CORNELL UNIVERSITY TURFGRASS TIMES

CUTT

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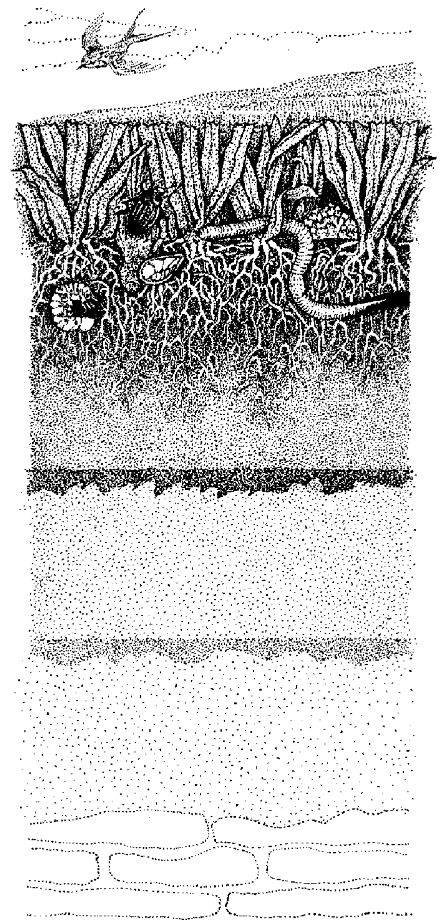

Composts As Soil Amendments

Compost is the product of biological decomposition of organic material in wastes under controlled conditions. An amendment is any material applied which alters the physical or chemical properties of a soil. Can compost be a suitable soil amendment when growing turfgrass? This is a question receiving more attention from turfgrass managers and researchers as alternatives to peat are sought and commercial production of composts increases. ■

Effect of Soil Characteristics

The ability of a soil to support a healthy stand of turfgrass is greatly influenced by inherent physical and chemical properties of the soil.

To properly manage turfgrass, it is important to understand soil characteristics and how they can affect growth and quality. Poor soil properties can lead to many problems, including inadequate drainage, reduced nutrient availability, soil compaction, and decreased microbial activity. This is particularly true of high traffic turf areas like golf greens and athletic fields which tend to be intensively used and managed.

When the physical shortcomings of a soil inhibit grass growth and ultimately the intended use of a turf area, modification by the addition of soil amendments may be called for to maintain adequate levels of oxygen, water, and nutrients. The appropriate amendment can improve plant growth, provide a better or safer playing surface, and reduce turf management problems. In a sandy soil, an amendment can increase the water holding capacity and ability to retain nutrients. On the other hand, a soil with too much clay can benefit from the addition of an amendment in order to reduce compaction and increase soil porosity.

The most common organic material used for soil modification is peat. Coarse-textured peat (such as sphagnum peat) can be used to modify fine textured soils and a finer, more decomposed peat (such as reed sedge or peat humus) is often used to modify coarser-textured soils. A number of benefits from the addition of peat have been recognized. Sandy soils amended with peat exhibit increased moisture holding capacity and fine-textured soils have better infiltration. Peat-modified soils have improved aeration and root penetration as well as increased nutrient retention and availability. Although peats are the

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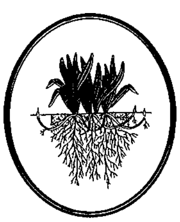
This Times

Short Cutts

New ASTM minimum standards for maintaining athletic fields are close to final passage.

Turfgrass Field Day



June 15, 1995

Ithaca, NY

Turfgrass Field Day Planned

The date for the 1995 Cornell Turfgrass Field Day has been set for June 15. As in the past, the Field Day is a program developed to highlight research ongoing at Cornell. It is a great opportunity for you to see where your research support is going, and to see how the Turfgrass Science Program at Cornell is serving you through research. More information will be coming soon.

What Happened to Fall?

By now you probably thought that you had missed your Fall issue of *CUTT*. Well you didn't. You have in your hands the Fall-Winter edition of *CUTT*—a double issue. Sometimes the best laid plans don't work out. Our Fall issue, I'm afraid, was completed a bit late. Rather than produce two issues on top of one another, we decided to combine them. You are still getting the same quantity and quality of information you would have received with two separate issues. Enjoy this issue of *CUTT*, and please forgive our procrastination this time.

ASTM Athletic Field Standards

The minimum standards for maintaining athletic fields are approaching the second hurdle in becoming a recognized standard. ASTM is an international standards organization that publishes consensus standards on everything from construction materials to testing procedures to sports equipment. Within ASTM there is a committee that addresses standards for playing equipment and facilities. There is also a natural turf subcommittee, of which Norm Hummel is a member, that has been working on minimum construction and maintenance standards for athletic fields. While any ASTM standard is voluntary, a school district following such an accepted standard would likely have less exposure to liability should an injury occur on the field. The standard was passed in committee and will soon be submitted for full society balloting. If approved, it will become an accepted standard. If you would like to receive a copy of this standard, contact Angelica Hammer, 20 Plant Science Building, Ithaca, NY 14853, or contact Norm Hummel at (607) 255-1629. Any comments on the standards are welcome.

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Scanning the Journals

A review of current journal articles

Fate of Fungicides

Movement of agricultural pesticides through soil has been studied extensively, but environmental fates of turf-applied fungicides are not well understood. Researchers in the Department of Agronomy at Purdue University conducted experiments to evaluate the role of thatch as a sorptive surface for fungicides, hypothesizing that thatch decreases mobility of fungicides and therefore decreases their potential to be transported off-site.

Fungicide sorption to thatch and soil was measured and compared. Data showed sorption of triadimefon, chloroneb, and vinclozolin to be up to nine times greater in thatch than soil, and the amount of fungicide sorbed was proportional to the organic carbon content of thatch or soil.

Results of this study indicate that the presence of thatch increases the capacity of the soil profile to sorb fungicides, which greatly reduces the probability that these compounds will be transported to ground or surface water. The researchers note that these findings apply only to turfs where accumulations of thatch are present. However, turf residues, even in the absence of a distinct thatch layer, can increase the organic content of the underlying soil which will increase the capacity of those soils to sorb pesticide. Further research concerning the movement of turf-applied pesticides in soils underlying thatch-free turfs is needed.

(From: C.J. Dell, C.S. Throssell, M. Bischoff, and R.F. Turco. 1994. Estimation of Sorption Coefficients for Fungicides in Soil and Turfgrass Thatch. J. Environ. Qual. 23:92-96.)

