Wastewater Use for Turf

The availability of fresh water for irrigation in many parts of the United States is becoming critically limited. This is especially true for irrigation of nonfood and fiber production sites including parks, commercial and residential lawns, athletic fields, golf courses, cemeteries, sod farms, and other landscape plantings. This is true even for the northeastern US where many people perceive an abundance of fresh water. Major metropolitan water suppliers in the northeastern US are required to double the supply capacity of their systems for the three summer months that are dominated by landscape irrigation demands.

As urban and suburban sprawl continues to grow, the demand for freshwater resources also increases. There is an obvious need to consider wastewater conservation and the use of alternative water sources for landscape irrigation. Wastewater has long been successfully used for irrigation in the southwestern US. Wastewater includes treated sewage effluent and nonhuman wastewater, grey water. Most large-scale wastewater irrigation comes from sewage treatment plant effluent.

The benefits of wastewater as an irrigation source include conservation of freshwater that would be used for irrigation, supply of small amounts of nutrients to enhance plant growth every time the site is watered, and a reduction of pollutant (phosphorus and nitrogen) discharge into surface water.

The potential hazards from wastewater irrigation involve salt injury to plants, long term effects on soil health (reducing drainage, increasing runoff/erosion), other soluble compounds in the water, and human pathogens in the wastewater. Proper water treatment has all but eliminated the human pathogen issue. Long-term use of wastewater irrigation of turfgrass sites in Arizona, a low rainfall area, has been shown to increase salt levels in the soil which could harm plant growth and destroy the structure of soils with clay.

In the northeast there has been very limited use of wastewater for irrigation. For example, in New York, just two of 850 golf courses in the state use wastewater for irrigation. One 36-hole golf course in Lake Placid, NY gets all its irrigation water from the city of Lake Placid; the city has reduced its phosphorus loading into Lake Champlain by 25 percent. To date, the Lake Placid golf courses, which have very sandy soil, have seen no turf damage from salt.

A. Martin Petrovic
Grasses prefer to be established in well-drained soils, and are tolerant of both full sun and shaded conditions. They prefer a non-alkaline soil, or lower soil pH.

The root systems tend to be shallow, and in heat and drought conditions of late summer, the fine fescues often go dormant and turn brown.

Coarse Fescues

In contrast, coarse fescues or tall fescues (Festuca arundinacea) are relatively coarse-leaved, darker green grasses that are drought resistant and somewhat shade tolerant in more southern locations. They are well-adapted to heavy clay soils and perform well in the transition zone states with hot summers and cold winters. Endophyte-free tall fescues are used extensively as forage grasses in pastures and rangelands throughout the US. Other improved turf cultivars are utilized on roadsides and also more recently as attractive turfgrasses in transition zone areas.

The turf-type tall fescues were selected and extensively bred to improve heat and drought tolerance and to have narrower leaves than the pasture-type such as Kentucky-31. Although tall fescue has short rhizomes, it has a limited capacity to spread given its bunch-like growth habit, and can thin in the shade. Reseeding on a regular basis may be needed to retain desired density over time.

Compared to fine fescues, the leaf blades of coarse fescue are relatively tough and require a sharp blade while mowing to prevent ragged edges. It is recommended to mow tall fescue at a height of 3 inches to avoid scalping and maintain density, while fine fescue can be successfully mowed at a lower height. Like fine fescue, tall fescue tolerates periods of drought, but in high temperatures, tends to go dormant. Both fine and coarse fescues are susceptible to several diseases which may be enhanced by exposure to excessive irrigation and fertilization. Fine fescues are susceptible to red thread and dollar spot, while tall fescue is susceptible to brown patch and fescue leaf spot.

Nitrogen Regulation Next?

The P regulation is a harbinger of what lies ahead. Consider the 100,000 acre Peconic Bay Estuary in eastern Long Island, NY. Prior to the mid-1980’s, Peconic Bay provided about 500,000 lbs. of bay scallops per year. By 1996 the harvest was reduced to 50 lbs per year. The massive drop was related to Brown Tide, a recurring algal bloom brought on by nutrient loading due to increased development around the bay.

A Comprehensive Conservation and Management Plan to address the Brown Tide is being implemented. This plan expects to reduce nitrogen by about $300 million to meet pollution reduction goals. In this case, the nutrient of concern is nitrogen (N) not exclusively P.

Nitrogen is thought to be the limiting nutrient in the Peconic Estuary and, when supplied, results in the Brown Tide. Singling out N is significant in that you simply cannot have good golf course turf without N. Additionally, as research has indicated, N has a significant effect on runoff and likely leaching as well. Slightly over 30 golf courses will be affected when the plan, which is in its early phase in 2004, is fully implemented.

