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Pesticides on Golf Courses: Mixing Toxins with Play?

By Caroline Cox

Is "an oasis of burbling creeks, swaying trees, and rolling seas of shimmering green"[1] an appropriate description of a golf course? Or would "a toxic waste dump, a destroyer of wetlands, and a misuse of farmland and water"[1] be more correct? What does pesticide use on golf courses mean for golfers, nearby residents, wildlife, and the environment in general? Consider the following stories:

Miami, Florida: "One year, in a tournament near Miami, I had to withdraw after thirty-six holes. The course had been heavily sprayed, and there was weed killer in the lake. When I got to the course for the third round, I couldn't hit a wedge shot thirty yards—I didn't have enough strength. My eyes were bloodshot, my complexion was very ruddy, and my right hand was swollen from taking balls from the caddie. My doctor said it was acute pesticide poisoning." *—Billy Casper*[2]

(Billy Casper was one of the top professional golfers in the U.S. during the 1960s. He won 51 major tournaments during his career and is in the golf Hall of Fame.)

Hempstead, New York: Following an application of the organophosphate insecticide diazinon to several fairways of the Seawane Harbor Golf Club, a flock of Brant geese came to feed in the treated area. That evening, several hundred of the birds were dead on the golf course and in the nearby harbor. During the next few days, a total of 546 dead geese were collected, and many more birds died in the harbor. Tests showed that diazinon residues in the birds were high, and the acetylcholinesterase (the enzyme inhibited by diazinon) activity in the Brants' brains was depressed by over 80 percent.[3]

Shizuoka, Japan: "For the first time in Japan, something other than liberal dosings of agricultural chemicals will be used to keep pests from ruining pristine greens and fairways on a golf course. Japan's first chemical free golf course, to be built near Lake Hamana in Hamamatsu, Shizuoka-ken, will be protected by heat-treating the soil using organic farming technology, it was reported Friday.

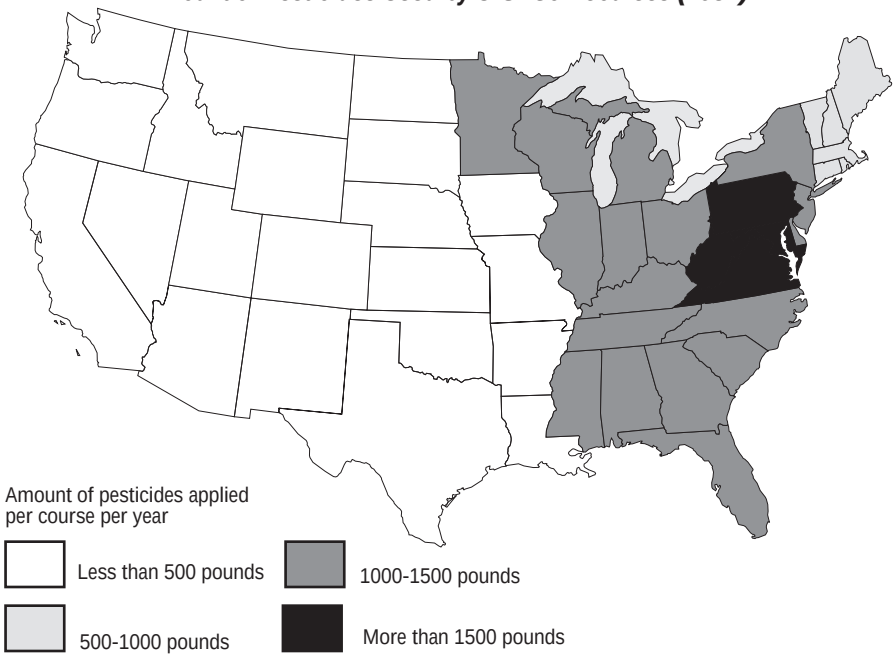
"Environmental pollution caused by agricultural chemicals used on golf courses has become a serious problem…."[4]

What Are the Problems Associated with Golf Course Pesticide Use?

The pesticides used on golf courses have the potential to cause problems for several reasons. Pesticides are applied at a high rate on golf courses, and the courses are repeatedly used by many people. Pesticides used on golf courses, as is true with most pesticides, are often acutely and chronically toxic to humans and wildlife, have not yet been completely evaluated by U.S. Environmental Protection Agency (EPA), and are used in combination with so-called "inert" (secret) ingredients whose identity is protected by trade secrets. Finally, pesticide contamination can move beyond golf courses themselves. Perhaps the best studied examples are those in which golf course pesticides have contaminated groundwater.