Identifying Salt-Tolerant Turfgrasses

Irrigation of turf or forage grasses with saline water is increasing in situations where better quality water is not available or must be conserved for human use or salt-sensitive crops. Since salts from irrigation can accumulate in production and recreation soils, researchers at the University of Illinois, Urbana, are looking at more efficient methods for developing and identifying new salt-tolerant (ST) turfgrasses. Creeping bentgrass (*Agrostis palustris* Huds.) is one of the more saline-tolerant of the cool season turfgrasses, but superior, salt-tolerant creeping bentgrass cultivars are needed for use in high salinity locations.

Selected cell cultures of creeping bentgrass grown in media containing 0-3% sodium sulfate (Na_2SO_4) were regenerated, rescreened, and compared to non-selected plants at the whole plant level. Researchers report that this technique proved successful for screening potentially salt-tolerant plants. Neither the selected nor the non-selected microcultured plants produced roots in the medium containing 3% sodium sulfate. However, the selected plants exhibited better root and shoot growth than non-selected plants at lower salinity (1.5-2.0% Na_2SO_4). This system of laboratory screening may provide a convenient method of detecting many whole plant performance traits, prior to expensive, time-consuming field trials.

(From: Yu-Jen Juo, M.A.L. Smith, and L. Art Spomer. 1994. Merging Callus Level and Whole Plant Microculture to Select Salt-Tolerant 'Seaside' Creeping Bentgrass. J. of Plant Nutrition. 17(4):549-560.)

Benefits of Turfgrass

Turfgrasses have been utilized for centuries by people to enhance their environment. Turfgrasses have always played an important role in protecting our environment, long before it became a major issue to modern societies. James B. Beard of the International Sports Institute in College Station, Texas, and Robert L. Green of the University of California, Riverside, recently analyzed the beneficial aspects of turfgrasses that improve our quality of life, which are just now being quantitatively documented through research.

Functional benefits of turfgrass include soil erosion control and dust stabilization and improved protection of groundwater due to the ability of turfgrasses to trap and hold runoff, which results in more water filtering through the soil-turfgrass ecosystem. Another extremely important function of turfgrasses is soil improvement through organic matter additions derived from the turnover of roots and other plant tissues.

Turfgrasses also provide a low-cost, safe recreational surface for many outdoor sports. Turfs provide a unique cushioning effect that reduces injuries to athletes when compared with poor or nonturfed soils, particularly in the more active contact sports like football, rugby, and soccer.

The researchers also address allegations that turfgrass culture has a major role adversely affecting the environment. A review of the scien-

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Scanning The Journals

continued from page 3

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Crabgrass and other annual grass weeds are often controlled by fenoxaprop. Researchers at the University of Maryland, College Park, conducted trials to determine if a prepackaged mix of 2,4-D + mecoprop + dicamba would influence the efficacy of fenoxaprop.

Improved cultivars of hard and blue fescues have been reported to be low growing and to maintain a dense, aesthetic cover under low maintenance. The new turf-type tall fescues are generally greener and exhibit both improved quality and improved persistence under low mowing.

tific literature provides no valid scientific basis for water conservation strategies or legislation requiring extensive use of trees and shrubs in lieu of turfgrasses. The main cause of excessive landscape water use in most situations is the human factor. The waste of water results from improper irrigation practices and poor landscape designs rather than any one major group of landscape plant materials. Groundwater contamination from the use of fertilizers is also addressed. Research has shown that fertilization of turfgrasses, according to established cultural strategies, presents a negligible potential for nutrient elements to pass through the root zone into groundwater or be transported by runoff water into surface waters.

(From: James B. Beard and Robert L. Green. 1994. The Role of Turfgrasses in Environmental Protection and Their Benefits to Humans. J. Environ. Qual. 23:452-460.)

Controlling Crabgrass

Crabgrass and other annual grass weeds are often controlled by fenoxaprop, a postemergence herbicide. Since crabgrass and broadleaf weeds are often found together in turfgrasses, tank-mixing a broadleaf herbicide and fenoxaprop to control several weed species simultaneously seems a logical option. However, previous experiments have shown that when fenoxaprop was tank-mixed with several different broadleaf herbicides, broadleaf control was usually good, but crabgrass control was only poor to fair.

Researchers in the Department of Agronomy at the University of Maryland, College Park, conducted trials to determine if a prepackaged mix of 2,4-D + mecoprop + dicamba would influence the efficacy of fenoxaprop if applied several days or weeks before or following the fenoxaprop application. Results from experiments run in 1992 and 1993 showed that smooth crabgrass (*Digitaria ischaemum*) control by fenoxaprop was reduced significantly when the broadleaf herbicide was applied less than 14 days before the fenoxaprop was applied. Reduced control was also observed when fenoxaprop was tank-mixed with the broadleaf herbicide. There was no reduction in crabgrass control when the broadleaf herbicide was applied 21 days before fenoxaprop or at least 3 days after fenoxaprop.

(From: P.H. Dernoeden and M.A. Fidanza. 1994. Fenoxaprop Activity Influenced by Auxin-like Herbicide Application Timing. HortScience 29(12):1518-1519.)

Low Maintenance Fescue and Mowing

Fescues (*Festuca* spp.) are commonly used in low-maintenance turfgrass sites such as roadsides, highway medians, cemeteries and grassy areas in parks and military installations. Low-maintenance grasses that retain density and acceptable aesthetic quality would also be suitable for golf course roughs and some lawn situations. Improved cultivars of hard and blue fescues have been reported to be low growing and to maintain a dense, aesthetic cover under low maintenance. The new turf-type tall fescues are generally greener and exhibit both improved quality and improved persistence under low mowing compared with Kentucky 31. Many of the improved tall fescue cultivars were bred to be better adapted to higher management levels than Kentucky 31. Although the attributes of these and other fescues have been reported, their performance has not been compared under diverse low-maintenance or limited-mowing situations.

Researchers at the University of Maryland, College Park, addressed this question in a study which compared the persistence and quality of Aurora hard fescue, Bighorn blue fescue, and Rebel II and Silverado tall fescues under low input conditions and three separate mowing regimes. The three mowing regimes were (1) mowing as needed to a height of 5.5 cm; (2) monthly mowing to a height of 8.0 cm; and (3) monthly mowing initiated following seedhead senescence to a height of 8.0 cm.

Initially, the tall fescue cultivars were of good quality. Within one year of seeding, however, Bighorn and Aurora quality surpassed that of both tall fescues. The tall fescues were more rapidly and extensively invaded by smooth crabgrass and white clover than either Bighorn or Aurora. Turf maintained under mowing regime 1 was generally of better quality. Lowest turf quality was most often associated with regime 3, particularly during spring and summer. In a three-year absence of irrigation or fertilizer inputs, Bighorn and Aurora maintained better quality and better resisted weed invasion compared with the tall fescue cultivars evaluated.

