

and after the last mowing for the year, which generally fell in the period of October 15 to 30. The grass was mowed at a 2.5-inch height every 4 to 7 days, depending on growth rate. The area was watered for 30 minutes (approximately 0.43 inches of water per irrigation) whenever the turfgrass turned bluish-green, a sign of moisture stress. Weed control consisted of a single broadleaf weed herbicide applied in September of each year.

### Summary Results

The mean annual precipitation over the 6 years of the study was 32.00 inches, which is 3.6% above the 30-year norm of 30.88 inches for Madison, WI. Annual deviations from the 30-year norm ranged from +11.15 to -5.07 inches. The mean annual irrigation water applied was 3.11 inches, but ranged from zero to over 5 inches, depending on rainfall amounts and distribution during the growing season.

Over the 6 years, runoff water accounted for 3.54% of the mean annual water input (precipitation + irrigation) while the percolate accounted for 45.56%. The remainder, 45.84%, is attributed to evapotranspiration (ET) loss, which would have averaged 0.086 inch per day based on a 28-week season. According to limited data (Beard, 1973; Taylor et al., 1987), this mean daily ET rate is typical for turfgrass in the upper Midwest.

The 6-year means for quantities of N and P in the runoff water were 0.37 and 0.32 lb/acre/year (0.0085 and 0.0073 lb/M<sup>2</sup>/year), respectively. For the mean annual runoff volume of 1.25 inches, this amounts to 0.30 lb N/inch of runoff and 0.26 lb P/inch of runoff. Runoff and N and P losses were dominated by what occurred when the soil was frozen. This runoff resulted primarily from snowmelt, but in some years included rainfall on frozen soil. Over the 6 years, runoff from frozen soil accounted for 70% of the total amount of runoff water collected. This runoff water contained 61% of the N and 72% of the P detected.

### Treatment Effects

Treatments superimposed on the 3 blocks of runoff plots were changed every 2 years. The first two years examined the effects of soil disturbance and remedial actions prior to turfgrass establishment on N and P losses via runoff water and N leaching. The next 2 years were devoted to testing the effects of fertilization and mowing practices. The treatment variable during the last 2 years of the study was type of fertilizer N carrier applied.

### Soil disturbance effects:

1. During the 1992 and 1993 *growing seasons* sub-

soil compaction had no influence on the amount of runoff water, but did increase runoff N and P losses by 125 to 133 %. Subsoil compaction effects on runoff N and P losses disappeared when the topsoil-subsoil interface was eliminated. Chisel plowing of the compacted subsoil had little influence on N and P loss.

2. When observed *over the entire 24 month period*, subsoil compaction and topsoil layering did not significantly influence the quantities of runoff water collected or the amounts of N and P detected. The effects of subsoil compaction, treatment of that compaction, and topsoil layering or mixing with the subsoil were inconsistent.
3. The various soil disturbance treatments had no statistically significant effects on the amount of percolate, its N content or its nitrate-N concentration. Among the soil treatments, the layering of topsoil rather than mixing half of it with the subsoil had the general effect of increasing the mean annual amount of N leached from 1.68 to 2.41 lb/acre and the nitrate-N concentration from 1.88 to 2.39 mg/L (ppm).

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\* M = 1,000 ft<sup>2</sup>



**Fertilization and clipping management effects:**

Three fertilization treatments were tested—none, application of a natural organic fertilizer (Milorganite 6-2-0), or application of a synthetic fertilizer (Scott's Turf Builder 19-3-4). The turf receiving these fertilizer treatments was subjected to both clipping removal and mulch mowing.

