ulates pesticides based partly on the quantity used. While glyphosate's use will likely be limited to spot treatments, FQPA and the EPA does not necessarily use or in many cases have good data in decision-making. When bensulide came up for review under FQPA recently the report published in the federal register assumed the herbicide was used on golf courses across the country for *Poa annua* control; its use actually was largely limited to putting greens in certain geographic regions. Alar, a plant growth regulator once widely used for ripening apples, was cancelled after the public became aware and concerned about its widespread use (Meryl Streep, the famous actress, was involved in Congressional hearings to aid in getting Alar cancelled). Until science, not politics, dictates EPA actions these types of concerns have to be addressed by the suppliers and end users through lobbying and public education.

Development of resistance in natural weed populations. Some concern exists that herbicide-resistant turfgrasses will result in the development of herbicide-resistant weeds. One possibility is that pollen from GM turfgrasses would pollinate wild relatives. While the potential for this exists (Wipff and Fricker, 2000), the problem is mostly an issue in seed production areas. In turf situations mowing largely prevents seedhead formation. Even if hybridization does occur the extent to which it would become a problem is unknown. Weediness is usually a combination of many factors, including competitiveness during vegetative growth, production, dissemination, and longevity of propagules (seed, rhizomes, etc.). It is unlikely a single gene for herbicide resistance could increase competitiveness, and the trait may fail to be expressed in the absence of occasional herbicide application (Johnson and Riordan, 2000). Genes that confer tolerance to biotic stresses (drought, heat, etc.) could potentially increase weediness potential, but turfgrasses require a multitude of inputs in order for them to thrive. Technologies are being developed that can prevent transformed plants from becoming established in unwanted areas. "Terminator" genes can be added to kill a plant unless certain treatments are given. Research is also being conducted to control "promoters", those parts of DNA which determine when a gene will actually be expressed.

Some species have very limited ability to become cross-pollinated:

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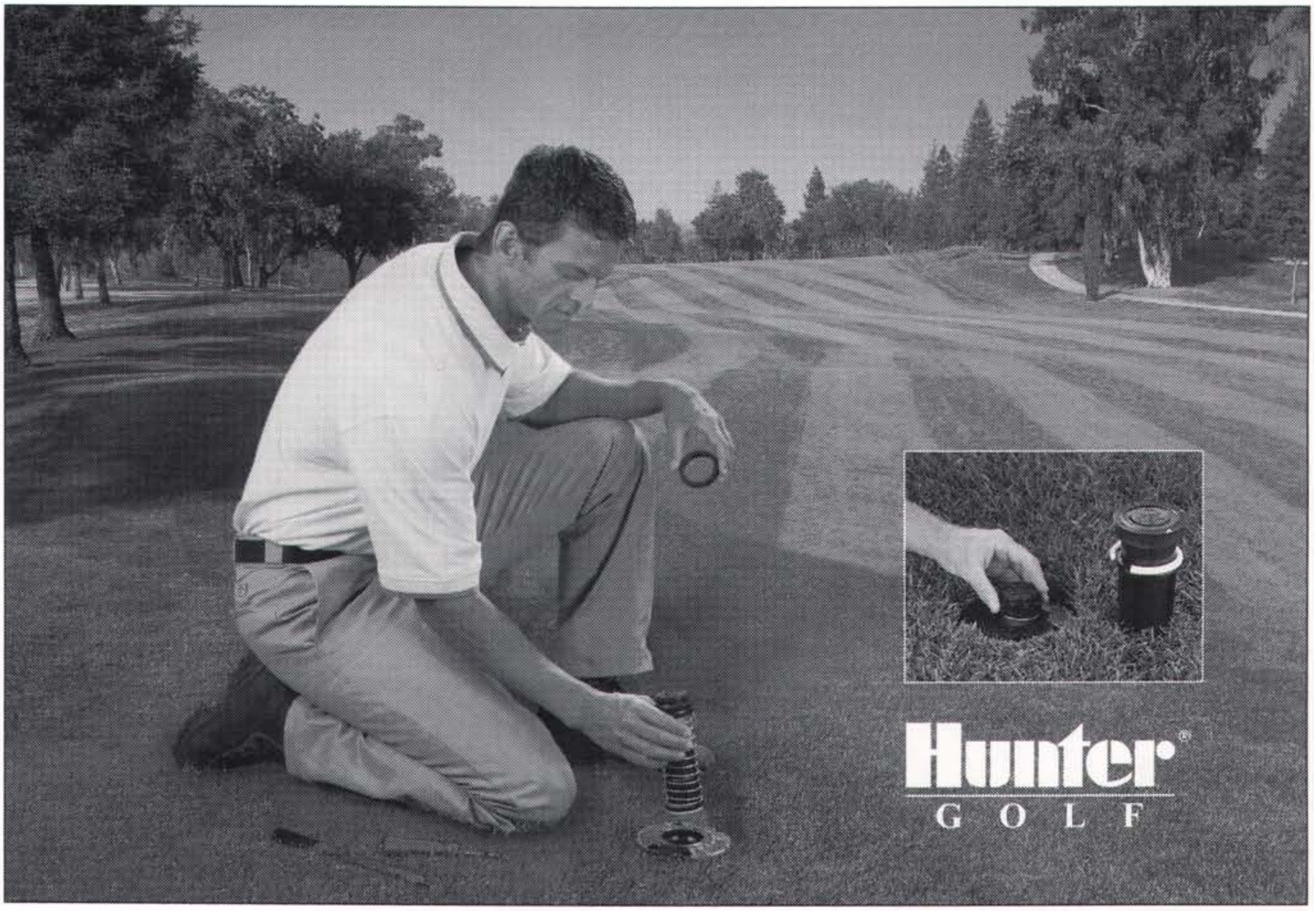