(From: P.H. Dernoeden, M.J. Carroll, and J.M. Krouse. 1994. Mowing of Three Fescue Species for Low-Maintenance Turf Site. Crop Sci. 34:1645-1649.)

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PRO-TECH For Industry Professionals

As an outgrowth of the 1993 Governor's Conference on Technology, Cornell Cooperative Extension has received State funding for a new initiative called PRO-TECH. The goal of the PRO-TECH program is to enhance the competitiveness and profitability of the turf, ornamental, fruit, and vegetable industries through educational programs which encourage adoption of new and existing technologies based on sound management and marketing principles.

The program will integrate technology with relevant cost, financial, operational, human resource and marketing information. Curricula will be developed to guide decision-making regarding technology adoption. Courses will be structured to introduce technologies, to enable managers to make informed decisions about the appropriateness of a technology in their enterprises and to develop action plans for adoption.

PRO-TECH is an industry-driven program. A partnership with the turf and ornamentals, fruit and vegetable industries is critical to the success of this program. Industry will provide guidance in determining priorities, and in program development and delivery. Enterprise managers, industry organizations, suppliers, distributors and others serving horticultural enterprises will be involved in the PRO-TECH initiative.

Working with groups of field staff, PRO-TECH staff and faculty will be actively involved in identifying technologies for which curricula will be developed, in organizing content, training staff and implementing courses. Industry representatives will be engaged in identifying and reviewing course content and assisting in program delivery.

Keep in touch with your local county Cornell Cooperative Extension office to learn more about local course offerings which will be delivered at the regional level in 1995.

For more information contact Joann Gruttadaurio at (607) 255-1792, who will work half time as a member of the PRO-TECH Leadership Team.

JOANN GRUTTADAURIO
DEPT. OF FLORICULTURE AND ORNAMENTAL HORTICULTURE

Editor's note: We recently learned that the PRO-TECH program was not funded in Governor Pataki's budget. The program's leaders hope to continue a scaled-down program without funding this coming year.

PRO-TECH Notes

The goal of the PRO-TECH program is to enhance the competitiveness and profitability of the turf, ornamental, fruit, and vegetable industries through educational programs which encourage adoption of new and existing technologies based on sound management and marketing principles.

Scanning The Journals

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Effects of Irrigation on Pendimethalin Efficacy

Researchers at Ohio State University in Columbus conducted a two-year field study to determine effects of posttreatment irrigation timing on pendimethalin efficacy for controlling smooth crabgrass in turfgrass. Factors investigated included herbicide rate, formulation, and the interval between pendimethalin application and the initial posttreatment irrigation.

Granular-formulated pendimethalin provided better weed control than wettable powder pendimethalin when averaged over all rates, irrigation events, and years. All herbicide-treated plots contained fewer smooth crabgrass plants than untreated check plots. Granular pendimethalin was not affected by a delay in posttreatment irrigation. In contrast, wettable powder pendimethalin efficacy was reduced if irrigation was applied later than the day of treatment.

The study indicated that the granular pendimethalin formulation was more effective than the wettable powder formulation when no irrigation or rainfall occurred within seven days after treatment. No efficacy differences were observed between formulations when the initial posttreatment irrigation was applied on the day of treatment. Therefore, both formulations should perform equally well in irrigated turf areas, so long as the wettable powder formulation is immediately incorporated with water.

(From: J.J. Gasper, J.R. Street, S.Kent Harrison and W.E. Pound. 1994. Pendimethalin Efficacy and Dissipation in Turfgrass as Influenced by Rainfall Incorporation. Weed Science 42:586-592.)

Compost

continued from front cover

When the physical shortcomings of a soil inhibit grass growth and ultimately the intended use of a turf area, modification by the addition of soil amendments may be called for to maintain adequate levels of oxygen, water, and nutrients.

most common organic soil amendment, other composted materials are becoming increasingly available. How a compost compares with peat in its effect on soil physical and chemical properties will determine whether or not it is a suitable amendment.

Compost Suitability

The main factors that affect a compost's suitability as a soil amendment include maturity, nutrient availability, pH, water-holding capacity, and absence of toxic compounds. Since a variety of materials may go into a compost, the resulting compost can also be variable. Inconsistency in the final product is a problem inherent in the nature of compost. For example, yard waste composts may vary considerably due to the types of yard waste brought to the compost facility at different times of the year. Composts produced from sludge or food processing wastes tend to be much more consistent. To determine compost suitability, a sample should be sent to a soil testing lab. However, since you must make the final determination, keep the following in mind.

Topsoils are manufactured by blending soil, sand and compost.

A compost should be mature. Immature composts can interfere with plant growth through nitrogen immobilization and the temporary production of potentially toxic compounds like ammonia. Generally, a mature compost is dark-colored and has an earthy odor. Don't confuse compost maturity with compost quality. Maturity means the energy and nutrient containing materials have been combined into a stable organic mass. Quality reflects maturity but also reflects the chemical composition of the compost substrates. For example, an industrial sludge composted to maturity may contain a sufficient level of contaminants to be regarded as poor quality.

A soil testing lab can determine a compost's nutrient content. Don't treat compost as a fertilizer. Compost derived from high-nutrient substrates such as animal waste have relatively high nutrient availability. Compost derived from plant material is likely to be nutrient poor. Many of the nutrients are bound in organic compounds, unavailable to plants. As the compounds break down, a compost's real nutrient value is realized over the long term as substantial amounts of plant-available nutrients are released and the need for continued fertilization may be reduced.

The addition of compost to a soil has the important benefit of increasing the ability to retain nutrients. This quality is reflected by the cation exchange capacity, or CEC which measures negatively charged particles which attract positively charged nutrients. Addition of compost increases porosity which in turn increases aeration and reduces compaction. Water retention in the root zone is also increased in sandy soils.

Researchers at the University of Washington, Seattle, have established the *guidelines* shown in Table 1 for identification of high-quality compost. Keep in mind that higher or lower values don't necessarily mean the compost is inferior. On the other hand, some composts may meet these general criteria, but other properties make them unsuitable for plant growth. In the final analysis, compare a compost's properties to the use and effect you wish to achieve with it.

How Much to Use

Quality composts are a great means of increasing the organic matter content of soils. The addition of 10-30% (by volume) compost to a soil will increase the organic matter content by 2-5% by weight. This is ideally achieved through off-site mixing and screening, but can also be achieved by rototilling the compost into the existing soil. There are even some companies manufacturing "topsoil" by blending compost, sand, and soil together to produce rich sandy loams.