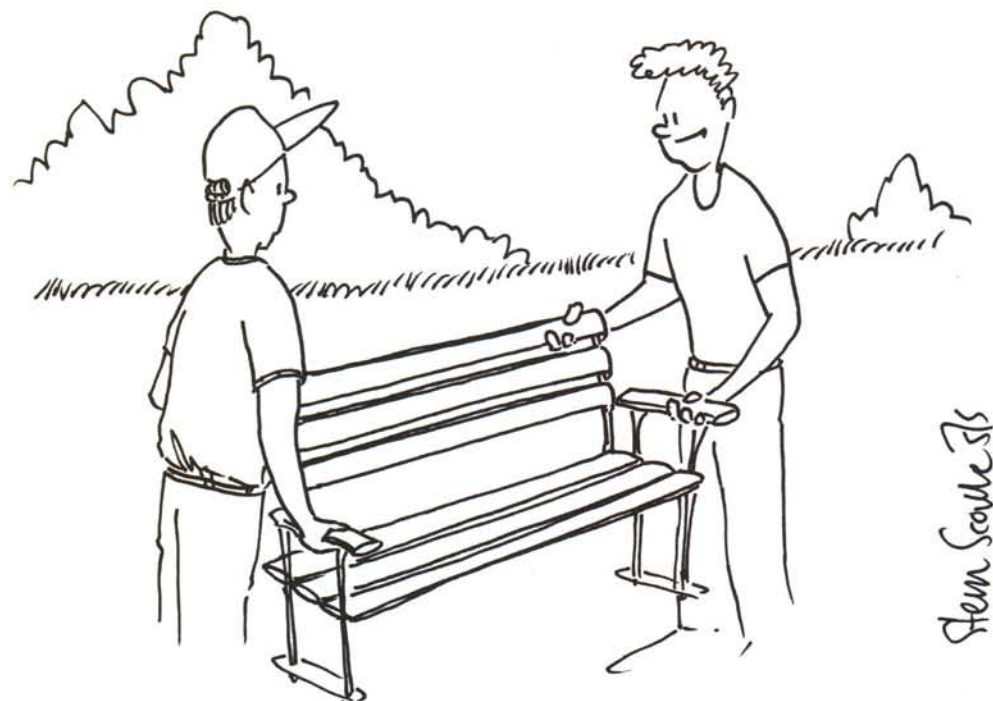
1. Type of fertilizer applied—all natural organic or synthetic—had no significant influence on the mean annual quantities of runoff water or its N and P content.
2. Not applying fertilizer for 2 years led to a 96% increase in the amount of runoff water when grass clippings were removed and a 63% increase when the grass was mulch mowed. With these increases in runoff, losses of N and P from non-fertilized turf averaged 48 to 146% more than from the fertilized plots.
3. Percolate volumes were not affected by the type of fertilizer applied or whether any was applied. Amounts of N leached and percolate nitrate-N concentrations were 40 to 48% lower for the natural organic fertilizer treatment than for the syn-

thetic fertilizer or non-fertilized treatment. If one were to estimate the amount of fertilizer N leached by using values obtained by subtracting from the fertilized treatments the values for the unfertilized treatments, the results would have been 0.48% synthetic N leached and a negative 0.21% of the natural organic fertilizer N leached.

**Nitrogen fertilizer carrier effects:**

The nitrogen carriers tested included 100 % water soluble urea and 5 slow-release N fertilizers. The slow-release fertilizers included one natural organic and one synthetic fertilizer, both of whose N release rate is controlled by microbial action. Another product was IBDU (isobutylidene diurea) whose N release is controlled by fertilizer solubility. The last two slow-release fertilizers were coated urea products wherein N release is controlled by the rate of exit of urea solution from the coated fertilizer granules.

1. No significant treatment effects on runoff water volumes or the N and P losses were detected at any time during the two years they were applied. The N losses ranged from 0.34 to 0.85 lb/acre (0.0078 to 0.0195 lb/M). The least loss occurred



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when IBDU and methylene urea based fertilizers were applied. The highest losses were in the all natural organic and polymer + S-coated urea treatments.

2. Although the annual P application rates ranged from zero to 25 lb P/acre (0.58 lb/M), there was no relationship between P application rate and the amount of P in the runoff water.
3. Quantities of N leached during the 2 years of application of fertilizers with different N carriers ranged from 1.13 lb/acre for the IBDU treatment to 2.60 lb/acre for the natural organic fertilizer treatment. Percolate nitrate-N concentrations ranged from 1.16 to 2.20 mg/L. Urea gave the highest percolate nitrate-N concentrations.