High Usage: EPA's most recent survey of national golf course pesticide usage, conducted by the American Association of Retired Persons in 1982, showed that golf courses applied an average of over three and a half pounds of herbicides per acre per year, a similar amount of fungicides, and about two and a half pounds of insecticides per acre per year. Total pesticide use was over nine pounds per acre. In some regions of the country, an average golf course uses over 1500 pounds of pesticides per year.[5] (See Figure 1.) This is much more intensive pesticide use than typical agricultural applications of pesticides, which average less than a pound per acre per year.[6] A recent survey of golf courses on Long Island, New York, found similar pesticide use rates,

Figure 1
Amount of Pesticides Used by U.S. Golf Courses (1982)[5]



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seven pounds per acre per year.[7]

The 1982 EPA survey also identified the 20 most commonly used golf course pesticides.[5] (See Figure 2.)

Incomplete and Inadequate Regulation: None of the compounds identified in the EPA survey has been re registered, meaning that toxicity testing or evaluation of the pesticides' active ingredient is incomplete.[8]

Because no chronic toxicity testing is required of complete pesticide formulations (the active plus the "inert" ingredients), complete toxicological information is not available about the pesticides used on golf courses.[9] For example, Daconil 2787, a formulation of the most commonly used golf course pesticide chlorothalonil, is 59.6 percent "inert" ingredients.[10] Neither the identity nor the toxicity of the "inerts" is known.

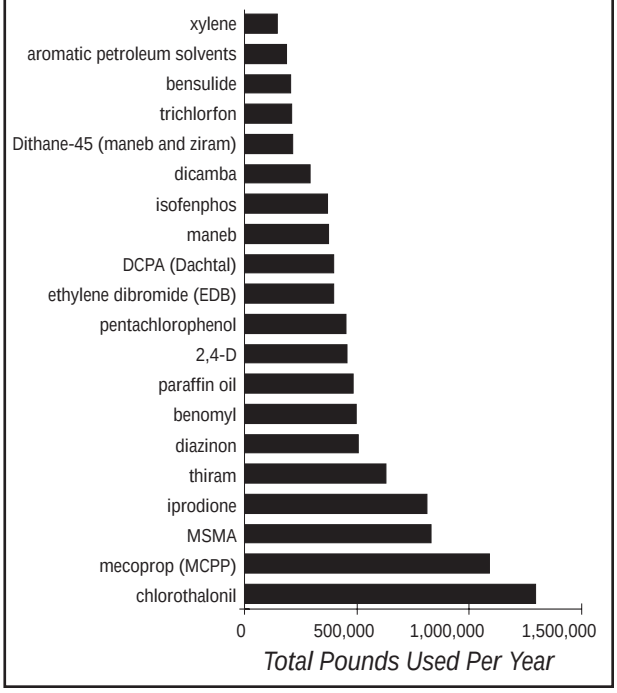
Even some of the active ingredients will never be tested for chronic toxicity. For example, the chlorinated phenoxy herbicide MCPP (mecoprop) is the second most heavily used pesticide on golf courses.[5] It is also registered for use on lawns, ornamental and sports turf, drainage ditches, and in forestry. Because these are all nonfood uses, EPA is not requiring any chronic toxicity testing of MCPP.[11]

Regarding chronic toxicity, of the five most commonly used golf course pesticides, two (thiram and MSMA) are neurotoxins,[7,12] two (iprodione and MCPP) are mutagenic (causing damage to genetic material),[11,13] and one (chlorothalonil) causes reproductive effects and may have "oncogenic [cancer-causing] potential"[14]

Exposure to Golfers: An estimated 23.5 million people play golf in the United States, and thus are directly exposed to the pesticides used on golf courses. This exposure is repeated as the average golfer plays over twenty rounds of golf per year.[15] In most states, golf courses do not notify golfers about pesticide applications, or post the areas that have been treated. The consequences can be tragic, as is illustrated by the story of Navy Lieutenant George Prior.

