first to the second year. In addition, canopy dieback increased by about 67 percent in all treated trees (although substantially less than the increased dieback observed in untreated trees). In another study (D. Smitley, personal communication), infestation levels were also observed to increase from one year to the next, even though trees had been treated for two consecutive years with Merit soil drenches or IMA-jet trunk injections. These results suggest that even consecutive years of treatments may only slow ahs decline, at least when EAB pest pressure is severe.

Protective Cover Sprays

McCollough et al. (2004) found that one or two applications of Onyx provided good control of EAB. Sevin SL and Tempo also provided good control of EAB when two applications were applied, with the first application in late-May and the second in early-June. Orthene was less effective. Astro® (permethrin) has not been evaluated against EAB, but has been extremely effective for controlling other species of wood-borers and bark beetles.

Smitley et al. (2005a) also tested Onyx cover sprays, and found that it provided good control the first year under relatively low EAB pressure. However, in the second year, under heavier EAB pressure, it was not effective. BotaniGard® was also ineffective under high EAB pressure (D. Smitley, personal communication).

Summary

Insecticides are valuable tools that have shown potential for protecting trees from EAB, including soil-applied systemic insecticides, trunk-injected systemic insecticides, and protective cover sprays applied to the trunk, branches, and (depending on the label) foliage. Some formulations can be purchased and applied by homeowners, others must only be applied by professional applicators. It is important to understand that success in **not** assured, and that trees will have to be treated each year. In most cases, it may be more cost-effective to remove and replace the tree. Insecticide applications have effectively protected ash trees from EAB. However, in some university research trials, trees have continued to decline from EAB attack despite being treated over consecutive years. In other studies, EAB treatments have failed completely! The bottom line is that research on chemical (insecticide) control of EAB remains in the early stages, and we still do not have enough experience to know under what circumstances insecticides treatments will be effective over the long term.

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Acknowledgements

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Fungicide Resistance in Turfgrass - An Introduction

By Paul Koch, *Turfgrass Diagnostic Lab, University of Wisconsin-Madison*

Author's note: This is the first in a three-part series looking at fungicide resistance in turfgrass.

Like many important discoveries in history, the first fungicide was discovered completely by accident. Bordeaux mixture, discovered in 1885 and applied to grapes in France, was originally meant to discourage passersby from picking the fruit. But it also was remarkably effective in controlling powdery mildew, and so the first fungicide was discovered and a fundamental shift in the way agricultural diseases are controlled had begun (De Waard, 1993). More effective fungicides were developed in the years to follow, and by the turn of the 20th century many non-selective and inorganic fungicides were being applied to agricultural and horticultural crops (Eckert 1988).

Nearly all fungicides developed before 1970 were multi-site inhibitors that protected the surface of the plant from pathogen infection, what would be known as contact fungicides today (Sisler, 1988). These fungicides were cheap and effective, and were the primary means of disease control for many growers. But beginning in the 1960's and influenced by the release of Rachel Carson's Silent Spring, public concerns over possible environmental contamination and mammalian toxicity led to the development of fungicides that were more selective in targeting the pathogen (De Waard, 1993). The selective nature of these fungicides left them more vulnerable to the development and proliferation of organisms that had developed resistance (Eckert 1988).

It is widely accepted amongst those who study fungicide resistance that the application of fungicides do not actually cause the fungi to become resistant to the fungicide. Instead, applications of fungicides control normal or "wild-type" isolates of fungi but cannot control those isolates that have undergone random mutations that render the fungicide ineffective (Couch 1995). With repeated applications of the same fungicide, the mutated isolates proliferate in the population and soon come to dominate the population (Figure 1). It is when these mutated isolates make up a significant proportion of the overall fungal population that we see a loss of disease control and observe "field" or "practical" fungicide resistance.