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Kentucky bluegrass, for example, is largely apomictic and cross-pollination is rare; other species such as *Poa annua* are self-fertile and the eggs are not always receptive to pollen blown from another plant. Of greater concern is out-crossing into other turfgrass seed production fields. If pollen from GM turf fertilizes even a few plants in a field which is not intended to be GM, the entire crop may be considered "contaminated". This could interfere with sales to locales or countries which have banned transformed plants. The European and Japanese public are especially anti-GMO.

A greater likelihood for development of herbicide-resistant weeds exists due to natural selection. Herbicide resistance of weeds has been documented for years in agricultural settings. In turf, *P. annua* is probably the most likely candidate to develop herbicide-resistant populations. *P. annua* is a relatively young species with many biotypes and it is quite possible some plants already exist which are naturally resistant to an herbicide such as glyphosate. If glyphosate is used exclusively a glyphosate-resistant population could develop. Unlike other grasses, *P. annua* is capable of forming seedheads at low mowing heights and pollen can be transferred between plants. In Australia, a ryegrass species (*Lolium rigidum*) has already been reported to be resistant to glyphosate (Johnson and Riordan, 2000). Resistant weeds will require alternate control strategies which may be as simple as switching to another herbicide.

One of the most ungrounded fears which is getting great press from the natural and native plants groups is that transformed, non-native species will move into "natural" areas and displace native species. This is unlikely because turfgrasses have been developed to require intensive care: regular mowing, fertilization, and irrigation. Transformed turfgrasses are unlikely to become a problem in conventional row cropping systems because they will quickly be shaded by the crops, the fields are routinely cultivated, and irrigation and fertility are generally limited.

To the end user the greatest problem may be lack of transformed turfgrasses for use. Since genes which are likely to be used in turfgrasses will probably be con-

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trolled by only a few companies, transformations will be limited to those varieties owned by those companies or to those varieties owned by companies which will enter into a contractual agreement with the gene-owning company.

The Ethics.

Ethics in science has always been subject to intense public scrutiny. In medieval times persons experimenting with science were deemed necromancers and witches. Conventional breeding of turfgrasses has been occurring for years: how is this different than using biotechnology to transfer genes? One could argue its not "natural" compared to conventional breeding which crosses genes within or between closely related species. Yet for years irradiation has been used to mutate plants, with over 1550 cultivars developed from this "unnatural" process (Rodgers and Parkes, 1995). People's perceptions vary widely. This past autumn I surveyed the advanced turf class students to determine their perceptions on biotechnology in turf. Keep in mind this is a group of well-educated students preparing to graduate, many of whom were in the top percentage of their high school class. The questions and response rates are listed in table 2. While all the students were comfortable with the idea of transferring genes between cultivars and species within a genus, not all were comfortable with genes being transferred between genera within a kingdom. Transfer of genes between plants and animals was unacceptable to 60% of the students. Only 30% of the students were comfortable with a hypothetical transfer of a gene from a plant into a human (some day humans may need to carry genes for chlorophyll production to exist in a crowded world). Ultimately the public determines what practices are ethically acceptable and this depends to a large degree on their state of knowledge.

Table 2. Response of upper-level turf students to questions regarding genetic transformations of turfgrasses, University of Wisconsin-Madison, 2000.

Question	Percent responding with a "yes"
Is it OK to insert a gene from one cultivar into another cultivar?	100
Is it OK to insert a gene from one turf species into another (e.g., Kentucky bluegrass into supina bluegrass)?	100
Is it OK to insert a gene from one turf genus into another (e.g., Seashore paspalum into creeping bentgrass)?	90
Is it OK to insert a gene for drought tolerance from the African lungfish into creeping bentgrass?	40
Is it OK to insert a gene from creeping bentgrass into humans to detoxify pesticide residues (over 50% of the genes are the same in plants and animals already)	30

Conclusion.

Despite public concerns over real and imaginary issues genetic modification of turfgrasses will proceed. It will not solve all problems, and will likely create some additional problems. In the end, it will provide some useful benefits, and the utility of turf and turf management practices will be etched up yet another notch from its humble beginnings centuries ago. What is needed now is a directed effort to gain public acceptance to minimize the public antipathy which is already occurring. It is incumbent on the turf industry to build public relations through education and to demonstrate the utility of GM turfgrasses. It is critical to provide clear answers to questions and concerns from the general public and the turfgrass manager. History shows that societies that embrace new technologies move ahead and prosper, while those that cling to the old ways wither and vanish (Diamond, 1997).

