uations. To be consistent, and to generate scientific data, a management program needed to be maintained equally across all cultivars.

Mowing heights, topdress frequency, grooming, nitrogen application rates, disease management and other cultural practices can differ greatly from one cultivar's needs to another. For example, large differentials in dollar spot (*Sclerotinia homoeocarpa*) susceptibility occurred with several cultivars.

If a plan were implemented based on suppressing symptoms of a disease-prone cultivar, over-application of plant protectants would be applied to other less disease-prone cultivars. This high application rate may mask disease symptoms that may otherwise be found on a susceptible cultivar .

At first it was a struggle developing a management plan, for it could impact quality ratings on certain cultivars. Common sense dictated not to tailor to individual cultivar needs but to manage everything as a general stand of turf.

I subscribe to "less is better" most of the time. In general, daily mowing heights were maintained at 120 to 125 thousandths of an inch. We topdressed every three weeks. There was daily grooming, water as needed and fertilizing based on soil and tissue tests and according to general color and clipping yield.

Disease controls applied only as needed based on symptoms observed on least disease-prone cultivars. Under this disease management program, cultivars prone to dollar spot got pretty ugly at times. It demonstrated clearly that great differentials occur with plant genetics vs. susceptibility to various diseases.

Data generated from this study would prove very useful to anyone selecting a new turf for putting green construction or overseeding. Perhaps less obvious is the useful information gained from the study on how to best manage these new cultivars.

The test green attracted a lot of attention from many individuals, stimulating much discussion on various management issues. Voigt, Randy Kane, Hank Wilkinson, Bruce Branham, Tom Fermanian, Andy Hamblin, USGA agronomist Paul Vermeulen and others combined with experiences from the study, contributed to a database on how to best manage various cultivars.

What makes on-site testing fairly unique are the tools and resources available. Better understanding the impacts of such inputs prove helpful and adds direct correlation to the practitioner. We all learned from each other in a growing environment found at most courses.

TABLE 1

NTEP On-site Green *Poa* Overseeding Rating

North Shore Country Club
(rated May 10, 2004)

	Percent Poa		
Cultivar	**Seeded**	**Unseeded**	**Standard Deviation**
L-93	23.3	13.3	8.2
Putter	21.7	16.7	4.9
Cato	26.7	20.0	7.5
Crenshaw	12.7	18.3	8.3
Grand Prix (LCB-103)	6.0	4.3	2.6
Penncross	23.3	21.7	10.4
Backspin	10.0	8.3	3.8
Trueline	13.3	13.3	4.1
Providence	11.0	8.3	3.3
SR 1020	21.7	15.0	11.3
SR 1119	13.3	9.3	2.9
Viper	23.3	20.0	6.8
Century	11.0	6.0	6.2
Imperial	7.3	5.0	2.0
Penn A-1	5.0	4.3	2.6
Penn A-4.	4.3	4.3	2.7
Penn G-6	11.0	8.3	4.5
Penn G-1	8.7	6.0	4.7
LSD 0.05	8.4		

Mean for seeded plots = 14.1; mean for unseeded plots = 11.3

The $64 question

"Which cultivar is the best?" is the key question. One might think that question deserves an easy answer. The best way I can respond is by first sharing which cultivars performed poorly. Often this relates to a cultivar's susceptibility to diseases. Color, texture and general quality did differ, but differences could be challenged with some if the varieties were not grown side-by-side.

I feel many cultivars can produce high-quality putting surfaces. In part, selecting the best cultivar relates to the level of commitment and resources available at each site. The higher-density cultivars require management practices that differ from those with half the shoot density. Like any relationship, the best fit is one where both parties can fulfill one another's needs.

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Color, texture and general quality did differ, but differences could be challenged with some if the varieties were not grown side by side.