While much has been made about the loss of disease control due to fungicide resistance in the past 20 years, reports of resistance to fungicides have been around for over 40 years. The first reports of fungicide resistance were to the cadmium and mercury-based fungicides in the late 1960's (Cole *et al.*, 1968; Massie *et al.*, 1968). In the 1970's, shortly after their introduction into the market, dollar spot resistance was reported to the benzimidazole class of fungicides that includes active ingredients such as thiophanate-methyl and benomyl (Warren *et al.*, 1974; Warren et al., 1977). Widespread reports of decreased fungal sensitivities to the demethylation-inhibitor (DMI) class of fungicides has been documented with many pathogens since the early 1980's (Detweiler *et al.*, 1983; Leroux *et al.*, 1988; Koller *et al.*, 1991; Golembiewski *et al.*, 1995; Peever and Milgroom, 1994; Franke., 1998). Most recently, reports of resistance to the strobilurin class of fungicides has been

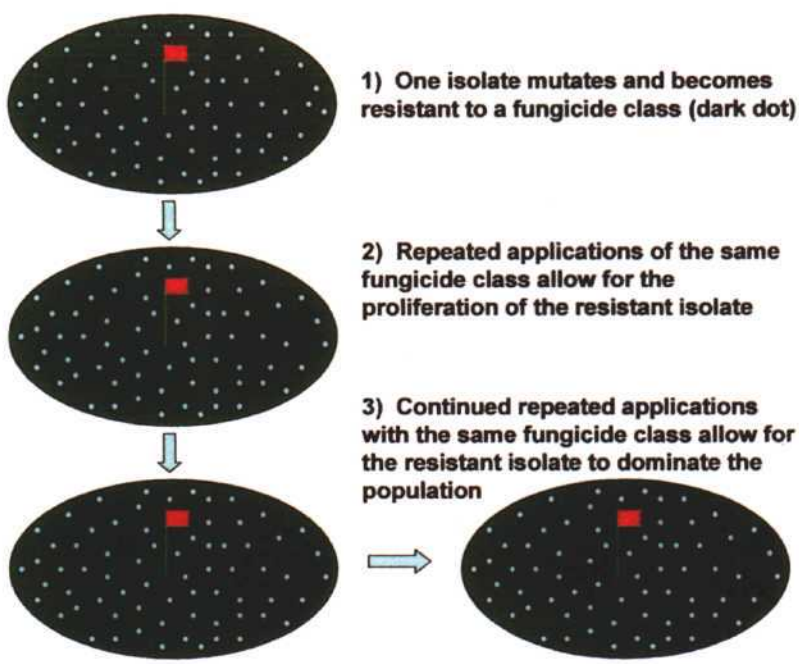

Figure 1: Under repeated applications of the same fungicide class, a single resistant isolate (dark dot) can proliferate and dominate the population.

observed in turfgrass and other crops as well (Wong and Wilcox, 2002). The speed and severity that resistance has developed to each of these fungicide classes has varied, and to understand why one must know the basics about how each of these classes inhibit fungal growth.

The benzimidazole class of fungicides inhibits fungal growth by interfering with microtubule assembly in the fungal cell, which in turn disrupts the development of the spindle fibers (Ishii, 1992). Thinking back to high school biology class, the spindle fibers are the structures that pull the chromosomes apart during cell division. So in a simple sense, benzimidazole fungicides inhibit cell division. The site where the fungicide binds to and inhibits cell division is controlled by one gene. If by chance there is a single mutation at that gene, the binding site will be altered and not allow for the binding of the benzimidazole fungicide. This fungal isolate has now obtained resistance to benzimidazole fungicides, and in the continued presence of benzimidazole fungicide applications will quickly proliferate and dominate the fungal population. Once the resistant isolate becomes the dominant isolate in the population, a sharp reduction in control in the field is observed. This drastic and rapid selection of resistant organisms in the population is known as disruptive or qualitative selection (Figure 2), and often leads to two distinctly different subgroups with very different fungicide sensitivities within the overall population (Koller and Scheinpflug, 1987).

