

liance, exclusive use for control of certain diseases and to resistance problems unlike any previously encountered by golf course superintendents and turf care professionals.

### Resistance problems

Resistance problems first observed with systemics demonstrated that their greatest strength—highly selective single-site action—could rapidly become a weakness in the presence of resistant fungal strains.

For this reason, fungicides with single sites of action, whether contact or systemic, have come to be known as "at-risk" fungicides. These fungicides contrast with most conventional contact fungicides that have multi-site action and, therefore, a lower risk of resistance.

Single-site fungicides are prone to resistance because they act on only one enzyme or enzyme site in a fungus. Repeated use of these chemicals exerts high selection pressure.

Single-site fungicides rapidly kill all susceptible fungi, leaving only resistant fungi that, through random mutations, rely on other enzymes to exist. Thus, it is possible for an at-risk fungicide to provide excellent disease control at first, which is then followed by catastrophic fungicide failure when resistant fungi become predominant.

### Reduce selection pressure

Recent research makes it clear that disease prevention and resistance management strategies must rely more on treatments that reduce selection pressure, through the use of low-risk, multi-site contact fungicides. At-risk agents can then be used on an as-needed basis, when their powerful effects can be maximized without undue threat of resistance.

Through the increased use of low-risk, broad-spectrum fungicides such as chlorothalonil, mancozeb, anilazine and others, the effec-

tiveness of valuable systemic agents can be preserved against resistance problems, perhaps indefinitely.

Resistance occurs whenever genetic changes in a fungal cell allow it to survive using enzymes other than the one that is attacked by the fungicide.

Whether resistance is based on changes to a single gene (monogenic) or to several genes (polygenic), resistant fungi almost always exist naturally in a population, though in small numbers.

### Resistance strength

Monogenic resistance is usually easier for a fungus to achieve; consequently, it tends to occur more often and much more quickly. Polygenic resistance seems to occur much more slowly, making it somewhat easier to combat.

Polygenic resistance is evidenced by a gradual decline in fungicide effectiveness, rather than a sudden, disruptive loss of control. As a single-site fungicide removes susceptible individuals, the population balance shifts toward those that are resistant, because they are the only ones genetically capable of surviving.

If the same treatment is used repeatedly, the resistant individuals are likely to become predominant as competition provided by the susceptible strains is eliminated.

### Pressure behind resistance

The frequency, uniformity of placement, and timing of at-risk fungicide application are factors determining the degree of selection pressure exerted on the fungal population. Together with the mode of action of the chosen fungicide and the reproductive rate of the fungus, selection pressure determines the speed at which resistance can occur.

By reducing the selection pressure on target populations, turfgrass managers can minimize the emergence of resistant strains, prolong the use of powerful but resistance-prone at-risk fungicides, and achieve the goal of attractive, disease-free turf.

The Fungicide Resistance Action Committee (FRAC) North American Working Group suggests two general strategies for reducing selection pressure exerted by at-risk fungicides:

1. Alternate or mix high-risk fungicides with other fungicides not having a cross-resistance potential. This normally involves the use of a broad-spectrum, multi-site contact fungicide with little resistance risk or an at-risk fungicide from a different chemical class.

2. Restrict use of the high-risk

## GUIDELINES TO PREVENT OR DELAY RESISTANCE TO TURF FUNGICIDES:

- 1) Minimize disease conditions
  - a) good cultural practices
  - b) resistant cultivars
- 2) Make good fungicide choices
  - a) be sure of the problem
  - b) decide if it warrants treatment
  - c) read the label- calibrate and apply properly
- 3) Know the chemical
  - a) is it prone to resistance problems?
  - b) is it protectant or curative (systemic)?
  - c) to what chemical group does it belong?  
(Avoid cross-resistance problems.)