### Discussion

The results of this research clearly demonstrate that in climates such as that of southern Wisconsin, runoff water from properly maintained Kentucky bluegrass turf on a 6% slope is predominantly snow melt. Water runoff when the soil was frozen contributed 53 to 92 % of the mean annual runoff and

averaged 70% for the 6-year lifetime of the study. Furthermore, this runoff contained 61% of the N and 72% of the P measured. The implications of these observations are numerous. The first is that studies that measure runoff and N and P losses only during the growing season fail to capture the bulk of the losses. Depending on weather, such studies may be measuring as little as 10% of the total annual runoff and quantities of N and P lost. Therefore, the risk of arriving at erroneous conclusions from such data collected is very high.

Observations made in the present study on soil disturbance effects on runoff provide an example of how data collected only during the growing season can lead to invalid conclusions. Measurements made only during the growing season supported the conclusion that an effective means for reducing urban runoff and loss of lawn N and P to surface waters is to regulate how turf is established - that subsoil compaction must be alleviated and a portion of the topsoil rototilled into the subsoil before seeding. But when the observations were extended over a full year to include runoff from the frozen soil surface, the conclusion is that in the long run subsoil compaction and topsoil layering do not significantly impact on the amount of runoff or its N and P content.

An assertion made by Barten and Jahnke (1997), who measured runoff P concentrations only during the growing season, is that the P in lawn runoff water comes from just two sources — fertilizer and soil. In the present study, 72% of the P was contained in snowmelt collected some 5 months after the last fertilizer application, there was no significant relationship between the amounts of fertilizer P applied and the quantity of runoff P, the ratio of N:P in the runoff water was 1.2:1 while the ratio of N:P in the fertilizers applied averaged nearly 15:1, and there was no loss of soil sediment that would contribute adsorbed phosphate. These observations collectively provide a substantial body of evidence that fertilizer was not one of the major sources of P in the runoff water.

There are few data that establish soil as a significant source of P in runoff water from turf. The results obtained by Barten and Jahnke (1997) clearly demonstrate that their measured concentrations of total P and "soluble reactive" P from 29 home lawns were unrelated to levels of soil test P in the lawns even though their runoff water samples contained up to 4.6 g/L of suspended solids. As pointed out previously, no soil sediment was collected in runoff water samples collected in the present study. While this does not discount soil contributing some water soluble P, the evidence available does not implicate soil as a major contributor to the P in turf runoff water.

Several researchers have identified plants and plant

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residues in the landscape as important sources of P in runoff water. (Burwell et al., 1975; Dorney, 1986; Sharpley, 1981; Waschbusch et al., 1999). These research reports prompted my clipping of Kentucky bluegrass to ground level from concise turf areas and leaching of the fresh or frozen and dried clippings with the equivalent of one inch of rainfall. The amounts of P leached accounted for all of the runoff P collected in this study, both during the growing season and from snowmelt. These observations are consistent with research done with tree leaves and agronomic crops and clearly implicates plant P as being a major source of the P in runoff water from turf.

The scenario wherein snowmelt dominated the annual quantities of runoff water and the N and P contained therein and the turf itself was a major contributor of P (comparable N data are lacking) provides an explanation as to why the soil treatments and turf fertilization practices tested in the present study had no statistically significant influences annual runoff losses of N and P. The question then arises as to what turf-grass culture practices might be implemented that could lead to significant reductions in the P loading of runoff water and what kind of improvements can be expected. With plant-derived P as a major source of the P in runoff water, there is a substantial baseline or natural concentration of P below which reductions are not possible without elimination of the vegetation from the landscape. The results of the present and other studies (Gross et al., 1991) suggest that maintenance of dense turf through regular fertilization and adoption of other recommended cultural practices to minimize the amount of runoff per se is quite possibly the most effective means for minimizing turf contributions of P to urban runoff water.

Numerous units of government in the upper Midwest have imposed restrictions on fertilizer phosphate use on turf with the intent of improving surface water quality. The results of the present study seriously question the value of these restrictions. Debate on further legislation should be suspended until more definitive research can be conducted. There is a dire need for innovative research that measures N and P in runoff water throughout the year and reliably partitions that N and P into its 3 most probable sources—fertilizer, soil **and plant**. Only when the contributions of each are established can effective strategies be developed to reduce N and P loads from turf.