Prior, a thirty year old flight officer and frequent golfer, died after twenty days of painful and difficult illness.[16] He had been in perfect health until a short golfing vacation. Extensive investigation by Navy pathologists showed that his death was caused by exposure to the fungicide chlorothalonil. During his hospitalization, his wife learned from the golf course that it had been sprayed twice with chlorothalonil during the week that Prior played there, although such information was not routinely made available to patrons.

Figure 2
Pesticide Chemicals Used on U.S. Golf Courses (1982)[5]



Effects on Wildlife: Pesticide-related bird kills have been one of the best documented problems associated with pesticide use on golf course. The New York State Department of Conservation has records of 25 cases of bird deaths caused by pesticide applications on golf courses going back as far as 1971.[3,17] The reports summarize deaths of hundreds of birds following exposure to the organophosphate insecticides diazinon, chlorpyrifos, and isofenphos. Blackbirds, blue jays, Brant and Canada geese, coots, grackles, gulls, mallards, robins, starlings, and widgeons have all been killed on golf courses.[3,17]

These 25 documented cases probably represent only a small fraction of actual bird kills, as there are only a handful of scientists who can document a pesticide-caused bird death. Also, dead birds are easily overlooked, crushed by automobiles, eaten by scavengers, destroyed by insects and bacterial decay, or washed away.[3]

Groundwater Contamination: The most careful study of groundwater contamination associated with golf course pesticide use found that groundwater under four Cape Cod golf courses was contaminated with seven pesticides (or their metabolites): chlordane, DCPA (Dacthal), chlorothalonil, isofenphos, chlorpyrifos, dicamba, and 2,4-D. Chlordane, an insecticide whose use on golf courses is no longer permitted, was found at levels over 200 times greater than the calculated health guidance level.[18]

Possible contamination of Cape Cod groundwater was of particular concern because of the Cape's large number of golf courses, its shallow groundwater aquifer that provides most of the residents' drinking water, and its sandy soils. Samples were analyzed for 14 pesticides and 3 pesticide metabolites, mostly chemicals used on the courses between 1984 and 1987.[18]

Residues of pesticides in water in other areas resulting from golf course use are mostly unstudied. A recent survey in New York found that the two most commonly used pesticides on golf courses on Long Island, chlorothalonil and DCPA, have also been found in Long Island's groundwater.[7]

Pesticides as Part of a Bigger Picture: Environmental Impacts of Golf Courses

Environmental concerns about golf courses focus on a number of issues in addition to pesticide use. At over 100 acres per golf course,[5] and the "fastest growing sport in North America"[19] golf courses can use up otherwise open space quickly. Construction of a golf course can involve significant alterations to the natural landscape and make the land unsuitable for other uses.

Examples are abundant. Around Palm Springs, California, construction of many golf courses has changed a desert ecosystem inhabited by lizards, snakes, and desert rodents into what a golf course architect called a tropical environment. The arrival of egrets, who had never been seen in the area

before and made the golf course their permanent home, was an obvious sign of the change.[2]

Near Astoria, Oregon, two golf courses applied for permits and zoning changes to build resorts that included golf courses. Environmental concerns centered around two issues: the developers asked to build closer to the sand dunes that paralleled the ocean beach than was permitted by county ordinances and part of the land proposed for the resorts was home to the silverspot butterfly (*Speyeria zerene hippolyta*), a threatened species. Developers of one resort cancelled their plans after more butterfly habitat was found; developers of the second resort plan to build a course with habitat set aside for the butterfly.[20,21]

In Ontario, Canada, a golf course was built with four holes on a Class I (provincially protected) wetland that was home to wild rice, pied-billed grebe, river otter, and blue-spotted salamander.[22] In a rather convoluted administrative process, the Ontario Municipal Board ruled that plans for the golf course should be rejected on environmental grounds. However, the course had already been constructed, and the Board found it had no jurisdiction to order restoration.[23]

Water use is another significant concern, especially in arid areas, areas with a dry season, or where water supplies are being used for people and industry. Bermuda grasses on golf courses in Arizona, for example, use over 30 inches of water per year.[24] A proposal for a Canadian golf course would use 10 percent of an adjacent creek's summer water flow for irrigation. Given that the creek is already nearly dry in August, residents are concerned about the wetlands that depend on the creek's water.[19]

Whatever the larger environmental issues, it appears that pesticide use on golf courses has the potential to magnify environmental impacts. If a golf course develops a conservation plan to protect an endangered butterfly, for example, how will use of insecticides on the course conflict with those plans? If a course is designed to preserve wetlands, how will pesticide use affect the plants and animals that live in the wetlands?