The plan calls for annual N use rates over the entire golf course be less than 2.85 lbs. of actual N per 1000 square feet. There are many questions being raised by this type of plan. It is not a law per se, but clearly golf courses will be expected to comply.

Regulating nutrient management may not be perceived to be as volatile or alarming as pesticide regulations, but for sure, the influence could be greater. You won’t need pesticides if you cannot fertilize your turf.

It’s time to consider how to justify your fertilizer practices. There is a significant amount of research available to assist with the discussion, but as with most areas, more is still needed.

Now is the time to embrace coming changes by educating yourself and adapting. If we do not react proactively with education, change will be forced upon us with regulation.

Frank S. Rossi

Top: Peconic Bay Estuary suffered a massive decline in scallop harvest due to Brown Tide.

Bottom: Brown Tide, a recurring algal bloom brought on by excessive nutrient loading due to increased development around the bay.
Coming to a State Near You: Nutrient Management

Nutrient management is a key aspect of golf turf maintenance. Fertilization influences many aspects of turfgrass management including playability, visual quality, and wear tolerance.

What if we had to be certified to apply fertilizer the way many turf managers have to be to apply pesticides? What if the government set a limit on the amount and type of nutrients you could use in a season? While these seem farfetched, there are some signs that fertilizer regulation is on its way.

We have grown accustomed to environmental regulations for irrigating golf courses and using pesticides. Nutrient management, specifically fertilizer use, has heretofore been immune to the rash of regulations.

**New Laws in the Midwest**

Consider that a state law went into effect in Minnesota on January 1, 2004 and a local ordinance effective January 1, 2005 in Madison, WI regulating the application of phosphorus (P). These regulations are intended to reduce overall use of P in an effort to minimize P loading of surface water bodies. The MN law includes golf courses while the Madison ordinance does not, for now.

The contribution of P to lakes and streams results in severe algal blooms that degrade water quality for recreation and consumption by reducing dissolved oxygen levels. The “greening” of the lakes in these sensitive Midwestern communities has made turf management an easy target: fertilizers run off lawns and pollute the lakes.

While it appears the initial intent of the regulations was targeted at home lawns surrounded by impervious surface, the MN ordinance does include P application to golf courses. What seems funny is that with large P contributions likely coming from septic and sewer systems, banning P on turf feels like worrying about a mouse when an elephant is going to run you over. Nevertheless, New York is considering similar regulation, as is the state of Maine; the regulation frenzy is underway.

Phosphorus is required in relatively large amounts by turf, surpassed only by nitrogen and potassium. Phosphorus is critical for photosynthesis, energy management and membrane function, all vital components of plant growth and P is relatively immobile in the soil, it is tightly bound in the top few inches.

**An Important Assumption**

An important assumption was made prior to passing the P regulations that is worthy of exploration. First, it is thought that soils that have tested high in P are more prone to P runoff than low P soils. Therefore, the P bans require a manager to have a soil test that indicates golf turf as well as for low maintenance settings with exposure to stressful conditions, including cold temperatures, drought and saline soil conditions or roadside salt spray. Fine leaf fescues are viewed as especially useful for settings experiencing variable light conditions and poor soils.

Over the last decade, the study of plant-plant interactions and utilization of allelopathy and plant interference as a potential weed management tool has received increasing attention. The use of allelopathy for weed management relies upon the species-specific responses of a target weed to chronic or sublethal doses of an allelochemical (plant growth inhibitor), which can be exuded or leached from nearby living plants or decomposing residues. Weed suppressive cover crops that have been successfully used to suppress annual weeds have included economically important cereals such as wheat, oat, rye, barley, sorghum, and rice.

Although studies on allelopathic crops have focused on economically important cereals such as wheat, oat, rye, barley, sorghum, and rice, many other weedy and crop species show promise of allelopathic potential for suppression of surrounding vegetation, including several turfgrasses such as buffalograss, perennial ryegrass, bermsudagrass, and both tall and fine fescues.
Prior studies have focused on the weed suppressive effects of tall fescue, which was shown to be potentially allelopathic by production of toxic root leachates.

The fine fescue cultivars Intrigue, Columbia, and Sandpiper proved to be more weed suppressive (less than 5–8% weed infestations) over time than other fine leaf fescue cultivars. Reliant II, Wilma and Oxford were also good performers in terms of weed suppression, while Treasure, Boreal, Rebel II tall fescue, Sylvia High and several numbered selections were much less suppressive (greater than 15–30% infestations).

Top: a plot of tall fescue. Bottom: seeds from tall fescue.