TABLE 2

North Shore NTEP Disease Rating (June 9, 2004)

Plot #	Cultivar	Dollar Spot %	LSD		Bipolaris %	LSD**		Moss %	LSD**
15	A-1	0.00	a	Dominant*	0.00	--	A-1	0.00	a
19	Dominant*	0.00	-	L-93	0.00	a	Dominant*	0.00	--
18	G-1	0.67	ab	L-93+SR 1119*	0.00	--	L-93+SR 1119*	0.00	--
1	L-93	1.00	ab	SRX1DIN*	0.00	--	Providence	0.00	a
22	L-93+SR 1119*	1.00	-	Providence	0.00	a	SRX1DIN*	0.25	--
20	SRX1DIN*	1.25	-	SRX1120*	0.00	a	A-4	0.33	ab
9	Providence	1.33	ab	A-4	0.00	a	Backspin	0.33	ab
21	SRX1120*	1.50	-	SR 1119	0.00	a	G-1	0.67	ab
8	Trueline	1.67	ab	Century	0.00	a	L-93	0.67	ab
17	G-6	2.33	ab	G-6	0.33	ab	G-6	0.67	ab
3	Cato	3.67	ab	LCB-103	0.33	ab	Putter	1.33	ab
6	Penncross	3.67	ab	Viper*	0.50	--	LCB-103	1.33	ab
16	A-4	4.00	ab	A-1	0.67	ab	SR 1119	1.33	ab
2	Putter	6.67	abc	G-1	0.67	ab	Crenshaw	1.33	ab
5	LCB-103	8.33	bcd	Trueline	0.67	ab	Trueline	1.67	ab
12	Viper*	8.50	-	Imperial	0.67	ab	SR 1020	1.75	ab
11	SR 1119	12.33	cde	Cato	1.00	ab	Cato	2.00	ab
10	SR 1020	15.50	de	Penncross	1.00	ab	Imperial	2.00	ab
7	Backspin	16.67	e	Backspin	1.00	ab	Century	4.00	bc
14	Imperial	16.67	e	Crenshaw	1.00	ab	Penncross	6.00	c
4	Crenshaw	18.33	e	Putter	2.00	b	Viper*	6.00	--
13	Century	20.00	e	SR 1020	2.00	b	SRX1120*	15.00	--

* — Not averaged over at least three reps or randomized. ** — Pr>F values not significant (Bipolaris = .47, Moss = .32, should be less than .05). Therefore statistical separation of means is not permissible because it is not clear if the different cultivars had any influence on pest presence.

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Now that the formal five-year commitment has been completed, we are free to look into other questions on potential cultivar differences. Competitiveness against *Poa annua*, ball mark recovery, long-term genetic disease resistance, genotype segregation, cultivar response to various *Poa annua* control chemistries, tolerance to ultra-low mowing heights, drought tolerance and attraction to plant parasitic nematodes, to name a few.

With help from Branham and Voigt and Kane of the Chicago District Golf Association, several of these questions are already being addressed.

A *Poa annua* study is underway to evaluate the bentgrass cultivars' competitiveness against *Poa annua*. In June 2003 *Poa annua* seed was used to overseed each variety cell. After double-core aerification with three-eighths-of-an-inch tines, the replicated 5x10-foot plots were divided in half, overseeding only half of the cell. A 5x5-foot isolation box was used to ensure no seed escaped outside the overseeded area.

Before removing the isolation box, the seed was worked in with a broom. Upon completion of the overseeding process, the entire green was topdressed with straight sand and watered in.

Over a several years we hope to see differentials of *Poa annua* establishment in cultivars. The second part of the study will include two objectives: to evaluate variety's tolerance to *Poa annua* control products and varieties ability to out-compete *Poa annua* when control products are implemented.

Overall, the study was very beneficial to our industry and especially fruitful for us in the Chicago area. We will continue to observe and utilize the on-site test green as a research site.

Visitors are always welcome to observe for themselves the evaluation plots. I also have other data easily shared via e-mail or hardcopy.

Dan Dinelli, certified superintendent of North Shore Country Club in Chicago, can be reached at ddinelli@aol.com. A version of this article appeared on the Tee-2-Green Web site, www.tee-2-green.com.

Weed-Free — Big Wish for Little Ponds

Winter is the time to prevent an aquatic hijacking this spring

By Stratford H. Kay

Editor's note: This is a follow-up piece to an article published in the May 2004 issue of TurfGrass Trends.

Aquatic weed problems are commonplace in small, shallow ponds, especially golf course ponds and other ponds surrounded by high-maintenance turf because of high nutrient availability from the surrounding watershed.