Composts can also be used as the organic component of sand based rootzones. The amount of compost needed is highly dependent on the properties of the sand and the design of the green

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Microbiology

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Algae

Algae can be found in essentially all soils worldwide. Although in most turfgrass soils, the algae are a minor microbial component, their presence, under certain conditions, can create difficult management problems. Unlike the previously-mentioned groups of microorganisms, algae are capable of photosynthesis, allowing them to synthesize their own carbon compounds. Since algae require light, their presence in turfgrass plantings is often observed on the soil surface in sparsely seeded areas and in excessively close-cut turf such as on putting greens.

The types of problems caused by algae in turfgrasses include 1) the formation of surface crusts, 2) the production of copious slime, and 3) the formation of 'black layer'. The soil algae responsible for these problems can be classified into the green algae and the cyanobacteria (formerly referred to as blue-green algae). The genera of green algae recovered from turfgrasses include *Cosmarium*, *Coccomyxa*, *Cylindrocystis*, *Dactylothece*, *Mesotaenium*, *Klebsormidium*, and *Ourococcus*. All but the latter two are capable of producing surface crusts and slime. The two most abundant genera of cyanobacteria in turfgrasses include *Nostoc* and *Oscillatoria*. The latter genus has been implicated as the primary cause of slime formation on golf greens. The cyanobacteria are also known for their abilities to fix atmospheric nitrogen, which, in some instances, may actually contribute to the nitrogen nutrition of the turfgrass plant.

Algae are strictly dependent on adequate soil moisture for activity. Algal problems occur whenever the soil remains wet for prolonged periods of time and where the soil surface is exposed or the turfgrass stand is thin and weak. Although fertility has no clear relationship to algal activity, the use of acidifying fertilizers such as ammonium sulfate can enhance algal colonization.

Managing Microbial Resources

It is apparent that the soil contains an extremely rich wealth of microbial resources in addition to the harmful microorganisms with which we are familiar. Microbial communities in turfgrass soils influence all of the important processes related to plant nutrition and the general maintenance of plant health. Furthermore, soil microbial communities provide a genetic resource of potentially useful products and processes that can be exploited for the management of turfgrasses. The challenge to turfgrass managers is to become an expert, not only in the management of what everyone can see aboveground, but to master the management of soil microorganisms to achieve the maximum, sustainable means of turfgrass health and maintenance.

Eric B. Nelson
Dept. of Plant Pathology

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Compost

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or sports field. Therefore, thorough testing of mix ratios by a competent lab will be necessary.

While the benefits of using compost are well documented, use only *thoroughly* composted materials from known sources. Make an effort to find a source with a good track record for successful plantings. It will be time well spent.

Mary Thurn
Dept. of Floriculture and Ornamental Horticulture

Table 1. Guidelines for identifying high-quality compost.

Physical Properties		Chemical Properties	
Color:	Brown to black	Organic Matter:	25 to 80 percent
Odor:	Earthy or mouldy	pH:	5.5-7.5
Moisture:	15-25%	Ash:	20-65%
Water-Holding Capacity:	150-200%	Nitrogen:	0.4-3.5%
Bulk Density:	0.2-0.6 g/cc	Phosphorus:	0.2-1.5%
		Potassium:	0.4-1.5%
		C:N Ratio:	25-30:1
		CEC:	50-150 meq/100 g

Topdressing For Success

The reasons for topdressing golf greens and athletic fields include controlling thatch, providing a smooth putting surface, and modifying the surface soil characteristics.

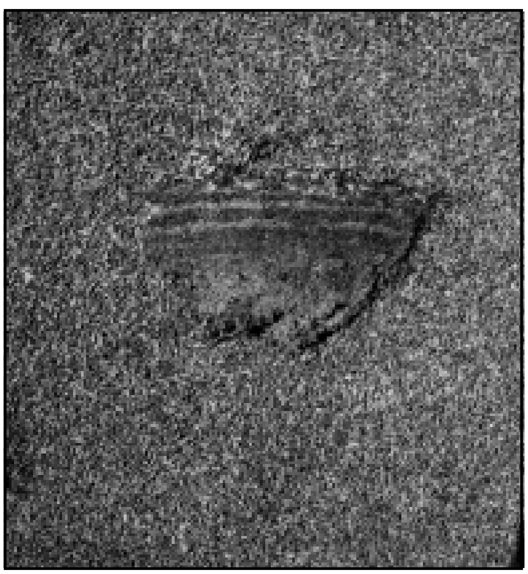
The practice of spreading soil, sand, organic matter, or some combination of these onto a turfgrass area goes back many, many years. In the early part of this century, golf course superintendents would mix their own topdressing from soil, sand, and manure, often keeping their formulas a secret.

More recently, topdressing is becoming as much a standard practice on high maintenance turf areas as fertilization. As routine as it seems, I often get the sense that many don't fully appreciate the impact this practice may have on their turf, good or bad, and the importance of selecting the proper topdressing material to achieve your goals.

Why Do We Topdress?

The reasons for topdressing golf greens and athletic fields are many. The primary reasons are to control thatch, to provide a smooth putting surface, and to modify the surface soil characteristics.

Topdressing is a means of biologically controlling thatch. The application of a topdressing helps minimize thatch by preventing the formation of a physical separation between the soil and the plants. The mixing of a topdressing material with the thatch as it accumulates actually provides an ideal environment for the decomposition of the organic matter. In some cases, the topdressing may actually serve as a microbial innoculum that further enhances decomposition.



Infrequent topdressing can result in layering.

Topdressings are also used to smooth or level the surfaces of greens and athletic fields. The putting surface of greens are kept smooth by light frequent topdressings. Irregularities in grade on larger areas, such as athletic fields, can be removed by applying topdressings and floating or regrading the affected areas.

What Should I Topdress With, and How Often?

The topdressing material you use will depend largely on the goals of your topdressing program. If your primary goal is to prevent thatch, or to remove subtle irregularities in grade, and the soil existing on the site is suitable, the area should be topdressed with a soil very similar to the existing soil.

Unfortunately, athletic fields are often constructed with heavy soils found on the site, and not well suited for high traffic. The surface physical properties of these fields can be improved through a topdressing program. Frequent, heavy topdressings with a sand or sand mix will build a more permeable cap on the surface of the soil that will expedite surface drainage, and improve the compaction resistance of the soil. The field should be topdressed at least twice a year with a high sand topdressing at a rate of 0.5 to 1 cubic yard of topdressing per 1,000 square feet. Topdressing should always follow core cultivation to further amend the soil surface.

