nds

photo credit Andy Keyes, Assistant Superintendent at The Meadows at Mystic Lake

An effective way to accomplish this is to treat your pond with Healthy Ponds AquaSpherePro, or a similar product, containing beneficial bacteria and enzymes that break down the organic waste and reduces the excess nutrients in the water.

The following is an example of a typical treatment plan for a typical pond:

1. Determine the type of algae that is present.

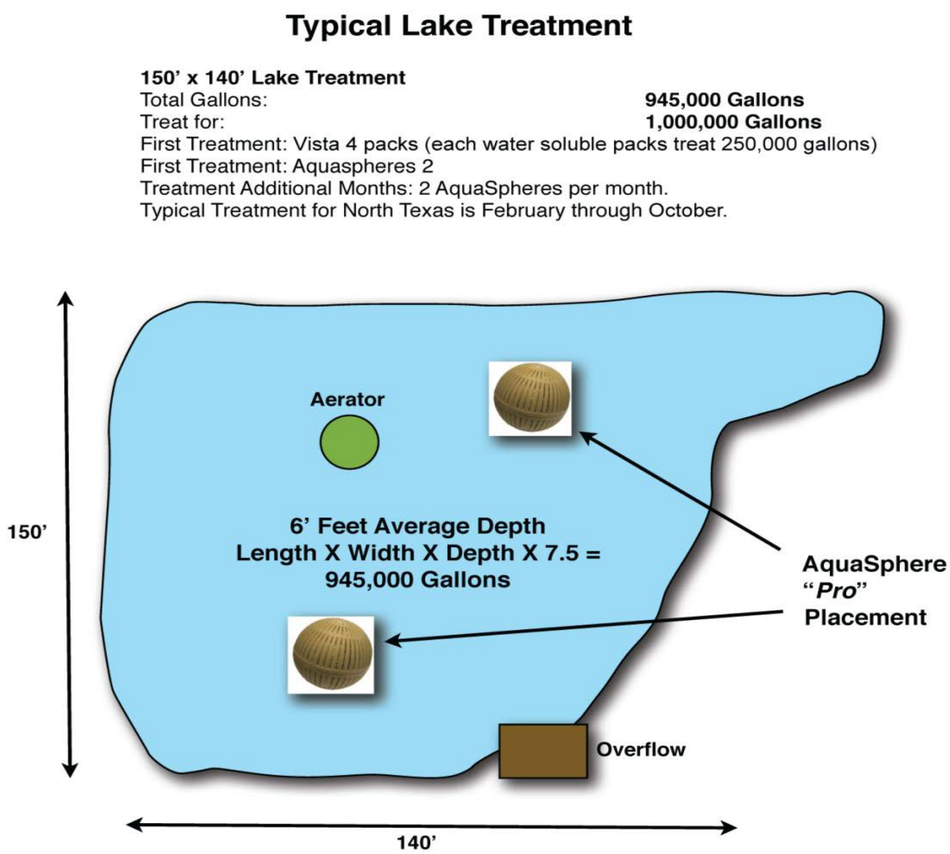
   Filamentous Algae – appears to be green clumps collecting around the water's edge. When pulled from the water it appears and feels hair-like.

   Planktonic Algae – appears like pea soup in the water.

2. Determine the correct amount of water in the pond to be treated. While

over treating a pond will have no adverse effect, under-estimating, and thus under-treating, will not achieve the desired results. To determine the correct amount of water use the following formula: Length x Width x Average Depth x 7.5

3. Treat with appropriate size and number of spheres. It is important to apply the proper amount of beneficial micro-organisms. For that reason Healthy Ponds has a variety of sized AquaSpherePro products to treat your pond.



Typical Pond Treatment Plan

Factors Affecting Performance:

- Ponds using aeration systems will see an even greater impact when using an all natural product with beneficial bacteria and enzymes.
- Large ponds can be quite irregular in shape. You will get better results if the beneficial bacteria and enzymes are distributed throughout the pond.

- Ponds subject to periodic loading of nutrient rich runoff through turf fertilization, frequent rainstorms may require additional treatment requiring a stronger dose of bacteria.
- Very shallow ponds may require additional treatments.
- Irrigation ponds require additional treatment to compensate for the turnover of water.

Ponds are like people, they are all different. Not every pond responds to the same treatment program. It is important to keep as much debris out of the pond as possible and to monitor the pond on an ongoing basis. Each pond has its own issues that need to be addressed to determine the most effective treatment plan.

“Got Duckweed?” Look for my next article later this season on Aquatic Weed control.

