iprodione is also used when screening for benzimidazole and dicarboximide resistance, respectively. Therefore, a further investigation was warranted using a broad range of boscalid concentrations to check for the possible existence of resistant strains of *R. floccosum*.

At the end of August an experiment was initiated on the course in an adjacent area where Daconil Ultrex had been applied a week earlier and no disease was evident. The treatments included Emerald at the highest labeled rate as well as Cleary’s 3336 (thiophanate-methyl), Chipco 26 GT (iprodione), and Banner Maxx

(propiconazole), all at typical rates for dollar spot. Honor, and unreleased strobilurin fungicide from BASF, was also applied at the highest rate indicated on its experimental label. All of the above are single-site fungicides. The remaining treatments were the multi-site fungicide Daconil Ultrex applied weekly at 1 oz. per 1,000 sq. and an unsprayed check.

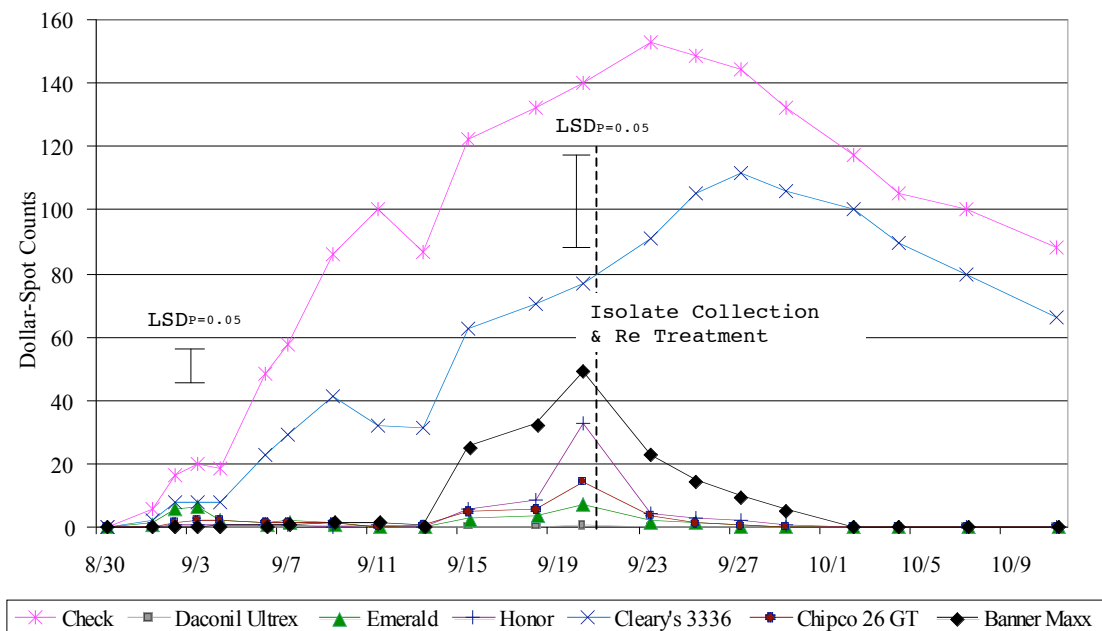
Trmt	Product	Class	Per M	Days
1	Check			
2	Daconil Ultrex	contact	1.0 oz	7
3	Emerald*	carboximide	0.18 oz	21
4	Honor [†]	QoI (strobilurin)	0.2 oz	21
5	Cleary's 3336	benzimidazole	1.0 fl oz	21
6	Chipco GT	dicarboximide	2.0 fl oz	21
7	Banner Maxx	DMI	1.0 fl oz	21
	*BASF 510	†BASF 505		

Three to four times per week Superintendent Jones counted and recorded the number of infection centers in each of the 6 ft by 9 ft plots set in a randomized-complete block design. At three and four days after treatment, the check plot had the most spots and the Emerald and Cleary's 3336 treatments had the second most. The other treatments were clean. On Day 5 the number of dollar-spots decreased on the Emerald plots and increased on the 3336 and check plots. By Day 8 the Emerald plots were almost devoid of dollar-spot symptoms. Banner Maxx protection broke down on Day 17; the other single-site fungicides began to weaken as well. The number of spots in all but the Daconil Ultrex plots increased from Day 17 until Day 21 when all of the other fungicides were reapplied.

An analysis of variance was performed with Day-4 counts, and at the 95%-confidence level all fungicide treatments had fewer dollar spots than the check. There were no differences among fungicide treatments although trends existed. A like statistical analysis of Day-21 counts indicated that once again all fungicides reduced the number of dollar spots when compared to the check. Honor, Chipco 26 GT, Emerald, and Daconil Ultrex were all superior to Cleary's 3336, which was indistinguishable from Banner Maxx. There were no statistical differences among Banner Maxx, Honor, Chipco 26GT, and Emerald. No distinction existed among Chipco 26GT, Emerald, and Daconil Ultrex, which had significantly fewer spots compared to Honor, Banner Maxx, Cleary's 3336, and the check.