## TURF FUNGICIDE CHEMICAL GROUPS SUBJECT TO RESISTANCE PROBLEMS

### 1) DICARBOXIMIDES- MODERATE RISK

examples: iprodione (Chipco 26019)  
vinclozolin (Vorlan)

resistance can appear suddenly, but appears unstable

Cross-resistance within the group and also to chloroneb (Terremec SP)

### 2) BENZIMIDAZOLES - HIGH RISK

examples: benomyl (Tersan 1991)  
thiophanate-methyl (Fungo 50, Spot Kleen)  
thiophanate-ethyl (Cleary's 3336)

resistance can appear suddenly, seems to remain stable: cross-resistance within the group

### 3) STEROL BIOSYNTHESIS INHIBITORS (SIs) (SBIs) (DMIs) LOW RISK

examples: fenarimol (Rubigan)  
triadimefon (Bayleton)  
propiconazol (Banner)

resistance may appear gradually and may shift back to sensitivity with time

Cross-resistance within the group (where studied).

### 4) PHENYLAMIDES- HIGH RISK

example: metalaxyl (Subdue)

resistance can appear suddenly and seems to remain stable

Source: Gail Schumann, Assistant Professor, Dept. of Plant Pathology, University of Massachusetts.

## CHOOSING COMPANION COMPOUNDS

- 1) Curative use needs a curative companion product.
- 2) Intervals should not exceed the limits of protection given by the companion product.
- 3) Systemic disease requires systemic partners.
- 4) Rates: for alternation: use FULL rates  
for mixing: it may be possible to use reduced rates but this must be tested by researchers

product to just one or two periods in a season when its utility will be greatest.

Tank mixes that incorporate multi-site contact fungicides with the at-risk fungicide minimize the chance of sudden, disruptive loss of disease control. For treatment of fungi such as pythium, alternating applications of effective fungicides with different modes of action should be used.

### Strategies by groups

Resistance has been documented in four major classes of fungicides: the dicarboximides; the benzimidazoles; the sterol demethylation inhibitors; and the phenylamides. Note that while the last three classes mentioned are systemic fungicides, the dicarboximides are contact fungicides that are resistance-prone due to their single-site action.

In the dicarboximide class, the single-site, contact fungicides iprodione and vinclozolin often provide excellent protection, but resistance to iprodione has been observed for dollar spot in Michigan and pink snow mold in Washington.

Cross-resistance to vinclozolin could also be predicted, since both

iprodione and vinclozolin have the same mode of action. For season-long protection against opportunistic fungal diseases such as dollar spot, it is advisable to start in spring with a broad-spectrum contact fungicide.

Early spring outbreaks of snow mold could be combatted through the

### *Avoid the repeated use of sterol inhibitors.*

use of non-dicarboximide fungicides, which have not shown evidence of resistance, especially against *fusarium nivale* strains. In this case, a broad-spectrum contact fungicide such as chlorothalonil could be used as a preventive, with additional curative power added by a benzimidazole, such as benomyl, when needed.

### Powdery mildew resistance

Benzimidazoles were once market-leading products due to their excellent control of dollar spot and brown patch, until resistant strains of dollar

spot developed in the late 1970s.

Resistant strains of powdery mildew and fusarium patch have also been observed with the benzimidazoles.

To extend the life of these valuable agents and keep resistant strains in line, application of a broad-spectrum contact fungicide can be recommended.

Applications of broad-spectrum contact fungicides kill resistant fungal strains and help to keep the overall balance of susceptible and resistant strains intact.

### Inhibitors are selective

Due to their selective, single-site action, sterol inhibitor fungicides, including triadimefon, propiconazol, and fenarimol, are likely to select resistant strains which will remain present in the resulting population.

Because all of these fungicides have the same mode of action, they cannot be alternated with each other or cross-resistance problems can occur.

Resistance to sterol inhibitors tends to develop more gradually, resulting in a gradual decrease in effectiveness over time. It is inferred that resistance to these agents is polygenic, requiring multiple gene changes over an extended period of time.

To keep potentially resistant strains in balance, the repeated use of sterol inhibitors should be avoided.