Weed problems may occur at any time of the year but are particularly prevalent from mid-spring through early fall, when the water is warm. Generally weeds begin to die and drop out by mid-fall and do not become troublesome again until the water temperatures stabilize above 60 degrees to 65 degrees in the spring. Fall and winter are excellent times to plan aquatic weed management operations for the coming growing season.

This also is the time to implement preventive maintenance as well as new management practices in the surrounding watershed that will help reduce nutrient runoff into your pond.

Prepare now for this spring

An understanding of the origins and causes of weed growth in small ponds is necessary to develop effective aquatic weed control and preventive maintenance programs for shallow ponds. The primary causes of aquatic weed problems, as emphasized in the May 2004 article, are the presence of clear, shallow water, which permits sunlight to penetrate to the pond bottom, and an abundance of nutrients (particularly nitrogen and phosphorus) that promote weed growth.

Aquatic plants may contain as much as 98 percent of their fresh weight as water, so it takes relatively low levels of nutrients in the water to produce a significant weed problem. Intentional planting of aquatic vegetation to "beautify" the pond (also called aquascaping) is another common source of aquatic weed problems. These introduced plants sometimes spread in the shallow waters and become weeds themselves. More often, however, the plants come with undesirable, contaminant plants or "hitchhikers" (e.g., duckweed, watermeal, waterferns and hydrilla), which then establish and begin to grow uncontrollably. The growth of these hitchhikers also is enhanced by the shallow water environment and nutrient abundance described previously. The best preventive maintenance for small, shallow ponds is to deal with the clear, shallow water and nutrient conditions that promote weed growth and to prevent weed introductions.

An effective preventive maintenance program has four primary components: observation, identification, planning and implementation.

First, observe regularly for signs of weed growth regularly throughout the year. It is necessary to look down into the water to see what may be growing on the pond bottom. A small garden rake is useful for this purpose. Also look for aggressive plant growth along the edges in very shallow water and for scum and other small plants floating just below or on the surface, especially on the downwind side of the pond (duckweeds, watermeal and other small plants tend to blow to the downwind edge). If you see anything unusual, have it identified and implement the appropriate management procedures immediately. Don't wait for it to become really bad before you worry about it. It is best to do this in spring or early summer before the water becomes too warm and plant growth gets out of hand. Also, if algaecides or herbicides are needed, the water will be cooler and the likelihood of a fish kill because of oxygen depletion is significantly less than during mid-summer.

Second, if you had a weed problem in this pond previously and did not conduct any weed management, the weeds most likely will

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For effective weed suppression, a pond needs to have very little water, preferably less than 2 feet deep.

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still be there the following spring. In this case, you need to consider what types of weeds were present last year. Accurate identification is crucial to effective prevention and management. This will provide a beginning point for planning your preventive maintenance strategy. Even if you did not have a weed problem previously, it's still wise to consider a program to prevent weeds from establishing. This is especially important if your pond is near potential sources of weed infestation.

Third, in planning your management program, you must consider what options may be practical for your particular pond as well as economically feasible and effective for your specific situation. This planning phase normally begins in late summer or early fall, when you still have plant material available for identification. Consult with a trained and licensed aquatic weed management specialist to determine best options for your pond.

Finally, you need to implement your management program before the weed growing season begins. The timing of implementation is very dependent upon the nature of your management plan and normally should begin in late fall to early winter. Waiting too late is a common mistake made by pond owners and managers. Once active weed growth begins, you are entering the phase of active management. At this time, preventive maintenance no longer is an option.

Preventive maintenance options

The type of preventive maintenance options that are effective and practical depend upon the size of the pond, what type of weed problems were present previously, and how severe the weed problems were. Once you have determined which options will be effective for your specific weed problems, you must consider the cost and time limitations.

Cost may be an overriding factor in your choice of maintenance methods, particularly if funds are limited. Time also is critical. You must have time to implement your plan before the warm weather begins. Some methods, such as draining, silt removal and installing a sediment basin will require several months or longer.