The DMI group of fungicides is actually part of a larger class of fungicides known as the sterol biosynthesis inhibitors (SBI). While it is unknown exactly how other groups within the SBI class inhibit fungal growth, the DMI fungicides bind to a site in the fungal cell's sterol biosynthesis pathway (Koller, 1988). Sterols play an important role in many different cell functions,

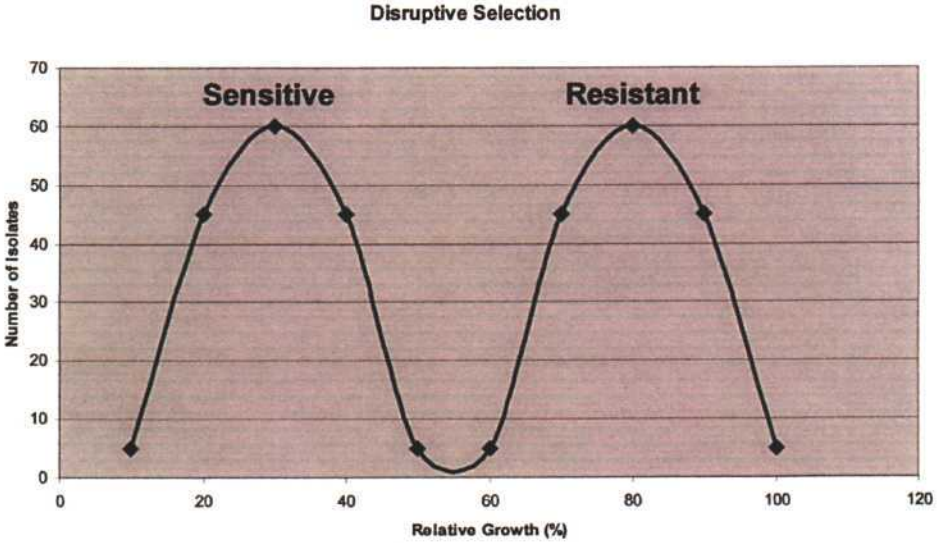

Figure 2: Repeated applications of the same fungicide class that act in a disruptive way can rapidly divide the fungal population into two subgroups with very different sensitivities to fungicides. Disease control failures in the field can develop rapidly. The benzimidazole class of fungicides acts in this manner.

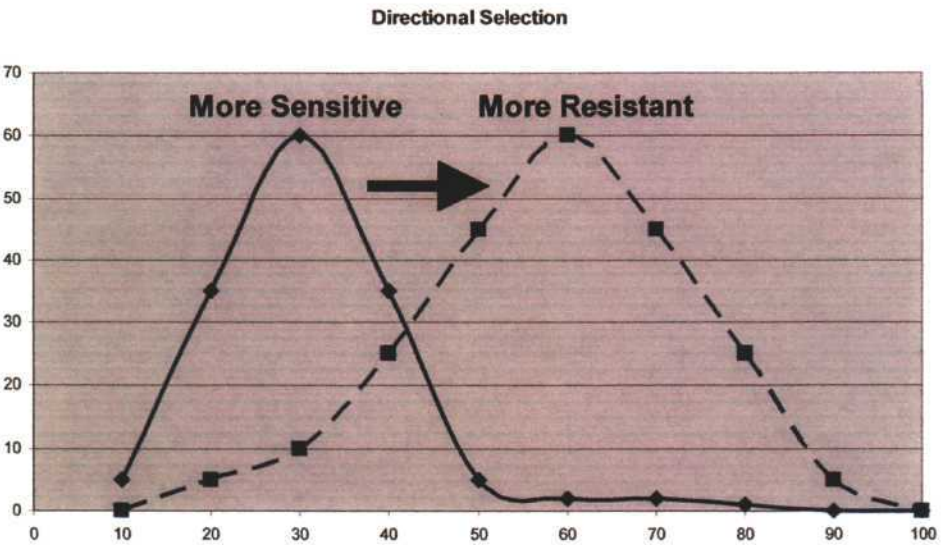

Figure 3: Repeated applications of the same fungicide class that act in a directional way can gradually shift the overall sensitivity of a fungal population towards being more resistant to the fungicide. Disease control failures develop slowly, even under repeated applications of the same fungicide class. The DMI class of fungicides acts in this manner.