### Phenylamides and pythium

Effective treatment of *Pythium* sometimes requires the use of at-risk fungicides, despite potential resistance problems.

Resistance has been noted in phenylamide fungicides for systemic pythium control, particularly metalaxyl. Other *Pythium* fungicides include propamocarb hydrochloride, etridiazole, chloroneb and phosethyl aluminum.

Because each of these fungicides has a different mode of action, resistance to any one can be countered by switching to one or more of the others.

Broad-spectrum contact fungicides continue to represent the cornerstone of an effective, low-risk turf disease control program.

Intelligent use of broad-spectrum contact agents opens the door for more effective and timely use of powerful but resistance-risk fungicides, which can then be used at times when they are likely to do the most damage to the fungus.

In this way, their long-term efficacy can be preserved against the threat of resistance. **LM**





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# WHEN 'CHEMOPHOBIA' STRIKES

Industry must continue to develop lawn and landscape programs that provide economically sound pest management for turf while satisfying public concerns.

by R. L. Brandenburg, Ph.D., N. Carolina St. Univ.

**T**he past year has seen a dramatic shift in public concern over pesticides. All evidence suggests that these concerns, whether real or imaginary, will proliferate and create a greater demand for changes within the green industry.

So how is the industry to face this new challenge?

It is up to lawn and landscape professionals to help discourage this

pesticide phobia. The green industry needs to develop programs that provide economically sound pest management for turf and programs to satisfy the public.

#### Why the recent concern?

It appears the public has developed a recent fear toward scientific developments directed at benefitting mankind. Perhaps some of this fear is the

result of the media focusing on dramatic stories that emphasize the negatives of recent advances in pesticide use. Although informing the public of potential health risks is certainly the responsibility of the news media (and many do so quite accurately), some prefer to capture the public's attention with a flare for the dramatic rather than for the facts.

The concern in the turf industry has coincided with common fears of pesticide residues in food. The focus has been that we are consuming large amounts of pesticide residues. Frank E. Young, when he was the commissioner of the U.S. Food and Drug Administration, stated, "That's a myth, and another myth is that any residue, no matter how little or how legal, is harmful."

The public is confused. Not confused over the fears, but rather confused over the emotional stories and conflicting reports on the facts.

As recently as 20 years ago, science could detect residues only in parts per million. Levels of any substance up to 999 parts per billion were undetectable and showed up as zero residue. Now some substances can be found at one part in a quadrillion (1:1,000,000,000,000,000).

These measurements simply indicate an advance in science, not a new health risk.

On top of all this is the fact that some consumer groups consider turf a non-essential use of pesticides. However, turf is a valuable commodity in many states that introduces billions of dollars into the economy. Turf also provides oxygen, reduces pollution, stops erosion, reduces dust and contributes many other favorable attributes to the environment and our everyday lives.

As lawn and landscape professionals, your livelihood depends on educating the public on the facts of your operations and the pesticides you use. You must also know the facts concerning pesticide risks and be prepared to discuss them in an intelligent manner. To simply disagree and fight any non-pesticide group simply creates an "us-and-them" scenario in which no one benefits. At the same time, practicing good stewardship of both the environment and of pesticide use will help ease public fears. Through a better understanding, I believe we can prevent a "snowballing" effect of the "chemophobia"-based fears we are experiencing today.