Moving Towards Solutions

How do we reduce the potential problems associated with pesticide use on golf courses? While this question has not yet been completely answered, the solution should include the following:

• Make sure that existing courses are being used at their full capacity before constructing new ones.

• Design golf courses to minimize potential pest problems and other environmental damage.

• Reduce golfer's expectations about how golf courses should look. "No longer can we afford the costs of manipulating the environment to allow us to push our turf beyond its genetic limitations," said Dennis Lyon, president of the Golf Course Superintendents Association of America. "The costs to produce the perfect golf course may be, if not financially too high, ecologically too high."[25] Greens that are not completely green, or fairways with an occasional weed, need to be a part of a golfer's game.

• Research and implement alternative pest management techniques. Biological control, breeding of disease-resistant turf varieties, and new cultural practices all show promise for golf course management.[15]

• Increase the number of well-designed integrated pest management (IPM) programs on golf courses. The next articles in this issue of the *Journal of Pesticide Reform* are introductions to some of the pioneers in golf course IPM. Their programs have made a good start; significant reductions in pesticide use and an increase in the number of courses using IPM programs are needed now. ■

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Cosmetic Standards on Golf Courses

By Tom Cook

When we apply the word cosmetic to golf course maintenance standards, the implication is that we are doing things to the course that make it more attractive but don't necessarily improve playability. I guess obvious cosmetic touches might involve planting annual flowers around tees, mowing fairways in stripes, or contour mowing fairways to create the illusion of curves and to define landing areas. Another cosmetic touch might involve reshaping bunkers or changing sand from gray to white or tan.

Cosmetic standards change much like fashions. Currently flowers and elaborate landscape plantings are in vogue. Depending on the year a given club may mandate a wall to wall green policy; that is, there will be no brown grass anywhere on the golf course, even in out of play areas. The same club might later switch and irrigate only tees, greens, and landing areas to create contrast between rough areas and groomed areas. With the increasing popularity of wildflowers some golf courses are converting out-of-play grassy areas into wildflower meadows. Some simply quit maintaining these areas and allow nature to take over.

Apart from its utilitarian value, water is a popular cosmetic touch at many golf courses. From simple ponds to elaborate artificial waterfalls and fountains, water features can have a profound impact on the appearance and character of the course. It's not fair to say water features on golf courses are purely cosmetic because many are strategically placed to create challenging golf shots or are part of the irrigation supply system.

Cosmetic standards vary a great deal, depending on the type of club. High status country clubs often have large cosmetic flower beds and extensive landscape plantings around the clubhouse and out on the golf course. Augusta National is a stunning sight during the Master's tournament when all of the azaleas are in bloom. In the Pacific Northwest many of our finest country clubs have a park-like or private garden atmosphere complete with rustic shelters, flowering vines, seasonal color, and bearing fruit trees.

> *"High cosmetic standards could cause managers to use more pesticides ...."*

It would be foolish to conclude that all wealthy private clubs fit the image I've just described. Some of the truly great private clubs in America are as rough, rugged, and spartan as you can possibly imagine. Resort golf courses run the gamut from elaborate ornamental embellishments to sites carefully situated in surrounding undisturbed vegetation with no significant cosmetic touches. Municipal and privately owned daily fee courses tend to have few cosmetic touches although there are many notable exceptions.

How Do Cosmetic Standards for Turf Quality Affect Pesticide Use?

Do these cosmetic touches have an influence on pesticide use on golf courses? In my opinion this question can't really be answered in general terms. Obviously high cosmetic standards could cause managers to use more pesticides than if standards were lower, but it's highly site dependent. For example, a club with extensive plantings of disease or insect susceptible shrubs or trees (i.e., large plantings of scab susceptible apple trees) or many poorly designed ponds might be forced to make frequent sprays to achieve maximum ornamental value.