Searching for the Plum Pox Virus

Plum Pox, also known as Sharka, is a viral disease of stone fruit trees such as plum, peach and apricot. It has been a devastating disease in Europe since the early 1900s, where it was first reported in Bulgaria, then spread throughout Europe. In recent years, the disease has spread to the Americas, first being found in Chile in 1992, then in the orchards of Adams County, PA, in 1999, and in Ontario and Nova Scotia, Canada in 2000. The disease remains localized at this time and it is hoped that it will be contained and eradicated before it has a chance to spread to the other parts of the North American continent. New York State Agriculture & Markets and Cornell University have established an extensive survey program to survey about 15,000 trees during the 2003, 2004 and 2005 growing seasons. No Plum Pox virus was detected during the 2003 and 2004 growing season. All samples were processed using the Durviz ELISA kit. One replicate of each sample was created and processed in adjacent wells of the ELISA plate. Plates were read using a plate reader set at 405nm. Samples were determined to be positive if their absorbance value reached 2.5 times the negative control value.

Additionally, a subset of approximately 300 random samples were selected to be processed using immunocapture-reverse transcription polymerase chain reaction (IC-RT-PCR) analysis.

New York State Agriculture & Markets and Cornell University have established a survey program due to our close proximity to the PA and Canadian confirmed positives.

Above: plum pox virus mottles a leaf of a plum tree. Below left: plum pox virus' effect on the stones of apricots. Below right: plum pox virus affects a variety of fruits including peaches.
Green Industry Show

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In additional field studies conducted in Ithaca and Riverhead — with a selection of cultivars with variable weed suppressive performance and using a large number of replicates for statistical power — the fine-leaf fescue cultivars Intrigue, Columbia, and Sandpiper proved to be more weed suppressive (less than 5%-8% weed infestations) over time than other fine-leaf fescue cultivars. Reliant II, Wilma and Oxford were also good performers in terms of weed suppression, while Treasure, Boreal, Rebel II tall fescue, Sylvia High and several numbered selections were much less suppressive (greater than 15%-30% infestations). All cultivars were established at a seeding rate of 4 lbs/1000 sq. ft. Although our data suggest that certain cultivars possess differential ability to suppress weeds over time, further studies are required to improve our understanding of the factors influencing weed suppression over time, including the impact of root exudation by weed suppressive cultivars.

What Makes It Work

With Dr. Frank Schroeder in the Chemistry Department at Cornell, we isolated and identified the main bioactive constituent in the inhibitory root exudates collected from the chewings fescue cv. Intrigue. This highly active inhibitor was identified as m-tyrosine, a simple derivative of p-tyrosine. M-Tyrosine was found in large quantities in root exudates of chewings fescue cultivars, strong red creeping fescues and Arizona fescue. It suppressed weed seed germination and seedling growth in both soil and soilless assays, generally at concentrations of 100 um or less, which are in the range of application rates of several preemergent herbicides such as pendimethalin.

Similarly, m-tyrosine exposure at low concentrations resulted in stunted root growth, reduced cell division and likely impact on cell elongation or cell wall formation in developing weed seedlings. The inhibitor is not highly selective in that it is active with every weed and crop species tested, but large crabgrass, barnyardgrass, dandelion, mustard, cress, and other small-seeded weeds are highly sensitive to its presence. Currently, we are attempting to further identify its mode(s) of action, and determine, with industry support, its potential to be developed as a soil-applied natural herbicide.

In ongoing studies with the NYSDOT and Dr. Senesac, we are evaluating a diverse collection of 25 turfgrass species and cultivars for their ability to establish across New York in a variety of field and roadside settings. Our better Festuca performers are part of this trial. The ultimate objective is to select a turfgrass cultivar or mixture that is tolerant of drought, salinity and low fertility, requires limited mowing, and establishes successfully that it is weed suppressive.

A daunting task? Perhaps, but our collaboration with Dr. Brown, a turfgrass breeder, at the University of Rhode Island to select for enhanced weed suppression and stress tolerance among existing cultivars of creeping red fescues and hard fescues as well as fescue/ perennial ryegrass hybrids will help us to address this goal.

Although the selection of highly weed suppressive turfgrasses is novel from both a traditional and molecular perspective, the development of fescue turfgrasses with enhanced stress tolerance is not. The combination of these attributes will hopefully lead to the future development and release of value-added turfgrasses which have utility as weed suppressive turfs in low maintenance settings, including roadsides as well as landscapes. In addition, attempted crosses or hybridization with closely related species such as perennial ryegrass may lead to characteristics including more rapid establishment and growth as well as enhanced weed suppression and stress tolerance.

Led by Leslie Weston and Carrie Berlin

Middle Northern Nurseries, Inc., Fairport, NY, a company that provides wholesale nursery stock for landscape contractors, garden centers, landscape architects, and municipalities, exhibits at the 2005 Empire State Green Industry Show.