including maintenance of the cell membrane and synthesis of hormones (Koller, 1992). In contrast to the benzimidazoles, several genes regulate the site that DMI fungicides bind to. This results in a gradual, step-wise process of worsening resistance with each subsequent mutation in the sterol biosynthesis pathway. With repeated applications of DMI fungicides, there is a gradual decrease in control of the target organism. This is observed in the field as shorter lengths of fungicide efficacy and disease "breakthrough" in higher pressure areas. This gradual resistance buildup in the fungal population is known as directional or qualitative selection (Figure 3), and often results in the delayed onset of observed fungicide resistance in the field for many years (Koller and Scheinpflug, 1987).

Strobilurin fungicides are also

part of a larger class known as the QOI fungicides. They work to inhibit fungal growth by inhibiting mitochondrial respiration in the fungal cell (Heany *et al.*, 2001). While the exact mechanism for development of resistance to the strobilurins is unclear, widespread field resistance in pathogens such as *Blumeria graminis, Venturia inaequalis*, and more recently *Colletotrichum cereale* in turfgrass has been documented (Wong and Wilcox, 2002; Wong, 2003). This rapid resistance development soon after the introduction of strobilurins to the market suggests that resistance develops in a manner similar to the benzimidazoles rather than the DMI's, but more research is needed to clarify this point.

Fewer new fungicide chemistries are being produced due to the onerous cost, and increased governmental regulation of older, effective fungicides such as chlorothalonil have left turfgrass managers with diminished disease control options. Many strategies for managing fungicide resistance have been touted for years, but little scientific data exists to actually support these strategies. Continued scientific research needs to go into the population dynamics of fungicide resistance to better understand how the resistant isolates relate to the sensitive ones in the turfgrass environment. This will allow for more effective fungicide management strategies, prolonging the effectiveness of our current fungicides years into the future.

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The Big Show Will Be Like No Other

By Tom Schwab, *O.J. Noer Turfgrass Research and Education Facility, University of Wisconsin-Madison*

This summer's turfgrass field day at the O.J. Noer Facility in Verona on Thursday, July 26 will be like no other. It will be the first ever joint field day sponsored by three different turf organizations for one common purpose – to learn the latest research and techniques to produce healthy, beautiful turfgrass.

The excitement is building for the combined TPI-WTA-MSC Field Day which is expected to draw over 1,000 attendees. The three large groups hosting the event include Turfgrass Producers International and the Midwest Sod Council, which encompass sod growers from around the Midwest and the world, and the Wisconsin Turfgrass Association, which gathers members from Wisconsin's lawn care, sports field, golf course, and landscaping industries. This special event includes 15 acres of trade show with equipment demonstrations, abundant turfgrass research presentations, a real Wisconsin breakfast and lunch, fireworks, family friendly games, and more. The Noer Facility is greener than ever with the addition of 20 acres of turfgrass that were grown in for this special event.

The official TPI-WTA-MSC Field Day with trade show and turf research tours will take place on Thursday, July 26, and it starts off with a wonderful Wisconsin breakfast. On the previous evening, July 25, the sod producers will sponsor Family Night, which includes an extra trade show. It is oriented for families and includes games, fireworks, and other activities, and WTA members may attend for no additional fee. But just to clarify, the TPI-WTA-MSC Field Day is mainly on Thursday.

Equipment and crowds will be big at this year's Field Day.

The relatively smaller golf course, sports, and landscaping equipment will also be displayed and available for demonstration.

All the latest turf products and NTEPs will be exhibited to help you with your management decisions.

John Stier, Kirk Hunter, and Rusty Stachlewitz will all be at the show with smiling faces and lots of information to share.