Before I attempt to answer this question I need to review the anatomy of golf courses just in case there is someone reading this who knows nothing about golf. A typical golf course is made of nine or eighteen holes or other multiples of nine holes. Each hole is composed of several distinct areas. Tees are where play starts on each hole. Tees range in size from eight foot by eight foot rubber mats to several thousand square feet. Each hole will have from one to five distinct tees so players of varying abilities can play the hole at different lengths. An average eighteen hole golf course has about two acres devoted to tees. Fairways are relatively large short cut areas where tee shots are supposed to land on par four and five holes. An average eighteen hole golf course will have from 20 to 40 acres of fairways. Greens are the targets for all shots. Greens are cut very short so the golf balls will roll smoothly when golfers putt. While green sizes vary, the average eighteen hole golf course will have about two acres of putting turf. The other major area on a golf course is the rough. Rough is all the area not taken up by tees, greens, fairways and water features. On a 120 acre golf course there will generally be 80-90 acres of rough.

Maintenance intensity is inversely proportional to the size of the area. Greens and tees are maintained more intensively than fairways, which receive more care than roughs. It's difficult to discuss cosmetic standards for turf care because there are no absolute standards to judge against. The best I can do is to explain what the general goals of maintenance are for each area on a golf course. From there I will try to describe the extremes for which people might shoot and how that might influence use of pesticides.

Pesticide Use in Rough Areas

Rough areas are normally maintained at a low level of intensity. Turf may be mowed weekly in outer areas and one to two times per week where rough adjoins fairways. Fertilization is minimal, often being limited to overthrow from fairway fertilizer applications. The only pesticides used on roughs in the Pacific Northwest are mixtures of herbicides that selectively kill broadleaf plants. My estimate is that less than 20 percent of rough areas are treated annually at most northwest golf courses. As a rule, tolerance

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for weeds in rough areas is high. In other parts of the U.S. where weed, disease, and insect pressures are much higher, roughs may be treated with pre-emergent crabgrass herbicides, insecticides for grub control, and possibly (though rarely), with fungicides for disease control. The extremes range from no treatments with any pesticides to annual sprays for weed control plus other pesticides when need arises. Private clubs with high standards for appearance and high end resort golf courses are most likely to treat rough areas cosmetically. Public golf courses are least likely to treat roughs cosmetically.

Pesticide Use in Fairways

Fairways are maintained with the goal of producing tight, dense, erect growing turf that will support golf balls. Typical mowing heights on fairways range from 3/4 to 3/8 of an inch. Short turf is desirable to facilitate proper shot making. The principle cultural practices used to achieve top quality turf include frequent mowing, periodic fertilization, and regular irrigation during dry periods.

On mature golf courses in the Pacific Northwest broadleaf weed control is done on a target basis. I estimate that about 20 percent of the fairway acreage is sprayed annually. Golf courses that have been well maintained have relatively few weed problems on fairways because of competition from turf. Insect problems are not consistent in the Northwest and it is unusual for insecticides to be applied here. When problems do occur they are generally treated on a target basis. Except at private clubs with very high quality standards fungicides are rarely applied to fairways of Northwest golf courses.

The picture is quite different in other areas of the U.S. where pest pressure is high. What would be considered cosmetic in Portland, Oregon might be necessary in Baltimore, Miami, Kansas City, or Chicago just to keep the turf alive through the playing season. In general, areas with hot humid summers and/or long growing seasons and significant summer rainfall face a real struggle to keep turf free from warm season weedy annual grasses, summer insect damage, and warm weather diseases. The combination of severe summers and cold winters creates a "transition zone" which is perhaps the most challenging area in North America to grow healthy turf.

Pesticide applications on golf course fairways range from none to annual pre-emergent herbicide applications, annual insecticide sprays, and repeated fungicide treatments during the growing season. The primary factor determining pesticide use intensity is climate, not cosmetic standards. Severe climates will require more pesticide treatments than mild climates in nearly every case.

Annette Gurdjian

Pesticide Use on Tees

Tees fall somewhere between fairways and greens in maintenance intensity. The primary goal in maintaining tees is to produce a smooth relatively flat surface for golfers to hit from. Turf is normally mowed short and often, fertilized as needed, and overseeded and topdressed to replace divots and maintain smoothness. Pesticide use on tees is similar to fairways ranging from none to seasonal treatments as needed. In more severe climates tees might be treated the same as putting greens.

Pesticide Use on Putting Greens

Putting greens generally receive the highest level of maintenance. Putting requires smooth firm surfaces which are achieved generally by daily mowing, seasonal coring, light frequent topdressing, regular fertilization, consistent frequent irrigation, and insect and disease control as needed to maintain near perfect turf. Because mowing heights range as low as one tenth of an inch, turf on greens exists right on the edge of life and death. Add in the difficulties of severe climates and it's easy to see the need for use of fungicides and to a lesser extent insecticides.