Evaluation of Core Cultivation Practices to Reduce Ecological Risk of Pesticides in Runoff from Turf

Runoff studies were carried out to identify which core cultivation practice, solid tine or hollow tine, maximized pesticide retention at the site of application. Measured quantities of pesticides in the edge-of-turf runoff and characteristics of a local golf course were used to calculate pesticide concentrations in a surface water receiving turf runoff. Surface water concentrations of pesticides were compared to published toxicity data. Identifying management practices that reduce pesticide loss with runoff will improve disease and pest control in turf while minimizing undesirable environmental effects associated with the off-site transport of pesticides.

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Summary

Pesticides associated with the turfgrass industry have been detected in storm runoff and surface waters of urban watersheds; raising concern of their potential environmental effects and a desire to reduce their transport to non-target locations. Runoff studies were conducted to compare the effectiveness of solid tine versus hollow tine core cultivation to reduce the quantity of pesticides transported with runoff from creeping bentgrass (*Agrostis palustris*) turf managed as a golf course fairway. The concentration of pesticides anticipated in a surface water receiving the runoff were calculated using data from this study and runoff volumes and pond dimensions recorded from a local golf course. Surface water concentrations were compared with levels known to be harmful to aquatic organisms. Key observations of the study were:

- Runoff volumes were less from turf managed with hollow tine compared to solid tine core cultivation.
- Greater quantities of pesticides were transported off-site with runoff from turf managed with solid tines.
- Concentrations of pesticides in a pond receiving runoff from turf managed with solid tines exceeded levels harmful to eight of nineteen aquatic organisms evaluated.
- Replacing solid tine with hollow tine core cultivation reduced surface water pesticide concentrations to levels below harmful concentrations for most of these organisms.

Figure 1. Creeping bentgrass turf managed with solid tine (A) or hollow tine (B) core cultivation. Cores removed with the hollow tines were air dried and worked back into the turf prior to pesticide application and simulated precipitation.

Text

Pesticides are applied to highly managed biotic systems such as golf courses, commercial landscapes and agricultural crops. Golf course turf often requires multiple applications of pesticides at rates that exceed those typically found in agricultural or home environments (1,2). Pesticides associated with the turfgrass industry have been detected in surface waters of urban watersheds; leading to increased suspect of contaminant contributions from residential, urban, and recreational sources (3-7).

Fairways comprise approximately one-third of a typcial golf course (8), which may border surface waters such as ponds, streams, and lakes. Golf course fairways and greens may be managed with core cultivation during the spring or fall to control thatch, alleviate surface compaction, enhance water infiltration, and stimulate root and shoot growth (9-14). Cultivation with hollow tines typically involves removing cores from the turf, which are air-dried and brushed back into the open holes. Solid tine core cultivation requires a reduced amount of labor and is less disruptive to the surface of the turf but is believed to cause localized compaction (15).

Management practices have been shown to reduce runoff and pesticides transported with runoff from agricultural crops (16-18). Research on turfgrass has also shown the influence of cultural and irrigation practices on nutrient and pesticide transport with runoff and leachate (19-26). The goal of the present study was to identify which core cultivation practice, solid tine or hollow tine, maximizes pesticide retention at the site of application; thus improving desired results of disease and pest control in turf while minimizing undesirable environmental effects associated with the off-site transport of pesticides.

Runoff Study Site

Experiments were conducted on turf plots managed as a golf course fairway at the University of Minnesota, Saint Paul, MN, USA. The site (Waukegan silt loam) was divided into 6 plots (24.4 m x 6.1 m, length x width) and sodded with L-93 creeping bentgrass (*Agrostis palustris* Huds.) sod 14 months prior to initiation of the reported studies. The turf was managed as a fairway with 1.25 cm height of cut (three times weekly, clippings removed), topdressed with sand (weekly, 1.6 mm depth) and maintained with sprinkler irrigation.

Figure 2. A commercially available insecticide, fungicide, and herbicide were tank mixed and applied at label rates to all plots perpendicular to runoff flow; 63 d and 2 d following core cultivation and 26 ± 13 h prior to initiation of simulated precipitation and runoff.

Runoff collection systems were constructed at the western end of each plot, modified from the design of Cole et al. (21). Water traveled from the runoff gutter to a stainless steel flume equipped with an automated sampler and flow meter. Gutter covers and flume shields prevented dilution of runoff with precipitation. Plots were hydrologically isolated with removable berms.

Management Practices

Plots were aerated twice (June 21st, Sept 28th) with either solid tines (ST: 0.95 cm diameter x 11.43 cm length with 5 cm x 5 cm spacing) or hollow tines (HT: 0.95 cm internal diameter x 11.43 cm length with 5 cm x 5 cm spacing) and top dressed weekly with sand (Figure 1). Cores removed with the hollow tines were allowed to dry, broken into smaller pieces, and worked back into the turf. A back-pack blower and leaf rake removed the turf and thatch from the plot surface. Sand top dressing was not performed immediately after core cultivation or within a week of simulated precipitation and generation of runoff.