The combined field day is something entirely new, and you won't want to miss it. Mark your calendars now to attend. The registration forms were mailed in May but if you missed getting one call the WTA office at 608-845-6536 or download one from the website www.wisconsinturfgrassassociation.org. The schedule follows:

• Wednesday, July 25

4:00 pm - 7:00 pm	Registration at the Noer Facility
4:00 pm - 9:30 pm	Family Night and Trade Show
5:00 pm - 7:00 pm	Dinner
Dusk	Fireworks

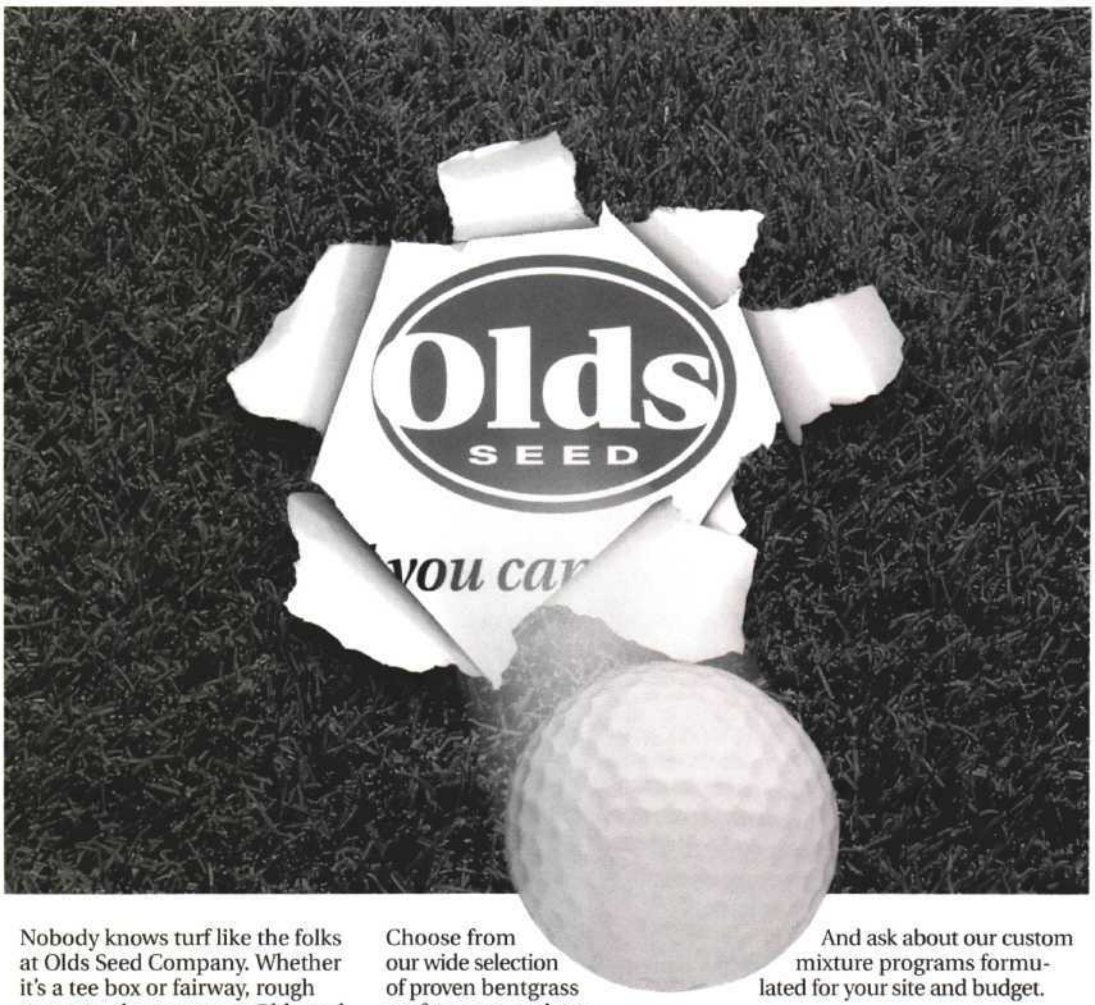
• Thursday, July 26

7:00 am - 2:00 pm	Registration at the Noer Facility
8:00 am - 10:00 am	Breakfast
11:00 am - 2:00 pm	Lunch
8:00 am - 4:00 pm	TPI-WTA-MSC Field Day with Trade Show and Turf Research Tours throughout the day