If you are planning to use one or more of these options, you also must consider the use of the pond during the following growing season — particularly if it may be needed for irrigation. In some cases, your pond may be out of operation well into or beyond the next growing season. Several potential options available for preventive maintenance of small ponds during the off season are discussed here:

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TABLE 1

Relative effectiveness of different management options on selected aquatic weed species.[1,2]

TARGET WEED	GRASS CARP	COPPER	DIQUAT DIBROMIDE	ENDOTHALL	GLYPHOSATE	FLURIDONE[3]	TRICLOPYR AMINE	2,4-D
ALGAE								
Filamentous algae – most species	NR	G	E	E[3]	NR	NR	NR	NR
Pithophora, Spirogyra, Lyngbya	NR	G	E	E[3]	NR	NR	NR	NR
Macroalgae – Chara, Nitella	E	G	E	E[3]	NR	NR	NR	NR
FREE-FLOATING PLANTS								
Duckweed	NR	NR	G	P	NR	E	NR	NR
Watermeal	NR	NR	NR	NR	NR	G	NR	NR
Mosquito fern (Azolla)	NR	NR	G	NR	NR	E	NR	F
Waterhyacinth	NR	NR	G	NR	F-G	NR	E	E
SUBMERSED (UNDERWATER) PLANTS								
American elodea	E	F	E	E	NR	E	NR	NR
Bladderwort	G	NR	G	P	NR	E	F-G	G
Brazilian elodea (Egeria)	G	G	E	P	NR	E	NR	NR
Brittle naiad (Najas minor)	E	NR	E	E	NR	E	NR	NR
Coontail	G	NR	E	E	NR	E	G	G
Eurasian watermilfoil	P	NR	E	E	NR	E	E	E
Hydrilla	E	F	E	G	NR	E	NR	NR
Parrotfeather	P	P-F	G	G	NR	E	G	E
Pondweeds (Potamogeton)	E	NR	E	E	NR	E	NR	NR
Southern naiad	E	NR	F	P	NR	G	NR	NR
Proliferating spikerush	E	NR	NR	NR	NR	E	NR	NR
Variable-leaf milfoil	P	NR	E	G	NR	E	G	E
EMERGENT AND FLOATING-LEAF PLANTS								
Alligatorweed	NR	NR	NR	NR	G	P	G	P
American lotus	NR	NR	NR	NR	E[4]	P	G	G
Bulrushes	NR	NR	F	NR	E	NR	NR	G
Cattails	NR	NR	F	NR	E	P-F	NR	P-F
Creeping waterprimrose	NR	NR	NR	NR	G	P	G	E
Grasses – most species	NR	NR	F	NR	E	NR	NR	NR
Pickerelweed	NR	NR	P	NR	G	F	G	G
Rushes *(Juncus)*	NR	NR	NR	NR	F-G	NR	NR	P
Smartweeds	NR	NR	F	NR	G	F	P	G
Spatterdock	NR	NR	F	NR	E[4]	G	G	G
Waterlilies *(Nymphaea)*	NR	NR	P	NR	E[4]	G	G	G
Water pennywort	NR	NR	G	NR	F-G	F	G	G
Wateshield	NR	NR	F	F	F[4]	G	F-G	E

[1] All herbicides listed except copper products have one or more water use restrictions following application. These restrictions vary widely with product and formulation. Consult the label for details.

[2] Relative effectiveness: NR=not recommended; E=excellent; G=good; F=fair; P=poor

[3] Note: only the amine salt (Hydrothol 191) has algicidal properties; the di-potassium salt (Aquathol) will NOT control algae.

[4] Care must be taken to prevent splashing and waves to keep the product from washing off the surfaces of floating leaves.

[5] Fluridone requires a long contact time. It should not be applied in areas of significant and continuous water flow. Split applications and/or use of slow-release formulations will extend the contact time in areas of slow to moderate water movement.

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Pond dyes Using a pond dye to block light penetration to the pond bottom is an inexpensive and effective method to prevent growth of filamentous algae and submersed (underwater) weeds. Pond dyes usually are applied at 1 gallon per acre (based on an average pond depth of 4 feet) for algae and most submersed weeds. A few plants, such as hydrilla, require 2 gallons per acre. For effective weed suppression, the pond needs to have very little water less than 2 feet deep. In areas shallower than 2 feet, algae and other weeds can grow even though a pond dye is used. Pond dyes can provide effective weed control for six months or longer, depending upon how much outflow occurs. They occasionally may suppress floating-leaved weeds (American lotus, fragrant water lily) in deep water but will not prevent their growth in shallow water. Pond dyes are not effective on floating plants (duckweed, watermeal, water hyacinths, etc.) or on emergent vegetation (cattails, rushes, bulrushes, etc.) growing around the pond margin.