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Winter Wonderland
For The WGCSA Couples Dinner Dance

By Scott Schaller, *Golf Course Superintendent, North Shore Golf Club*

The 2000 WGCSA Couples Dinner Dance was at Trout Lake Golf and Country Club in Minocqua, Wisconsin on October 6th and 7th. Our gracious hosts were Dan and Sherri Barrett. The Barretts put a lot of time in preparing this event for the supers and their wives. The fall colors in the north woods were at their peak. All was set for an outstanding weekend retreat.

Well, little did we expect 8 inches of snow fall Friday night, into Saturday morning.

But this did not stop the 29 couples from having a **great** time up north. Yes, we missed out on playing a great old classic golf course, but Dean Musbach of Reinders Brothers organized and ran a fine hospitality room on Friday night and a wonderful dinner was served at Minocqua Country Club with an excellent band keeping the crowd pretty lively all evening.

The snow was the only disappointing thing about the weekend, especially when the next three weekends in Minocqua were in the mid 60's. But the good news about all of this was that we will be heading up there again this fall to get the whole experience of the great north woods including golf. Mark off the dates October 5th and 6th on your social couples calender. Dan and Sherri Barrett have promised a great time with great weather. See you there.

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The WGCSA and all of its members truly **thanks** all of the above contributing vendors.

Its appreciated by **all** and with your support we are able to promote this WGCSA event.

Clubhouse and grounds at Trout Lake G&CC in Minocqua on the morning of October 7, 2000!

Dean Musbach's truck on the morning of the second day of the Couples Weekend!

No golf on the 13th green this day in October!

Dinner Dance host Dan and Sherrie Barrett.

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Fungicides: What You Should Know

By Jeff Gregos, *TDL, Department of Plant Pathology, University of Wisconsin-Madison*

Part I: Formulations and Topical Modes of Action

Following my presentation on fungicides at the Wisconsin Turfgrass and Greenscape EXPO, I have received numerous e-mail requests for the outline of the material I presented. With most of you developing your management plans for this year, this might be a good time to share some "back to the basics" information with you. The more that you know about a fungicide, the better off you will be as a consumer and the more efficient your fungicide program will be.

Over the next three issues of *The Grass Roots* I will be detailing everything that you should know about fungicides. In this article I have taken an in-depth look at formulations and topical modes of action. In the May/June issue I will be concentrating on fungicide families and host/pathogen interactions. The final installment will be an article on fungicide resistance and management programs to prevent resistance. Enjoy the series, and if you ever have questions on fungicides, I am only an e-mail or a phone call away.

Fungicide vs. Fugistat

Even though we commonly refer to our disease control chemicals as fungicides, this is actually incorrect. Most of the fungicides used today are actually fungistats. If you break down the root word of fungicide ("fungi", fungus, and "cide", to kill), this would mean that we would only have to spray the fungicide once. But we all know this isn't the case. What a fungistat actually does is inhibit the growth of the fungus either by preventing germination of spore or inhibiting hyphal growth. In simpler terms you could consider fungicides as growth regulators of fungi. This inhibition usually occurs for a determinant amount of time, due to the expected life of the chemical.

Formulations

There are four major formulations that fungicides are manufactured as; granulars, wettable powders, wettable granulars, and liquids. Granulars (G) are usually applied to a fertilizer, clay, or corncob carrier. The amount of active ingredient in these products is reported as a percentage. An example of this is Turfcide 10G, where the amount of active ingredient is 10%. Knowing how active ingredients are labeled for percentage can aid in product and price comparison. This is the only formulation that is applied to the turf in the dry form.

Wettable powders now come in two forms, WP (Wettable Powders) and WSP (Water Soluble Packet). Both of these forms are the same, with the only difference being the packaging. The WSP have become more popular recently due to limited exposure to the handler. The water-soluble packet can be added directly to the tank, and the packaging material will dissolve in water. Care should be used in storing and handling to prevent the packaging from getting wet. It is also a good idea to dissolve the packets in a bucket and then pour the bucket into the spray tank. Like the granulars and the wettable granulars, wettable powders active ingredient is labeled as a percent. Prostar 70WP is an example of a 70% wettable powder.

The next group probably has the largest collection of formulations and very little differences among them. A majority of the difference is based on what the different manufactures decided to call them. This group includes Wettable Dry Granulars (WDG), Wettable Granulars (WG), Dry Granulars (DG), and Extruded Granulars (EG). You may also find some of these formulations as WSP's. In general, the size of the particle in these products makes them more convenient to handle because less dust is given off when weighing or mixing. As mentioned above, these products are measured in percent A. I. An example of this is Bayleton 50 DF. The wettable powders and wettable granulars go into suspension when mixed with water, therefore it is important that proper agitation is provided when using these products.

The final group of formulations is the liquid forms, which include Flowables (F), Soluble Concentrates

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