The success of a program to amend surface soil characteristics will only be as good as the sand selected to topdress with. The sand should be uniform in particle size with most of the sand particles falling into the medium and coarse size fractions (0.25 to 1.0 mm). Table 1 lists a recommended particle size distribution for a sand topdressing for athletic fields.

Many theories exist on the selection of topdressing materials for greens, the most controversial being sand vs. sand mix. The proponents of straight sand topdressing argue that there is sufficient organic matter in mature greens, so that additional organic matter is unnecessary. Furthermore, straight sand is less expensive than sand peat mixes, and much easier to apply.

Proponents of sand based mixes argue that straight sand can become hydrophobic, and that it is biologically sterile. Furthermore, research conducted at the University of Rhode Island several years ago showed better turfgrass quality with sand:soil topdressings compared to sand alone.

Newly constructed greens should be topdressed with the same mix used for construction; this normally being a sand:peat or sand:soil:peat mix. New greens constructed to USGA Recommendations or similar have very little cation exchange capacity (CEC); an 80:20 sand sphagnum peat mix rarely having a CEC of more than 2 meq/100 grams. This inherent lack of fertility makes fertility management difficult, especially during the maturing years. It is very desirable, then, to continue to add organic matter through topdressing.

The sand used as the base of a putting green topdressing mix should be uniform in particle size, with most of the particles falling into the fine through coarse size fractions (0.10-1.0 mm). There is little tolerance for sand particles larger then 1 mm in diameter, since these will be difficult to work into the turf, leaving the potential for mower damage. Table 1 lists my recommendation for sand particle size for a putting green (or tee) topdressing. Many topdressing sands in New York State are very fine in texture.

Table 1. Recommended topdressing particle size distributions.

Sand Particle Size	Sieve Mesh Size	Athletic Fields % Passing	Putting Greens % Passing
2.0 mm	10	95-100%	100%
1.0 mm	18	80-100%	95-100%
0.25 mm	60	0-25%	0-30%
0.10 mm	140	0-10%	0-10%

While this may be working out well for topdressing older, native soil greens, these sands have the potential to seal off the surface of sand based greens built to USGA or similar specifications.

Topdressing should be applied at least monthly during the growing season at a rate of 0.25 to 0.5 cubic yards per 1,000 square feet. Infrequent topdressing may result in the formation of alternate layers of thatch and topdressing (see photo), a condition that no doubt has a negative effect on water and air movement in the soil.

Working in the topdressing after it dries on the surface should be performed by an experienced worker. I saw two incidences of severe turf injury this past year alone from excessive dragging of greens following topdressing. If you are topdressing during stress periods, you may consider brushing it in rather than using a drag mat.

What Type of Organic Matter Should be Used?

There are several sources of organic matter that can be included in your topdressing material. Well decomposed products such as peat humus and reed sedge peats blend very uniformly with sand and are ideal organic sources for topdressings. Since there are many mucks being sold as peat, be sure that the peat you use is high quality. I recommend that any peat used in topdressing have a minimum organic matter content of 85%, as determined by a loss on ignition test. Mucks have a high silt and very fine sand contents, and will seal up sands.

Sphagnum peats are very high in organic matter and are well suited for use in topdressing. Since sphagnum peat is more fibrous than the reed sedge peats and peat humus, there may be some segregation of the peat from the sand, especially when it dries.

There are some high quality composts being marketed in New York and surrounding states. Quality composts (see article on compost beginning on page 1) are suitable for topdressing materials, and may actually be advantageous to peat. The benefits of some composts for disease suppression are becoming well known. The main disadvantage of compost is the presence of small wood chips. A topdressing supplier can screen much of this out with a 1/4 or 1/8 inch screen. Any wood chips remaining on the turf surface will be removed with the first mowing, without damage to the mowing equipment. With the proliferation of compost products on the market, I would recommend physical and chemical testing any topdressing mix containing compost before you topdress your greens or athletic turf.

Can I Switch Topdressings?

It is not desirable to switch topdressing materials. Unfortunately, there may come a time when you have no choice due to supply problems or economic considerations. The greatest danger in switching topdressing is the potential for layering in the profile. If your must seek out an alternative topdressing source, look for a product with a sand particle size similar to your existing topdressing material. A competent soil testing laboratory can assist you in determining similarities in topdressing materials. Switching a topdressing from one that has no organic matter to one that does (or vice versa), presents less of a layering potential than switching sand sources.

Topdressing fine turf areas can bring great improvements to high value turfgrass areas. Selecting the proper topdressing material and topdressing frequently enough to show some benefit are the keys to a successful program.

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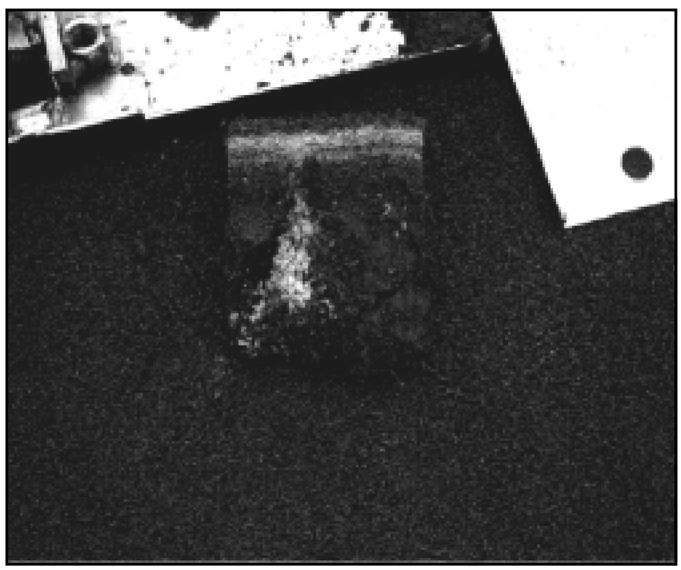

Light, frequent topdressings build up a sand "cap".

The Microbiology of Turfgrass Soils

It might be safe to assume that most turfgrass managers consider soil to be a mysterious world below the turfgrass canopy. Rarely do they consider soil as something that should be managed as prudently as the turf itself.

Most soils below turfgrass stands contain a vast array of living organisms, ranging from the larger macroscopic earthworms and insects, to the microscopic invertebrates, bacteria, fungi, actinomycetes, nematodes, algae, and protozoa.