Pesticide Application and Simulated Precipitation

A rainfall simulator was constructed to deliver precipitation similar to natural rain (27) (Figure 2). Measured rainfall rates were similar to storm intensities recorded in Minnesota, USA, during July through October. Prior to initiation of simulated precipitation (48 h), each plot was pre-wet with the maintenance irrigation beyond soil saturation to allow for collection of background samples and to ensure uniform water distribution. Irrigation water samples and resulting background runoff were collected for analysis. Petri dishes were distributed across the plots to verify pesticide application rates and rain gauges were distributed throughout each plot to quantify simulated precipitation. A commercially available insecticide, fungicide, and herbicide containing chlorpyrifos, flutolanil, mecoprop-p, dicamba and 2,4-D were tank mixed and applied at label rates to all plots perpendicular to runoff flow (Figure 3). Simulated precipitation was initiated 26 ± 13 h after pesticide application. Soil moistures were 46 ± 7% water holding capacity within 3 h prior to initiation of the simulated precipitation.

Runoff Collection and Pesticide Analysis

Runoff water samples were collected using automated samplers equipped with a flow meter to recorded water level in the flume, calculated flow rates, reported total runoff volume and collected time-paced samples from each plot. Water samples were removed from the automated samplers and stored frozen until laboratory analysis. Concentrations of chlorpyrifos, dicamba, flutolanil, MCPP and 2,4-D were measured by direct injection of filtered samples onto a high performance liquid chromatograph with a photodiode array detector and quantified by direct comparison with external standard calibration curves of the analytical standards.

Calculating Pesticide Concentrations in a Pond Receiving Turf Runoff

Pesticide loads (mg m^{-2}) in the edge-of-plot runoff were calculated from recorded runoff volumes (L m^{-2}) and measured concentrations (μg L^{-1}) of pesticides in the runoff. Pesticide concentrations in a body of water receiving the runoff was determined using characteristics of a golf course located less than 20 miles from our study site; including the volume (L) of a pond receiving runoff from a known area of the golf course (m^2); considering the percentage

Figure 3. A rainfall simulator deliver precipitation resembling storm intensities recorded in Minnesota, USA. Runoff collection gutters guided runoff from the turf to flumes equipped with automated samplers and flow meters. Gutter covers and flume shields prevented dilution of runoff with precipitation.

of that area represented by fairway turf. Estimated pesticide concentrations in a pond receiving runoff from fairway turf managed with solid tine or hollow tine core cultivation were compared to published toxicity data to evaluate which core cultivation practice would be the most efficient at reducing environmental impacts. A detailed description of the calculations, toxicity data and statistical analysis are provided elsewhere (28).

Reduced Runoff Volume with Hollow Tine Core Cultivation

Runoff volumes were reduced in fairway turf plots aerated with hollow tine compared to solid tine core cultivation. Although the period of time between core cultivation and simulated precipitation was greater for the first runoff event (63 d) than the second runoff event (2 d), due to a delay in the construction of the rainfall simulator, the overall trends observed between solid tine and hollow tine core cultivation remained the same; showing reduced runoff volumes with hollow tines for more than 80% of the samples (63 d = 81%, 2 d = 87%). Calculation of cumulative runoff volumes from plots receiving core cultivation 63d prior to rainfall simulation demonstrated a 10% reduction in cumulative runoff volume with hollow tine (HT) relative to solid tine (ST) (HT = 3,149 ± 932 L; ST = 3,490 ± 1,107 L). A 55% reduction in cumulative runoff volume with hollow tine compared to solid tine core cultivation was observed when plot received core cultivation 2d prior to rainfall simulation (HT = 1,856 ± 139 L; ST = 4,164 ± 1,698 L). The percentage of precipitation resulting as runoff from plots aerated with hollow tines was less than quantities observed from the solid tine plots; suggesting greater infiltration with hollow tine core cultivation (Figure 4). Other researchers have measured enhanced water infiltration in turf managed with hollow tine core cultivation compare to untreated turf (29, 30) and greater saturated water conductivity and air porosity in turf managed with hollow tines compared to solid tines (15). The greatest difference in soil physical properties between plots was most prominent shortly after cultivation and diminishes with time as roots grow, compaction dissipates and holes are covered or filled; resulting in the greater distinction in runoff volumes between treatments at 2 d following cultivation compared to 63 d.

Figure 4. Mean percentage of applied precipitation measured as runoff from turf plots managed with solid tine core cultivation or hollow tine core cultivation 63 d and 2 d prior to simulated precipitation and runoff. Error bars represent the standard deviation of the mean.