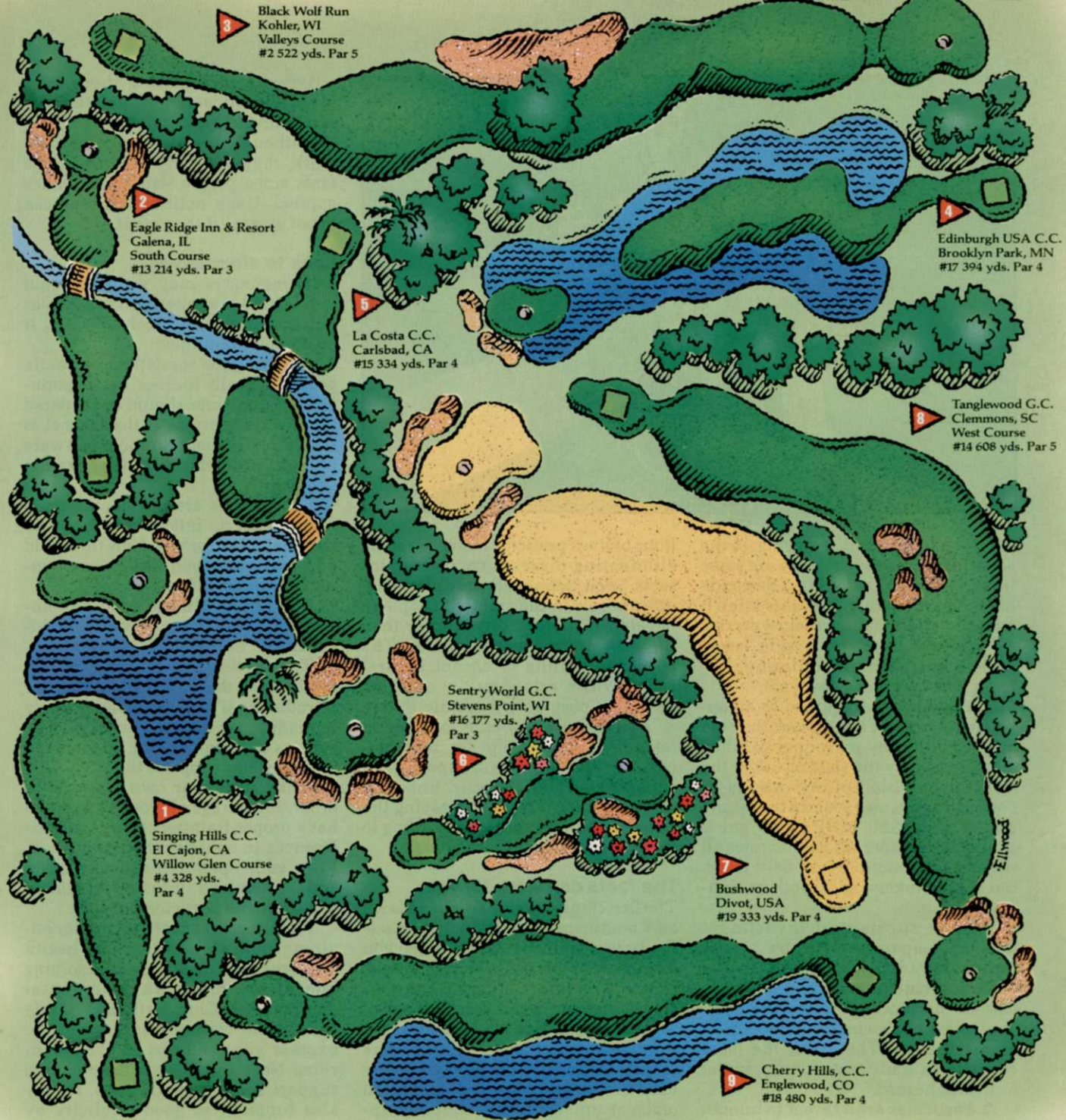
#### Fact vs. fiction

One of our most difficult tasks is separating fact from fiction. This is especially difficult since we sometimes



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even see scientists disagreeing on the same topics. However, there are some important facts that all turf pesticide users should know. With this knowledge at hand, intelligent answers can be provided to clientele with legitimate—but perhaps, unfounded—fears. The two major fears are:

**1. Pesticides are applied in a hazardous manner.** They are not; they are applied either by personnel certified and licensed by the state or under the direct supervision of one who is licensed. Companies spend 8 to 10 years and \$30 to \$50 million to get a pesticide registered. That includes all the research, not only on field trials, but also on toxicological and environmental studies.