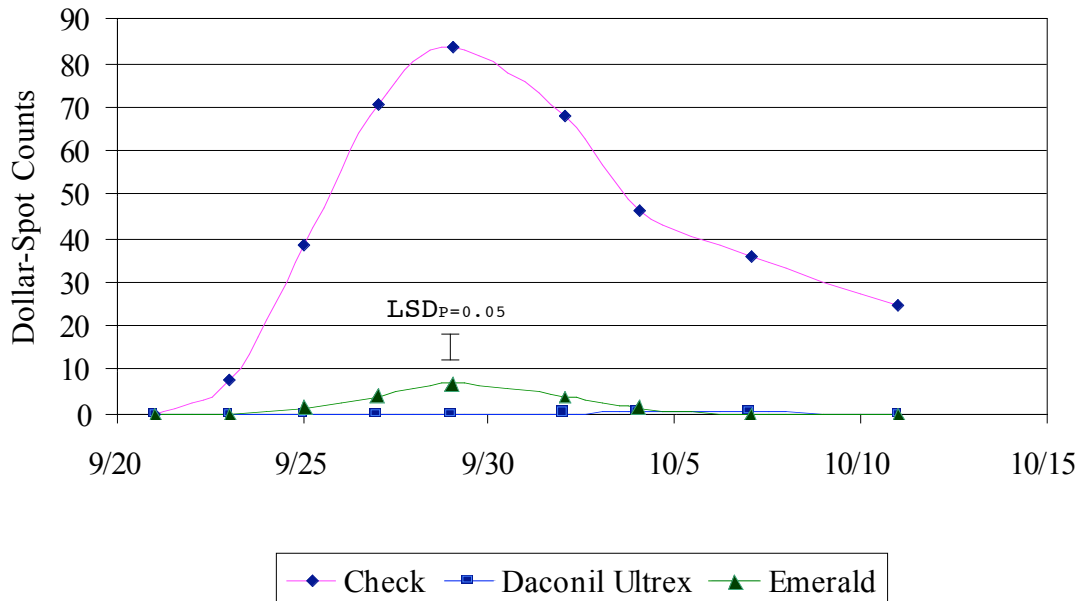
The treatments were reapplied on Day 21 after diseased leaves had been collected from selected plots. The second application of Emerald in this experiment was in point of fact the third since the general area had already received an application in July (see above). The number of spots in all treatments decreased except for Cleary's 3336 and the untreated control in which disease activity continued to increase in both. The number of spots began to decrease in the check and Cleary's 3336 plots on Day 27 and Day 31, respectively. It is of note that following this Emerald application there were no short-term increases in dollar-spot numbers as had been observed previously.

EXPERIMENT I



On an adjacent area in the same fairway, a second study was initiated on September 20 approximately two months since Emerald was applied to the general area. In this experiment there were only three treatments: Emerald and Daconil Ultrex applied at the same rates as in the first experiment and an untreated check. Dollar-spots appeared in the Emerald plots beginning on Day 4 and had disappeared by Day 14. Leaf-tissue samples from twenty dollar spots were collected during period of activity. The greatest numbers of spots were counted on Day 8. An analysis of variance of Day-8 data showed the Emerald treatment to be significantly different from both the Daconil Ultrex treatment and the check treatment at the 95% level of confidence.

EXPERIMENT II



From half of the leaf-tissue samples, the fungi were isolated into pure cultures and screened in the lab using a discriminate concentration of 40 ppm boscalid. All ten isolates grew to some extent as did a common strain, an iprodione-resistant strain, and a DMI-resistant strain; the growth of a benzimidazole-resistant strain was relatively stunted. These strains are routinely used as “testers” to check for a “false positive” when performing resistance screening. Therefore, these lab results were inconclusive, and the detection of an *R. floccosum* strain resistant to boscalid was not confirmed. A thorough investigation of these phenomena is underway using a range of concentrations from 5 ppm to 1280 ppm boscalid. If a failure of traditional poison-plate methodology is confirmed, it would raise a serious question as to what lab techniques could be used to determine whether or not a strain of *R. floccosum* is resistant to boscalid.

While we were able to duplicate twice what the two superintendents observed, we have no reason to suspect boscalid-resistance as a cause. An explanation for these short-term occurrences of a limited number of dollar spots following the Emerald applications at the two golf courses as well as following the initial application of Emerald in one experiment and the only application in another remains a mystery. In the event of the appearance of a few dollar spots shortly following an application of Emerald, our recommendation is to not panic with a

follow-up application of a contact fungicide. The spots should disappear in a few days as shown in our experiments. This is highly likely if the label instructions are followed. In the event that the spots do not fade away and increase in number, “contact a BASF representative or local turfgrass expert for further investigation.”