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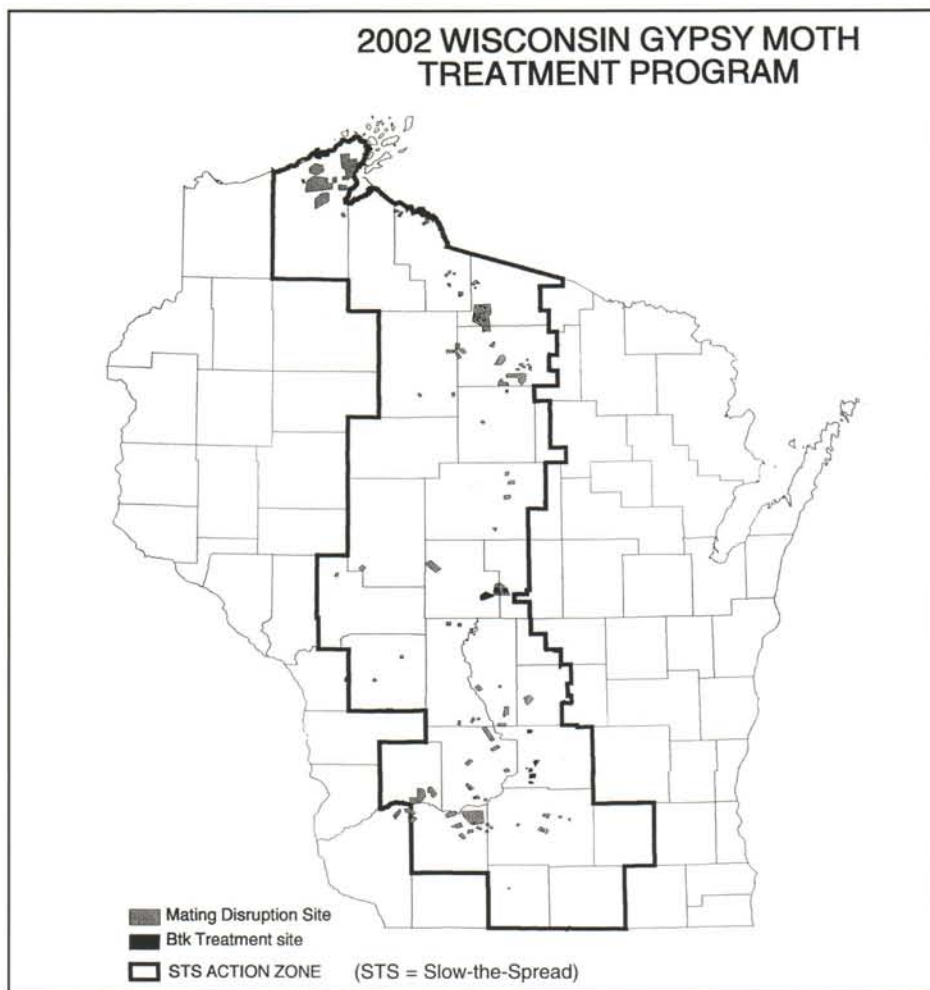
# Gypsy Moth Treatment Areas Proposed for 22 Wisconsin Counties

By **Monroe S. Miller**, Golf Course Superintendent, Blackhawk Country Club

This is Dr. Steve Millett's busy time of year, too, since he has taken over as program coordinator of Wisconsin's gypsy moth control program. Aerial spraying is proposed this spring and early summer to treat 100 sites covering more than 330,000 acres in 22 Wisconsin counties to control the spread of the destructive forest pest. That is three times the acreage of last year's effort, making it the largest state gypsy moth spray program in the nation.

"Gypsy moths threaten our state forests and urban trees because they feed on the leaves of oaks and hundreds of other species of trees and shrubs," explained Steve in a recent interview. "Gypsy moths have a negative impact on Wisconsin's economy affecting the timber, paper, nursery and tourism industries. It's also a nuisance to homeowners to see trees stripped of leaves and to watch hundreds of thousands of caterpillars crawling around," he added.

Twelve sites will be treated in May with *Bacillus thuringiensis* sub sp. *kirstaki* or Btk. Btk, the commonly used organic pesticide, has been used successfully in gypsy moth treatments for more than 30 years. Gypsy moth caterpillars eat the leaves that have been treated with Btk and eventually die. The remaining sites will be treated in June and possibly July with pheromone flakes. These rice-grain sized flakes carry the scent of the female gypsy moth, which confuses the male moths and disrupts their mating cycle. "The switch to pheromone flakes will save the state \$2.8 million," according to Steve.