Such a substantial investment pushes companies to insure proper limitations are placed on the label of each pesticide. Misuse could lead to loss of the product before the company even had a chance to recoup its research costs. Therefore, the label restrictions limit any environmental or health hazard.

**2. Pesticides are a threat to human health.** Not necessarily. The misinformed perception of natural vs. synthetic has fueled the fire over this. People perceive “natural” foods as being healthier, yet they contain a surprising assortment of substances that consumers aren’t aware exist in food.

It has been estimated that as much as 90 percent of our cancers may be related to the environment. Two articles in *Science* (April 17, 1987) present a startling presentation that the air we breathe in our home and other “natural” and daily aspects of life presents a much greater cancer risk than pesticide residues.

The public cannot forget the mil-

lions of lives pesticides have saved by eliminating diseases carried by insects. Such factors certainly play a significant role in the fact that people in developed countries live longer than those in underdeveloped ones. The public is willing to accept natural risks, while rejecting “synthetic” risks that pose only a minute threat.

Americans are living longer and healthier lives. Except for skin cancer, attributed to overexposure to sunlight, and lung cancer, linked to smoking, cancer rates are staying the same or have decreased, according to the National Cancer Institute.

### The facts can work for you

The first thing you should do as a lawn and landscape professional is to use the facts to your advantage. When you discuss pesticides with your clientele, present the information in a professional manner. Keep emotion out of the discussion. You may even want to develop a pamphlet containing some factual information to give your customers. Consult your local extension office or university for additional information on pesticides in turf.

The public has a right to know the facts. Developing a trust in you as their turf manager is a big step in the right direction. Dressing and acting in a professional manner is also critical to develop a good reputation in your clientele.

We also need to practice good stewardship of the environment and make sure we use pesticides wisely. Calibrate properly, apply as directed and don’t cut corners in safety. When accidents happen, it reflects on the whole industry.

Turf professionals can’t afford to fight the posting laws being passed in many states. Although this is a sen-

sitive subject, fighting these laws gives the appearance that there is something to hide.

Although these laws require extra work, they will help diminish some fears since people will know what’s applied. Upon notification, they can avoid an area if they want to.

### Look to alternatives

Turf managers may want to begin looking more at alternatives, such as cultural and biological controls, if customers want them.

Milky spore for Japanese beetle grubs is again increasing in popularity. Companies should be prepared to offer this service if the market is there. Turf managers should be aware of biological controls as they are developed.

Universities are developing more information on Integrated Pest Management (IPM) for turf. New threshold and scouting techniques are continually being refined.

The future will see a natural progression away from preventive treatments to “on demand” applications.

The public’s current concerns certainly make this an excellent time for introducing IPM. The public is likely to readily pay for such services. The success of turfgrass IPM programs in several states supports this.

Make sure your own house is in order. Encourage all your workers to have proper training and attend conferences to enhance their education. Keep your operation squeaky clean and be involved in the development of reasonable pesticide policy.

Finally, as an act of concern for environmental stewardship and health concerns, you might consider joining one of the many environmental groups (Sierra Club, National Wildlife Federation, Nature Conservancy) to express your interest in their concerns. Not only will your membership support these organizations, it may also function as good publicity by showing that groups should work together for the intelligent resolution of differences in goals.

### Decisions based on fact

This article is not meant to downplay the risks involved with the use of pesticides. They must still be properly used and applied. It does, however, present a scientifically-based report on their use in home lawns.

This information should be useful in minimizing the current fear many have of the green industry. The final decision on turf management lies with the homeowner; but let the homeowner decide based on facts, not on emotion. **LM**



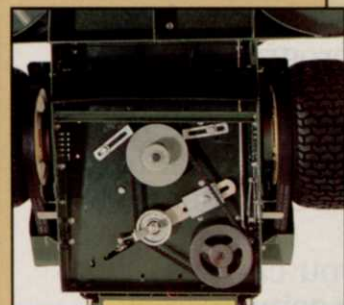
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