Grass carp Stocking grass carp at low rates (three to four fish per acre) may be an effective preventive measure for submersed weeds. These low rates are not effective in ponds where there already exists a significant submersed weed population. In a few states, grass carp are illegal. A permit also may be required to purchase grass carp. Check with your state fisheries agency to determine the legality of stocking grass carp and whether or not a permit is required.

Pond draining Draining the pond (i.e. water level manipulation) partially or entirely in the winter is inexpensive and may be effective for suppressing many submersed weeds and filamentous algae. To lower the water level in a pond, you must have a water control structure that can be opened or closed at will. The water level should be kept down for at least three months during winter, and the pond should be refilled before spring. If fish are an important resource, do not completely drain your pond.

Sedimentation basin One of the major problems in small ponds is the tendency to fill in with sediment over time, thus creating shallow water areas suitable to colonization by aquatic weeds. One effective way to reduce sedimentation is to construct a smaller pond just above the main pond to function as a sedimentation basin. During periods of heavy rainfall and accompanying erosion, suspended sediment in the inflowing stream will be deposited largely in the sedimentation basin. Cleaning out a small sedimentation basin is much easier and cheaper than doing the entire pond.

Pond reconstruction Pond reconstruction is an effective method of reducing weed problems in old ponds, but it's quite expensive (up to $10,000 or more per acre). This usually involves, at the minimum, dredging (or bulldozing of a drained and dry pond) the shallow, silted-in areas of a pond.

A complete pond reconstruction will require rebuilding of the dam to current specifications, constructing a new water control device and overflow spillway and, very often, building a sedimentation basin above the larger pond. Reconstruction can be done at any time of the year when the necessary equipment can get to the pond and will require several months to more than a year to complete, depending upon pond size and the extent of the reconstruction. You also will have to restock the pond with fish after it is filled again. This method removes soil and sediments that contain roots and seeds of many weeds. It will not be effective in preventing the re-establishment of small floating plants such as duckweed and watermeal, which are readily transported by waterfowl and other wildlife.

Additional information on pond construction and reconstruction can be obtained from your local Natural Resources Conservation Service (formerly the Soil Conservation Service) office.

Before you accept any plants, examine them closely for unwanted "hitchhikers," such as duckweed, watermeal, and other species that might infest and quickly overtake your pond.

Watershed management practices

Changes in management practices in the watershed surrounding the pond and along inflowing creeks or ditches will help prevent the conditions that promote aquatic weed growth, particularly sedimentation and nutrient runoff. This entails establishing a vegetated buffer at least 50 feet wide around the pond and its inflowing water sources.

Direct drainage into the pond from culverts also is a major issue, particularly if the culverts collect water from high-maintenance turf or from subsurface drainage for golf course greens. In this case, building runoff water retention basins and rerouting runoff and drainage water into these basins may be quite effective in preventing nutrient and silt from entering the pond. This is especially true if outflow from the retention basin then passes through grass filter strips or another vegetated buffer before it can enter the pond or the inflowing stream.

Allowing native vegetation to colonize the pond margin and form a buffer is partly effective in reducing nutrient and sediment runoff. On golf courses, industrial campuses and in housing complexes, the purchase and planting of wetland plants around the pond and inflowing creeks may produce more satisfactory appearance in the buffer zone than simply allowing native vegetation to colonize on its own. If this approach is used, use only plants that are native to your state and purchase them from a local wetland plant dealership.

Perennial plants are more effective than annuals. Your state department of agriculture should have a listing of wetland plant nurseries. Before you accept any plants, examine them closely for unwanted hitchhikers, such as duckweed, watermeal, and other species that might infest and quickly overtake your pond. Avoid water primroses, cattails, lotus, spatterdock, and fragrant water lily, as these tend to be aggressive and may become a problem.

