Evaluation of Fungicides, Wetting Agents and Microbial Based Products for Control of Fairy Ring and Localized Dry Spot Caused by *Bovista plumbea* and *Agrocybe pediades*

Principal Investigators: Wendy Gelernter, Ph.D. and Larry J. Stowell, Ph.D., CPPP, CPAg

Cooperator: Eric Lover, Dove Canyon Country Club

Sponsors: Aquatrols, Plant Health Care, Naiad, Zeneca

Summary: A study was conducted to evaluate the efficacy of fungicides, wetting agents and biological control products, when applied curatively, for the management of fairy ring and localized dry spot. Results included:

- Symptoms of fairy ring that were observed during this trial included localized dry spot and the presence of puffballs (*Bovista plumbea*) and mushrooms (*Agrocybe pediades*). The presence of mushrooms or puffballs tended to occur in those plots where symptoms of localized dry spot were the most severe.
- The best performing products included Heritage plus Primer (with or without post-application irrigation), ProStar plus Primer, Nature Safe and Nature Safe plus Compete. These products all provided control that was commercially acceptable.
- Products that did not perform significantly better than the check included Heritage (without Primer), Nature Safe plus Yuccah Concentrate, Nature Safe plus Yuccah Concentrate plus Compete and Naiad.
- These findings indicate that the addition of Primer to fungicides such as Heritage and Prostar may be important for consistent performance, especially where symptoms of localized dry spot are severe. This confirms findings from PTRI fairy ring studies conducted in 1997, where the addition of Primer to Prostar resulted in significantly improved efficacy vs. Prostar alone. In addition, the results demonstrate that post-application irrigation does not appear to play an important role in the performance of Heritage.
- These findings also demonstrate that nitrogen fertilization (in the form of the organic fertilizer Nature Safe) is an important tool in alleviating the symptoms of fairy ring.
- In an interesting and unexpected twist, the addition of the wetting agent, Yuccah Concentrate, to Nature Safe fertilizer significantly decreased the efficacy the Nature Safe application. Similarly, the wetting agent Naiad did not provide good control of any of the fairy ring symptoms seen in this trial. This data indicates that although wetting agents are believed to be efficacious against fairy ring related dry spot symptoms, not all wetting agents perform equally. The reason for the disappointing performance of the wetting agents tested in this study is not clear.

Materials and Methods:

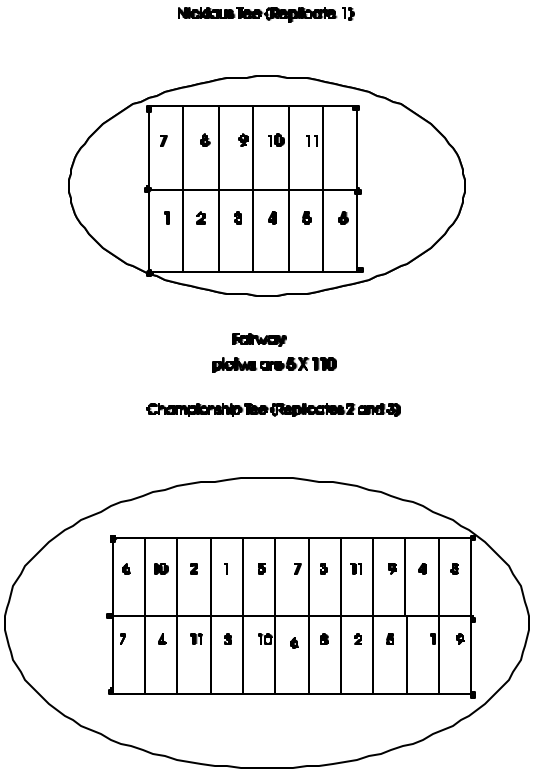
Location: Research plots were located on bentgrass tees at Dove Canyon Country Club, Dove Canyon, CA. This location was selected based on consistent infestation with fairy ring fungi, including *Bovista* and *Agrocybe*.

Experimental design and application: Plots measuring 5 feet by 10 feet were replicated three times in a randomized design (see plot plan below).

Sprayable treatments were applied with a CO_2 backpack sprayer equipped with 8008 VS flat fan nozzles and delivering 1.7 gallons of water per 1000 square feet, with 28 psi at the boom. Calibration of each nozzle was confirmed prior to application to be within 5% of the desired nozzle flow rate. Boom height was 17 inches above the ground. The spray swath was 5 feet. Speed was 3 mph. Spray bottles were agitated by shaking 10 times prior to charging with compressed CO_2. Spray lines were purged with water and then CO_2 prior to changing treatments. Nature Safe was applied using a Gandy drop spreader, forming a

33-inch swath. Calibration to deliver 1 lb N/A (12.5 lb product) resulted in a Gandy setting of 43. The accuracy of calibration was confirmed to be within 5% of the desired rate by conducting 3 passes of 15 linear feet each at the specified settings, collecting the product in question and weighing it.