The counties with proposed treatment areas are Adams, Bayfield, Clark, Columbia, Dane, Grant, Green, Iowa, Iron, Jackson, Juneau, Lincoln, Marathon, Marquette, Monroe, Oneida, Portage, Price, Richland, Sauk, Vilas, and Wood.

"Treating urban sites always presents some extra challenges because of higher populations and more traffic," Millett says. "We're proposing to spray portions of Wisconsin Rapids and Port Edwards in Wood County with Btk. Other urban areas that we're

proposing to treat with pheromone flakes are located in Madison and Middleton in Dane County, and Wausau and Schofield in Marathon County." Pheromone flakes only need one application to be effective whereas two applications of Btk are required.

The map above shows the treatment areas of the state. If you see a plane flying about 50' above ground level in the upcoming month or two in those areas, chances are it is Dr. Millett and his staff giving our trees and shrubs every chance current science can. 🌿



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# Know Your Pest!

By Dr. R. Chris Williamson, Department of Entomology, University of Wisconsin-Madison

Without question, having a comprehensive knowledge of a respective pest is the key to successful management! Regardless of the pest you are attempting to control (a disease pathogen, an insect, or a weed), you must first be able to accurately identify the pest.

Next, you must know as many attributes and characteristics about its biology as possible including behavior and habits, life-cycle, life stage that causes damage, as well as when it is most susceptible or vulnerable to respective control tactics. Without such information, effective management of a respective pest is jeopardized.

For example, given the fact that most white grubs are most vulnerable to chemical treatments when they

are newly hatched and they are quite difficult to control as fully mature, third-instar grubs, it would not be advantageous to make an application of a grub control product in the spring. Not that the treatment application of the respective control product will not provide any control, but a significantly higher percentage of control (> 90% compared to 65% - 70%) could have been attained if the control application was made when the grubs were newly hatched, young grubs.

Subsequently, the timing of a treatment is crucial to effective control. This concept is further illustrated by the biology of black cutworm (BCW) caterpillars. Since BCW caterpillars feed on the foliage of turfgrasses nocturnally (at night), the most effective control strategy is to apply a respective insecticide treatment in the late-afternoon or early-evening and to withhold irrigation for at least 12 hours to allow the BCW caterpillars to be exposed and/or consume the control agent. As a result, the maximum amount of control can be achieved; otherwise the percent control declines due to factors such as lack of exposure, photodegradation of the insecticide, as well as volatilization of the insecticide. Examples are endless; therefore, ensure you know what pest you are dealing with, fully understand its biology, then implement a control tactic that will maximize its control.

Ultimately, you may save valuable resources such as time and money, as well as protect the environment by not having to make repeat treatment applications due to poor control with initial control application. ♻



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# 2002 WGCSA Spring Educational and Business Meeting

By *Dustin Riley*, Golf Course Superintendent, Oconomowoc Golf Club

The initial step to the 2002 golf season was taken as a good attendance of golf course superintendents, assistants and affiliates gathered at the Ramada Inn in Fond du Lac on Tuesday, March 5 for the annual Spring Education and Business Meeting. Many superintendent minds were placed at ease as snowfall totals nearing one foot blanketed the majority of Wisconsin several days earlier. Telephone calls from owners, members or the golfing public would be postponed for at least several days.

The educational portion of the

meeting was arranged through the GCSAA and its Superintendent Leadership Series. This year's speaker was Dr. Schwab. Dr. Patt Schwab is president of *FUNDamentally Speaking* and travels internationally inspiring audiences to use humor to gain control over change and adversity. She presented the morning educational session on the subject of "Dealing with Jerks – and Knee Jerk Reactions."

Her presentation revealed several effective hints for handling the conflicts and pressure induced by difficult people. Statements such as "The

easiest way to deal with a jerk; don't be a jerk yourself" or "Focus on the good things in life" are just a couple of her successful views. Dealing with jerks should not be avoided. "Blaming isn't changing! Wishing a frog would turn into a prince is a waste of your time. In dealing with jerks, your job is not to change them or get even with them. It is merely to get something productive out of the interaction."

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