Also avoid planting any type of submersed plants (often marketed as oxygenating plants) such as coontail or the water milfoils, as these can readily become problematic in small ponds.

Among the more attractive and acceptable perennial herbaceous species native to many regions of the country and which establish easily are soft rush, bulrushes, pickerelweed, arrowhead and arrow arum. Trees and shrubs such as black willow, alder, and buttonbush are excellent choices for both appearance and bank stabilization. A good ground cover of perennial grasses within the 50-foot buffer zone also is useful.

Finally, remember that preventive maintenance and one or more watershed improvement practices constitute only a part of a successful aquatic weed management program. Equally important to successful aquatic weed management are maintaining a constant vigil and taking immediate action when nuisance aquatic vegetation appears. Always seek reliable sources of information and recognized professional expertise when developing and implementing your pond management plan.

Stratford H. Kay, Ph.D., currently is working with the North Carolina Division of Water Quality's Watershed Assessment Team. An aquatic resources management specialist and consultant, he can be reached in Fuquay-Varina, N.C., at skay3409@earthlink.net.

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No Objection to Injection

The technology has changed and more superintendents are sold on the benefits of fertigation

By Anthony Pioppi, Contributing Editor

The way Allen Olson sees it, there's just no reason for superintendents to be living without fertigation.

"It's got a lot of things going for it. If a superintendent is squeezed for time, squeezed for manpower, he'll be getting a better job," Olson says.

OK, so Olson may be more than a little biased since he's the product manager of fertigation systems for Dallas-based Flowtronex PSI. All favoritism aside, the numbers bolster Olson's enthusiastic endorsement. More than 50 percent of all irrigation systems being installed in the United States, whether in a new course or for an upgrade on existing layouts, have fertigation equipment as part of the package. In some areas of the country, such as the Southwest and Southern California, more than 90 percent of the systems are now fertigation-friendly.

The systems have long been a favorite of grow-in superintendents, while superintendents at existing courses have been slower to come around. Olson says that has changed.

"It's best use is for color and growth maintenance through the growing season," Olson says. "It's a beautiful tool for that."

Fertigation made its debut in Florida during the mid 1970s, but it took awhile to catch

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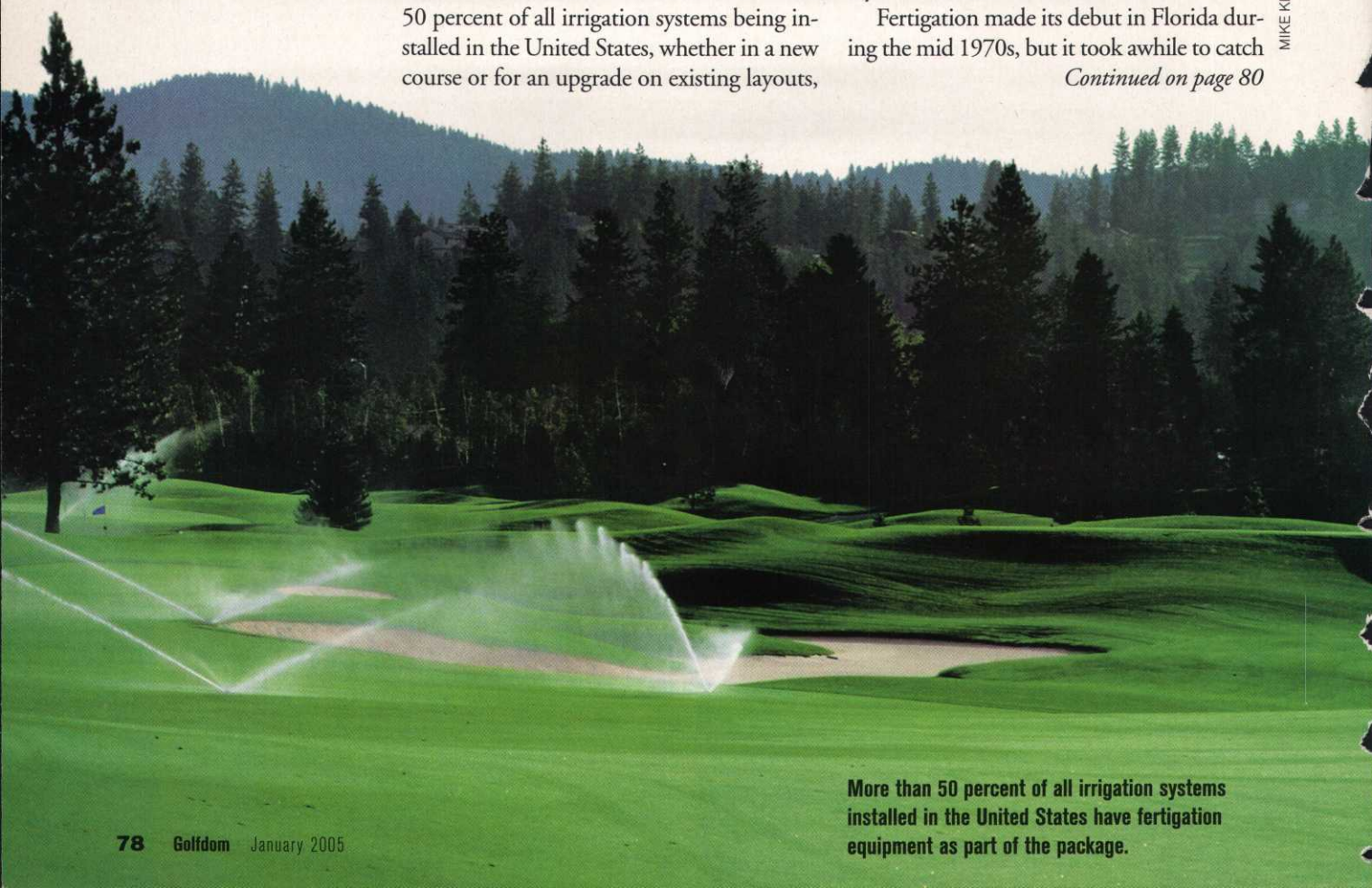