Plot Plan.



To evaluate the effect of irrigation following application of Heritage, certain plots (treatments 2 and 3) were covered with plastic tarps (6 ml weight) that were secured with metal staples immediately prior to post treatment irrigation. This allowed all treatments except 2 and 3 to receive 1/10" irrigation immediately following product application. The covered plots remained dry underneath. Following irrigation, the tarps were removed.

Treatments: Application dates and treatments tested are listed in Table 1 below. Treatments were initiated when symptoms first appeared on 6/8/98.

Evaluations: Evaluations were made every two weeks, from 6/8/98 – 9/9/98. Percent dry spot damage was calculated visually, while the number of fruiting bodies for *Agrocybe pediades* and *Bovista plumbea* were determined by counting the total number of fruiting bodies per plot. Identifying characteristics for *A. pediades* included fruiting bodies (mushrooms) with yellowish-brown caps (2.5 - 5.0 cm wide), thin stalks, absence of a veil and brown spore prints. *Bovista plumbea* was identified by the small, round, smooth puff-ball shaped fruiting body, and the lack of a stem, or base attaching the fruiting body to the ground.

Percent data dry spot data was transformed prior to statistical analysis using the arcsine (square root) of the proportion. All data was subjected to analysis of variance, and treatment means separated using Fisher's LSD, where $P<0.05$.

Results and Discussion:

Mixing and handling: All products handled well, although the Nature Safe granule was quite fragile and was easily ground into smaller particles inside the hopper of the Gandy applicator. To prevent this from occurring, the Gandy spreader was carried between plots to prevent grinding of the granules. If drop spreaders are commonly used to apply this product, it is likely that calibration and rate delivered will be difficult to correctly measure as a result.

Phytotoxicity: None of the products tested caused any phytotoxicity.

Efficacy: Fungi present in non-treated check plots (and some of the treated plots as described below) during the course of the trial included *Bovista plumbea*, with puffball shaped fruiting bodies (Figure 1), and *Agrocybe pediades,* with fruiting bodies that were small brown mushrooms (Figure 2). The *Bovista* puffballs were present in much higher numbers than the *Agrocybe* mushrooms, however. In addition to the presence of fungal fruiting bodies, symptoms of localized dry spot (LDS) frequently appeared in association with fungal fruiting bodies. These symptoms were light to moderate during the course of the trial.

Figure 1. Puffball fruiting bodies from *Bovista plumbea.* This was the dominant fungal species observed during the course of the trial.

Figure 2. Mushroom fruiting bodies from *Agrocybe pediades.*

The best performing products included Heritage plus Primer, ProStar plus Primer, Nature Safe, and Nature Safe plus Compete. The Heritage plus Primer combination performed well whether or not post-application irrigation was applied, a finding that is confirmed by results of PTRI's 1997 fairy ring study at Del Mar Country Club.

Interestingly, the products listed above did not always perform as well when they were applied in different tank mixtures. For example, Heritage applied without Primer did not perform as well as the Heritage/Primer mixture; it was not significantly different from the check (Table 2) in controlling LDS symptoms, although it did do a good job of suppressing the appearance of *Bovista* and *Agrocybe* fruiting bodies. This is in contrast to 1997's data, which indicated that Heritage applied by itself did a good job of controlling LDS symptoms that were related to a heavy infestation of *Agrocybe*. Since *Bovista* was the predominant fungus species present in the Dove Canyon 1998 trial, it is possible that Heritage is not as active on *Bovista* as it is on *Agrocybe.* It is also possible that a preventive application of Heritage (as opposed to the curative applications made in this test) may have provided better control of *Bovista.* The addition of Primer (which has previously been shown to perform well in managing LDS symptoms) to Heritage masked this deficiency on the part of Heritage. Based on the data generated so far, it seems advisable to include Primer in tank mixtures with fungicides such as Heritage or ProStar to insure optimal fungal control and LDS symptom management.

Table 2. Percent dry spot damage and incidence of Bovista puffballs. Treatments that performed significantly better than the untreated check are highlighted in green, and those that performed significantly worse than the check are highlighted in red. Percent data was transformed prior to statistical analysis using the arcsine (square root) of the proportion. Data was averaged over all sampling dates and was then subjected to analysis of variance, with treatment means separated using Fisher's LSD (P<0.05)

Trt	Mean % Dry Spot Damage (4 dates)	Mean # Bovista puffballs (2 dates)
1	7.1 bcd	0.0 a
2	6.3 bc	0.0 a
3	0.4 a	0.0 a
4	1.5 a	0.0 a
5	1.1 a	0.0 a
6	3.3 ab	0.4 a
7	7.9 cd	5.3 c
8	2.8 ab	2.0 ab
9	6.8 bcd	0.9 a
10	12.5 d	3.9 bc
11	9.6 cd	1.4 a