Actual pesticide use on greens varies drastically from region to region. In Portland, Oregon, four to twelve fungicide applications may be needed depending on the year. In more severe climates twice that many applications may be needed. Insecticides are rarely applied more than one time per year in the Pacific Northwest. Insecticide use in other parts of the country will generally be higher but is quite variable. Since putting turf needs to be nearly perfect to be functional the concept of cosmetic standards probably doesn't apply here.

What about herbicide use on greens? Again it depends greatly upon where the golf course is and what kind

of grass is being grown.

For example, in the Pacific Northwest greens are normally planted with creeping bentgrass, *Agrostis palustris*. Over a period of five to twenty years annual bluegrass, *Poa annua* invades and normally dominates the turf. People in this region generally accept annual bluegrass as the climax grass and no attempt is made to control it because it grows well most of the year, produces an excellent putting surface, and has no more pest problems than bentgrass.

In other northern areas annual bluegrass also invades bentgrass but is prone to many pest problems and periodically dies out in summer and/or winter. Many view it as a weed in these areas and herbicides may be applied annually to control it.

Annette Gurdjian

The picture gets more complicated in the south where bermudagrass, *Cynodon sp.* is the logical choice for putting greens. Because bermudagrass goes dormant in winter and winter is a popular time for golf, greens are often overseeded with perennial ryegrass, *Lolium perenne*, to provide temporary putting turf until bermudagrass comes back to life in late spring. This process is cumbersome, time consuming, and produces less than perfect putting surfaces.

One way around the problem is to plant creeping bentgrass on greens for a year around surface. The problem here is that now we're growing bentgrass out of its zone of adaptation under very difficult summer conditions. Insect and disease problems can be severe resulting in the potential need for more fungicides and insecticides. Current research is aimed at producing better bermudagrasses and more stress tolerant bentgrasses. In the meantime there is no best approach for maintaining putting greens in southern regions.

The Influence of Geography

Of all the factors that affect pesticide use on golf courses the most important is geographic location. Mild climate areas generally have fewer disease and insect problems than climates featuring extended periods of heat and humidity. The relatively low stress environments of Northern Europe and the Pacific Northwest of the U.S. and Canada have lower pest pressures than southern Europe, Southeast Asia, and the southern parts of North America. In-between areas often have the greatest stresses of all because they have extreme weather conditions in winter and summer.

Grass species adaptation is an important factor affecting pesticide use. Attempting to grow cool season grasses in warm season areas will ultimately require more disease and insect control efforts than growing grasses where they are best adapted.

Golfer's Expectations

Finally, golfer expectations affect pesticide use to some degree. In particular golfer demands for faster, shorter putting surfaces and shorter fairways means grass is cultured in a more stressful environment. Smaller plants with less well developed root and shoot systems tend to be less tolerant of wear, heat, cold, drought, or excess moisture. This, in my opinion, predisposes grass to more disease problems than it would get if mowed taller. These somewhat unrealistic expectations of golfers are at least partially the result of tournament golf as portrayed weekly on television. Golfers tend to forget that the golf courses hosting tournaments have been carefully groomed for many months so they will be nearly perfect during the week of the tournament. Many golfers seem to come away with the impression that every golf course should look just like these tournament courses all year long. Faced with this pressure and the resulting increase in maintenance intensity, golf course superintendents are forced to rely more on pesticides to keep grass healthy than they would otherwise.

Conclusions

I'm not sure I can draw all of this together but I will try to leave you with some thoughts to ponder.

• Cosmetic standards have less impact on pesticide use than geographic location, turfgrass adaptation, or golfer expectations.

• In the U.S., the Pacific Northwest and the arid west have the lowest pest pressure while the southern half of the nation probably has the highest. The north central region and New England fall somewhere between these extremes.

• Areas most likely to receive frequent pesticide applications such as greens and tees make up only about 5 percent of the total acreage of the golf course.

• Generalizations about pesticide use on golf courses can't be made. Even within a small geographic area pesticide use may vary dramatically between private courses, public and municipal courses, and resorts. Concerns about pesticide use can only be addressed on a case by case basis.

There are many excellent texts for technical information on golf course maintenance and pest management. Below are several that I use regularly. If you want to have a better understanding of golf courses and golf course maintenance practices these sources are a good place to start. ■

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