The combined field day of the three organizations will be a unique opportunity to meet people with similar interests. Coincidentally, there is a conference of other state turfgrass researchers from the north central region of the U.S., meeting at the Noer Facility this same week. Some of them will be participating in the turfgrass research tours at Field Day. So if our UW-Madison turf researchers can't answer all you questions, someone from one of the other 12 Midwest state universities will. There is just so much going on at this exciting show. If you can only attend one meeting this summer, this is the one.

Athletic field demonstrations will also be included.

TURF PROS



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A Series of Events

By Pat Norton, *Golf Course Superintendent, Nettle Creek Country Club*

Life is a series of events surrounded by the routine of daily existence. Some of us have more events than routine...others have too much routine...while most of us have a healthy combination of both drama and the mundane. We all take for granted the daily routine...not realizing how blessed we are to have that normalcy...until an event, or series of events...are encountered that test us a little bit.

During the late summer of 2006, I began negotiating a personal series of events that tested me somewhat...and made me realize more fully that I've been really quite fortunate so far in this life.I suppose that everybody does realize that good health and good family combine to create a good life...but a small testing once in awhile helps to remind us humans that life is not to be taken for granted.

My little journey began during my weekly hot shower in late August of last year. During that shower and in the weeks to follow...repeated washing of the lower groin area revealed that my left testicle felt rather strange...sort of like a hard walnut...definitely not the same texture as the other side. But...since I was enjoying the washing process so much...I rationalized that "it's nothing...and soon will disappear!" So I did the intelligent thing and waited...and washed...and washed some more...over the next sixty days before I finally contacted a urologist for an appointment! It took my doctor about one minute to hear my story...examine me...and declare that immediate surgery would be necessary.

So, on November 9th of last year...I became what my younger son and his friends refer to as a

'Uniball'...and no, it really doesn't affect my balance at all. The ultrasound, the CATSCAN, and the biopsy all revealed that I had testicular cancer. A 1991 vasectomy did reveal that the removed testicle never was functional. So, at the very least I did sire three children on a single testicle and never charged a stud fee for any of them!

The tissue biopsy resulted in my first bit of good luck. There are basically two groups of testicular cancer. 'Non-semanova' refers to a group of cancers of the testicle that are more aggressive...requiring much more aggressive post-surgery treatment programs...i.e. ***chemotherapy***. 'Semanova' refers to a type of testicular cancer that is much more passive, slow moving, and easy to control. I was diagnosed with Stage 1 semanova...so it was all early, early, early...and easy, easy, easy!

Actually, it was a very fortunate series of events that could have been much worse. So, of all possible cancers, I turn up with one of the very best ones for men to contract. Simple outpatient surgery with less complications than my two hernia surgeries of winters past. I did have to undergo 21 radiation treatments in January '07, which was no big deal. I was especially grateful to have daily visits with the radiation oncology nurses as opposed to visiting the chemotherapy oncology unit. There were too many elderly patients courageously battling cancer through chemotherapy over in that unit. It always made me wonder about the courage level I would be able to muster were I needing that same therapy regimen.

Life began to get back to normal in February as the doctors closed the book on the therapy...with the final visits to the urologist and the radiation oncologist happening in March. I was cleared to begin physical activity soon thereafter...which meant that I could start punishing myself severely on the Life Cycle and the weights over at the Rec Center. I had gained almost fifteen pounds during the winter inactivity/radiation treatment phase. I clearly remember being extremely nauseated and almost fainting the first few times working out. I also clearly remember the doctor then telling me to take it easy...and not be in such a hurry to get back into shape.

As the weeks passed...I got to the point with physical recovery that strenuous workouts four or five times weekly were my