The organic nitrogen fertilizer, Nature Safe (applied either by itself or in combination with Compete, a microbial based rhizosphere inoculant), resulted in high quality turf that had significantly reduced dry spot symptoms, as

compared to the non-treated check. The addition of Compete to Nature Safe had no obvious effect on the good performance of Nature Safe, however. This data indicates that Nature Safe, and possibly other nitrogen fertilizers, can be used to mask the symptoms of fairy ring/LDS by promoting the growth of healthy turf. Alternatively, it is possible that the organic fertilizer stimulated the growth of beneficial microorganisms that helped reduce pathogenic microbe populations responsible for fairy ring/dry spot symptoms. However, when the organic wetting agent, Yuccah Concentrate, was added to Nature Safe, an increase in LDS symptoms and *Bovista* fruiting bodies was observed. In a similar vein, the wetting agent Naiad also appeared to promote symptoms of LDS and to increase *Bovista* fruiting bodies.

Table 1. Treatments Tested

TRT	PRODUCT	ACTIVE INGREDIENT	RATE/1000	APPLICATION	APPLICATION DATES	SPONSOR
1	Heritage	50% azoxystrobin	0.4 oz	monthly applications, beginning at onset of symptoms, water in	6/8, 7/8, 8/3	Zeneca
2	Heritage	50% azoxystrobin	0.4 oz	" do not water in	6/8, 7/8, 8/3	Zeneca
3	Heritage + Primer	50% azoxystrobin	0.4 oz + 6 oz	" do not water in	6/8, 7/8, 8/3	Zeneca
4	Heritage + Primer	50% azoxystrobin	0.4 + 6 oz	" water in	6/8, 7/8, 8/3	Zeneca
5	ProStar + Primer	50% flutolanil	6.0 oz	" water in	6/8, 7/8, 8/3	all
6	Nature Safe	8-3-5 organic fertilizer	1 lb N	" water in	6/8, 7/8, 8/3	PHC
7	Nature Safe + PHC Yuccah Concentrate	8-3-5 organic fertilizer + 80% yuccah plant extract	1 lb N + 6 oz	" water in	6/8, 7/8, 8/3	PHC
8	Nature Safe + PHC Compete	8-3-5 organic fertilizer + 4 X 10^{11} cfus/lb rhizosphere inoculant	1 lb N + 1.5 oz	monthly applications (Compete every 2 wks), beginning at onset of symptoms, water in	6/8, (6/22), 7/8, (7/20), 8/3, (8/17)	PHC
9	Nature Safe + Yuccah Concentrate + Compete	8-3-5 organic fertilizer + 80% yuccah plant extract+4 X 10^{11} cfus/lb rhizosphere inoculant	1 lb N + 6 oz + 1.5 oz	monthly applications (Compete every 2 wks), beginning at onset of symptoms, water in	6/8, (6/22), 7/8, (7/20), 8/3, (8/17)	PHC
10	Naiad	Soil penetrant	16 oz	monthly applications, beginning at onset of symptoms, water in	6/8, 7/8, 8/3	Naiad
11	Non-treated control					all

Table 3. Fairy ring control as a function of dry spot damage, incidence of Bovista puffballs and incidence of Agrocybe mushrooms.
Treatments that performed significantly better than the untreated check are highlighted in green, and those that performed significantly worse than the check are highlighted in red. Percent data was transformed prior to statistical analysis using the arcsine (square root) of the proportion. Data was subjected to analysis of variance, and treatment means separated using Fisher's LSD, where P<0.05

	Percent Dry Spot Damage				Mean # Bovista puffballs/plot		Mean # Agrocybe mushrooms/plot
Trt	**7/8/98**	**8/3/98**	**9/1/98**	**9/9/98**	**8/17/98**	**9/1/98**	**8/17/98**
1	3.3 ab	16.7 a	1.7 ab	6.7 ab	0.0 a	0.0 a	0.0 a
2	5.0 ab	16.7 a	0.0 a	3.3 a	0.0 a	0.0 a	0.0 a
3	0.0 a	0.0 a	0.0 a	1.7 a	0.0 a	0.0 a	0.0 a
4	0.0 a	0.0 a	0.0 a	6.0 ab	0.0 a	0.0 a	0.0 a
5	0.0 a	0.0 a	0.0 a	4.3 a	0.0 a	0.0 a	0.0 a
6	0.7 a	0.0 a	3.3 ab	9.3 ab	0.7 a	0.0 a	0.0 a
7	5.0 ab	5.8 a	9.0 bc	11.7 ab	3.0 ab	7.5 b	1.0 a
8	3.0 ab	1.3 a	0.0 a	6.7 ab	4.0 ab	0.0 a	0.0 a
9	4.0 ab	3.3 a	1.7 ab	18.3 b	1.7 ab	0.0 a	0.0 a
10	6.0 b	10.7 a	21.7 c	11.7 ab	4.3 b	3.5 ab	0.0 a
11	6.7 b	11.7 a	10.0 bc	10.0 ab	2.7 ab	0.0 a	2.7 b