Most turfgrass managers do not have a strong understanding of turfgrass soils, particularly the biological aspects. Certainly most know that living things, such as worms and insects can reside in soil, but they're not sure where in the soil they live or what they live on. In fact, it might be safe to assume that most turfgrass managers consider soil to be a mysterious world below the turfgrass canopy. Rarely do turfgrass managers consider soil as something that should be managed as prudently as the turf itself. It is becoming clear, however, that the management of the soil, in particular its biological components, is perhaps as important as the management of the plant for the long-term productivity and health of a turfgrass stand.

Most soils below turfgrass stands contain a vast array of living organisms, ranging from the larger macroscopic earthworms and insects, to the microscopic invertebrates, bacteria, fungi, actinomycetes, nematodes, algae, and protozoa. The types, numbers, and activities of these organisms directly and indirectly impact on turfgrass health. Most turfgrass managers are familiar with the harmful effects that some microorganisms have on turfgrass health. For example, these damaging microorganisms include fungal, bacterial, and nematode pathogens of turfgrass plants, cyanobacteria—a form of blue-green algae that causes black layer, and green algae that cause surface crusting and plant damage. There are other groups of microorganisms that are indirectly harmful to turfgrass plants. These include pesticide-degrading non-pathogenic and pesticide-resistant pathogenic microorganisms. In nearly all cases, turfgrass managers have developed elaborate management techniques to avoid some of the detrimental effects caused by the activities of these organisms. Despite the presence of harmful microorganisms in turfgrass soils, most soils contain large populations of beneficial microorganisms. These offer the most promise for enhancing turfgrass health and maintaining long-term productive turfgrass stands (Table 1).

Bacteria

Of the microorganisms in soil, bacteria are found in the greatest abundance and are perhaps the most diverse in their morphology and activities. Many different populations of bacteria with a wide array of activities can be found in most turfgrass soils; many carrying out processes important to plant health (Table 2). However, the exact bacterial composition of each soil may vary depending on the soil type, prevailing environmental conditions, and management practices.

Bacteria are small, rod-shaped organisms that reproduce prolifically by simple cell division, producing massive amounts of cells in a short period of time. Under favorable conditions, bacteria may divide every 20 minutes, so that conceivably, one bacterium could give rise to one million bacteria in 10 hours! Although the total numbers of cells can be great, the size of each individual cell is quite small, usually not more than one or two microns (0.00004 inches) in length.

During the explosive growth of bacteria, a diverse array of food sources must be available to support such a high rate of metabolic activity. During the transformation of food sources, a number of metabolic by-products are also produced. As a result, great chemical changes may occur in the soil as a result of the proliferation of

Table 1. Important beneficial microorganisms found in turfgrass soils.

Microbial Group	Major Benefit to Turfgrasses
Nutrient-cycling microorganisms	Making nutrients available to plants Decomposition of organic matter
Thatch-degrading microorganisms	Thatch maintenance
Nitrogen-fixing microorganisms	Improvement in turfgrass nutrition
Endophytes	Pest resistance Stress tolerance
Mycorrhizal fungi	Improved phosphorus nutrition
Plant growth promoting rhizobacteria	Improved root and shoot development Disease tolerance Protection from pests
Biological control organisms	Protection from pests

bacteria in the environment. It is this latter attribute that makes bacteria such significant microorganisms in the turfgrass environment.

Bacteria require water in order to grow and reproduce. Their survival is limited if water availability diminishes. Although, most bacteria in turfgrass ecosystems are extremely good saprophytes (i.e. they prefer to live on decaying organic matter), some are endophytic (i.e. they live inside healthy plants, usually in roots). In both cases, they are usually good competitors with plant pathogens which results in reduced damage from plant pathogenic fungi.

Of particular importance to turfgrass health are the bacteria that play a role in nutrient transformations in soil, particularly those involved in nitrogen cycling. Numerous bacteria within the genera *Azotobacter*, *Azospirillum*, *Enterobacter*, and *Klebsiella* are efficient free-living nitrogen-fixing bacteria. That is, they take nitrogen from the atmosphere and convert it to a form that the plant can use. Although they contribute significantly to the nitrogen nutrition of such grass species as *Poa pratensis* (Kentucky bluegrass), the magnitude of their contribution to the nitro-

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Despite the presence of harmful microorganisms in turfgrass soils, most soils contain large populations of beneficial microorganisms.

Table 2. Predominant bacteria and their known activities in turfgrass soils.

Bacterial Genus	Predominant Activities
Arthrobacter	Degradation of pesticides Decomposition of organic matter
Azospirillum	Nitrogen-fixation
Azotobacter	Nitrogen-fixation
Bacillus	Biological control of diseases and insects Decomposition of organic matter Degradation of pesticides Denitrification Phosphate solubilization Conversion of ferric to ferrous iron Release of native soil potassium Manganese oxidation
Desulfovibrio	Conversion of sulfates to sulfides
Enterobacter	Nitrogen-fixation Biological control of diseases
Flavobacterium	Decomposition of organic matter Phosphate solubilization Pesticide degradation Biological control of diseases
Klebsiella	Nitrogen-fixation Conversion of ferric to ferrous iron Manganese oxidation Pesticide degradation
Nitrosomonas	Oxidation of ammonia to nitrite (nitrification)
Nitrobacter	Oxidation of nitrite to nitrate (nitrification)
Pseudomonas	Decomposition of organic matter Biological control of diseases Plant growth promotion Some species can be pathogenic to turfgrasses Denitrification Phosphate solubilization Conversion of ferric to ferrous iron Release of native soil potassium Manganese oxidation Pesticide degradation
Thiobacillus	Conversion of inorganic sulfur and iron compounds to sulfates and ferric forms of iron Denitrification
Xanthomonas	Biological control of weeds Some species are pathogenic to turfgrasses Decomposition of organic matter

Great chemical changes may occur in the soil as a result of the proliferation of bacteria, making them such significant microorganisms in the turfgrass environment.

Microbiology

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One of the more pivotal groups of bacteria that impact on turfgrass health are those involved in the biological control of turfgrass pathogens.

Fungi are best known for their disease-causing activities on turfgrasses. However, the vast majority of fungi found in turfgrass soils are beneficial to plant health.

Many of the antibiotic compounds produced by actinomycetes also affect the growth and development of pathogenic fungi allowing the organisms to participate in the biological control of turfgrass diseases.

gen nutrition of turfgrass plants in the field is unknown. Undoubtedly these organisms have the potential to contribute substantially to the nitrogen economy of a turfgrass planting if they were managed in an effective way.