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More than 50 percent of all irrigation systems installed in the United States have fertigation equipment as part of the package.

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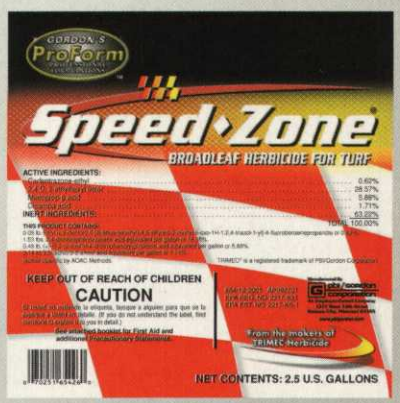

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Some superintendents have found turf to be disease suppressive as the result of fertigation.

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on in other regions. Initially the technology and fertilizers held the concept back.

"Strange things happened. There were problems with the equipment, and combos of fertilizers did not blend well," says Dave Davis, owner of David D. Davis Associates, an irrigation-consulting firm based in Crestline, Calif.

According to Davis, fertigation took steps forward about 20 years ago.

"The technology started to change," he says. "Fertigation had always been a tool for agriculture and it became one for turf, as the golf course business truly became a business."

The fertigation equipment came with automatic controls and metering that changed as flow rates changed.

In the middle 1990s the industry saw an influx of new companies, which Davis says were often run by retired college professors. As this happened the systems continued to improve and turned out to be a labor-saving device for the golf course.

Running between $6,000 and $20,000, fertigation for most superintendents is a needed hand that pays itself off in a short period of time. The low-end price is for a one-pump system while the high end is for three pumps that each work at their own rates.

Besides never having to delay play (lost revenue) and never having to commit a worker to spraying, the proper fertigation technique can also reduce the amount of fertilizer used.

"It's a great tool for saving labor," says Greg Bergwin, a superintendent who is now chief operating officer of Liquigistics, a manufacturer of fertigation and water treatment systems.

Olson says even a reduced amount of nitrogen can be used more efficiently by the plant, with some superintendents finding disease suppression as a result of fertigation. As Olson points out, using less fertilizer has benefits other than saving money. "If we can be more environmentally sensitive, we should be," he says.

Part of that equation, according to Bergwin, is to make sure the spray program used by a course is site specific. For some superin-

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