Of equal importance to the nitrogen-fixing bacteria are the those involved in organic matter degradation. These organisms play a key role in maintaining the delicate balance between thatch accumulation and thatch degradation. These organisms can be managed to some degree. In fact, there are a number of commercial preparations of thatch-degrading microorganisms as well as preparations of the enzymes that they produce. Some of these have been used successfully in a thatch maintenance program whereas other fail miserably.

One of the more pivotal groups of bacteria that impact on turfgrass health are those involved in the biological control of turfgrass pathogens. These bacteria can be found in all types of turfgrass soils, from low maintenance to high-maintenance areas. Their effects may sometimes go largely unnoticed. However, they can have huge impacts on disease development. In some cases, high populations of these bacteria are responsible for the development of what we call suppressive soils. These are soils where conditions are ideal for disease development and the pathogens are present, but no disease develops because of the activities of these biological control bacteria. Since all of these bacteria prefer to live on dead and decaying plant tissue, large amounts of organic matter, either in the form of topdressings or direct soil amendments, are usually very beneficial in promoting the activities of these bacteria.

Fungi

The fungi are best known for their disease-causing activities on turfgrasses since nearly all of the economically-important turfgrass diseases are caused by fungi. However, pathogenic fungi represent only a small proportion of the total communities of fungi in soil. The vast majority of fungi found in turfgrass soils are beneficial to plant health. Some of the major genera of fungi present in turfgrass soils include *Penicillium, Aspergillus, Trichoderma, Gliocladium, Fusarium, Mucor*, and *Mortierella*.

Fungi obtain their energy for growth through the decomposition of organic matter. It is not surprising, therefore, that organic matter decomposition is one of their predominant activities in turfgrass ecosystems. Generally, fungi are more prevalent than bacteria in soils of pH lower than about 5.5 whereas bacteria tend to predominate in higher pH soils. Since fungicides are the primary pest control chemical used on golf course turf, soils at these sites can vary dramatically in the composition of fungal communities, depending on the type, rate, and frequency of fungicides used. Mycorrhizal fungi are another beneficial group of fungi that form unique symbiotic associations with plant roots called *mycorrhizae*. In mycorrhizal relationships, the fungus benefits from the carbon provided by the plant while the plant benefits from the increased phosphorus nutrition and water movement to the roots. Both bentgrasses and bluegrasses have been reported to be mycorrhizal, although little information is available on the beneficial or detrimental properties of mycorrhizae in these grasses. As with other fungi, mycorrhizal fungi are sensitive to a number of fungicides commonly used in turfgrass management.

Some of the better-known fungi used in turfgrass management are endophytes. Fungal endophytes are typically found in the seeds and leaf sheaths of nearly all turfgrass species. Most commonly, however, the endophytes of perennial ryegrass, tall fescue, hard fescue, chewings fescue, and creeping red fescue have been exploited. Useful endophytes have not been found in creeping bentgrass and Kentucky bluegrass.

Actinomycetes

One of the least known and least understood groups of soil microorganisms are the actinomycetes. These microbes are classified more closely with the bacteria, but they grow more like a fungus. Although their populations in some soils can be quite high, their growth rates are much slower than the other microorganisms in soil.

Actinomycetes are typically more abundant in dryer soils high in organic matter or in high temperature soils. As a group, they are not tolerant of low soil pH (i.e. less than 5.0). They prefer to grow at temperatures ranging from 80 to 100 degrees. Some of the major genera of soil actinomycetes include *Streptomyces*, *Nocardia*, *Micromonospora*, and *Actinoplanes*.

These organisms are best known for their abilities to produce a number of industrially and medically-important compounds. Many of the clinically-important antibiotics used in human and animal medicine come from soil actinomycetes. Many of the antibiotic compounds produced by actinomycetes also affect the growth and development of pathogenic fungi allowing the organisms to participate in the biological control of some turfgrass diseases.

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Bluegrass

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grasses. They are not competitive in blends, and are susceptible to leaf spot disease. Examples of common bluegrass types include Alene, Rhonda, Voyager, Kenblue, and South Dakota common.

Mid-Atlantic Ecotypes: The mid-Atlantic ecotypes are bluegrasses that were bred or selected for drought and heat tolerance, which are characteristics very important for sod production in the mid-Atlantic area. These grasses have very deep rhizomes, and are usually the best summer performers in non-irrigated conditions. They tend to be coarse textured. Examples of mid-Atlantic ecotypes include Livingston, Wabash, SR-2000, Huntsville, and Preakness.

BVMG Types: The Baron, Victa, Merit, Gnome (BVMG) types are high seed yielders, so they are popular components of blends to bring the cost down. They may be stemmy in the spring. They are less disease resistant than other improved varieties, and they have later spring green-up. Besides the four varieties listed above, other bluegrasses in this category include Fortuna, Marque and Kelly.

North Latitude Compact Types: The north latitude compact types are dwarf types with high density and reduced vertical growth rates. These varieties have shown better disease resistance, have slower green up in the spring, and are competitive in blends. Examples of this class of varieties include Blacksburg, Midnight, Able I, Indigo, Unique, Glade, America, and Barsweet.

Bellevue Types: The Bellevue type bluegrasses are moderately aggressive. They have the best winter and spring color, but can be stemmy in the spring. They have good disease resistance and good summer performance. These varieties are compatible in blends, but are not very competitive. Examples of Bellevue types include Columbia, Dawn, Classic, Banff, Trenton, Suffolk, Freedom, and Haga.

Other Types: This class of bluegrasses catches those that don't clearly fit in one of the other classes. Many of these varieties are actually hybrids of Bellevue types and Baron. These varieties are moderately competitive and have good disease resistance. Therefore, they are useful in blends. Examples include Aspen, Adelphi, Challenger, Cobalt, Eclipse, Liberty, NuBlue, Nustar, Shamrock, and Washington.

Based on the characteristics of these bluegrasses, Dr. Meyer went on with the following recommendations (see also Table 1):

Fairways: 50-100% aggressive types with some north latitude compact types.

Medium traffic areas: 10-30% aggressive types, 10-30% north latitude compact types, 10% Bellevue types, and 20-30% others.

General purpose lawn areas: 0-5% aggressive, 10-20% BVMG types, 10-20% mid-Atlantic ecotypes, 10-20% north latitude compact types, 10-20% Bellevue types, and 10-20% other types.

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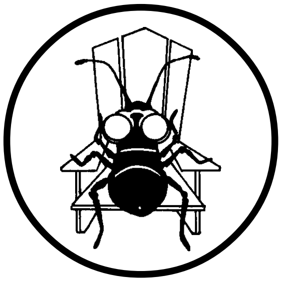
Of the several turfgrass variety trials we have in place in Ithaca, nowhere do we see greater varietal differences than with Kentucky bluegrasses. Among more than 100 varieties, you see differences in color, growth habit, texture, density, and disease resistance.

Table 1. Recommended uses for Kentucky bluegrasses.

Turf Use	Aggressive Types	Mid-Atlantic Types	BVMG Types	North Lattitude Compact Types	Bellevue Types	Other Types
Fairways	50-100%			Some		
Medium Traffic Area	10-30%			10-30%	10%	20-30%
General Purpose Lawn	0-5%	10-20%	10-20%	10-20%	10-20%	10-20%

Winterizing Your Sprayer



Pest Watch

Taking the time to properly store sprayers results in longer lasting equipment and safe, efficient application of pesticides.

- ***Clean it thoroughly***
- ***Check for worn parts***
- ***Remove pump***
- ***Seal it from dirt***
- ***Store it safely***

Another season is coming to an end, and that means preparing equipment for storage. Taking the time to properly store sprayers results in longer lasting equipment and safe, efficient application of pesticides. Donald R. Daum (formerly with Penn State Extension, Ag. Engr.) and Thomas F. Reed, Regional Manager of TeeJet in Dillsburg, PA, offer the following five-point checklist for winterizing your sprayer.

1) Thoroughly clean the sprayer; drain it completely, especially the filters, pump, pressure regulator, selector valve, gauges, and any other fittings that may retain water. Cleaning solutions and methods for cleaning sprayers are presented in Table 1.

Nozzle tips and screens can be cleaned in a strong detergent solution or kerosene using a soft brush such as an old toothbrush. Remember, follow the same safety precautions during cleaning as for applications. Use a respirator, rubber gloves, or other protective gear as may be directed by label instructions.

2) Check the sprayer for worn parts. List all components that need replacement and order the parts well before the next spraying season. Pay particular attention to nozzle spray tips. New spray tips produce uniform distribution when properly overlapped. Worn spray tips have a higher output with spray concentrated under each tip. Damaged spray tips have erratic output and can result in over-and under-application.

3) Before winter storage, remove the pump and follow the manufacturer's recommendations for storage.

4) Seal off any openings to prevent entry of dirt, debris, or rodents.

5) Store the sprayer where it will not be damaged by other equipment. Store polyethylene tanks under cover to prevent possible deterioration by sunlight. Store galvanized steel tanks indoors away from moisture to prevent rusting.

Table 1. Cleaning solutions and methods for cleaning sprayers.

Pesticide Used	25 Gallon Cleaning Solution	2.5 Gallon Cleaning Solution	Instructions
Hormone herbicides, salt or amine formulations (2,4-D, dicamba, MCPA)	1 qt. household ammonia	1/2 cup household ammonia	Thoroughly agitate, flush small amount through system, and let remainder stand in sprayer overnight. Flush and rinse.
	—or—	—or—	
	2 lbs. trisodium phosphate	1/4 lb. trisodium phosphate	Same as above except let stand for at least 2 hours.
	—or—	—or—	
	1/2 lb. fine activated charcoal and 1/2 cup powder detergent	2 tbsp. fine activated charcoal and 1-2 oz. powder detergent	Agitate, operate sprayer for 2 minutes, let remainder stand for 10 minutes, then flush through sprayer. Rinse.
Other herbicides (atrazine, simazine, alachlor)	1/4 lb. powder detergent[1]	1 tbsp. powder detergent[1]	Rinse with clean water before and after using sudsy solution.
Insecticides[2] and/or fungicides	1/4 lb. powder detergent[1]	1 tbsp. powder detergent[1]	Agitate, flush, and rinse.

[1]Liquid detergent may be substituted for powder detergent; mix at a rate to make a sudsy solution.
[2]Organophosphate and carbamate insecticides may be detoxified by adding household ammonia to the cleaning solution (1 qt./25 gallons or 1/2 cup/2.5 gallons).

Reduce Your Reliance On Pesticides

Before the next growing season begins and you get overwhelmed with work, take a little time and develop a strategy to reduce your reliance on pesticides. In addition to a possible savings of money, think about the positive effect on the environment. Let's face it, daily, you work with plants, soil and people. I consider you to be the ultimate environmentalist. Why not enhance your image and show your peers and customers that you practice environmental stewardship and reduce the amount of pesticides you apply.

The majority of turfgrass managers are professional, conscientious people consumed by many tasks. Pest management is only a small component of the turfgrass system. When pesticides are applied properly (for the correct pest, at the right rate and time) the manufacturers claim they are safe and will control the pest. However, there are people overusing, misusing and abusing pesticides. This enhances the controversy surrounding pesticide use.

There are strong arguments for and against changing your current pest management practices to lessen the amount of pesticides ending up in your body, other living organisms, the soil, water and air. Do not look at the challenge of reducing pesticide use as a risk to the turf quality or your job. All turfgrass managers growing and maintaining turf in all types of settings can attempt to decrease the amount of pesticides they apply.

The key to reducing your reliance on pesticides is an open mind and willingness to learn. The winter is an excellent time to plan and gather turf, pest and management information. Seek out every possible practice that will promote a healthy turfgrass plant. The best sources for this information are Cornell Cooperative Extension, trade magazines and educational seminars and conferences such as those sponsored by Cornell University or the New York State Turfgrass Association.

Start with a simple plan. Think of all the methods you can implement to promote dense, healthy turf and thus reduce your reliance on pesticides; for example: cultivation, over seeding, fertilization, etc. Critically review your overall program. Obviously, you are implementing many cultural practices already. Determine methods to ascertain if they are working. Find new options to add, delete, or improve your cultural and fertility regime.

Establish techniques to document the real needs of the turf. Be prepared to take soil samples and monitor the turf on a regular basis. Researchers at Cornell have developed simple guidelines to monitor turfgrass pests.

Solve pest problems early before they spread into large areas. Spot treat only where the pest occurs. This will help reduce the amount of pesticides applied.

For every pest management action, document what was done, where, how much, cost of product, and on what date. Note the target pest(s) and the specific reason for action. Knowledge about labor hours involved in mixing and spraying will be particularly useful in cost/benefit analysis of the pest management strategies and techniques. This information is necessary to judge the efficacy and cost of any management action employed.

Keeping good records each year will enable you to evaluate the effectiveness of new and existing turfgrass management methods once the season is over. In addition, the records will help point out important trends in pesticide use each year. For example, after a new program has been in place for several seasons, has there been a reduction in the total amount applied? Comparing annual information will also point out recurrent pest trends and successful management strategies.

Document your efforts and let people know what you are doing. This is an excellent way to show people turfgrass managers are true stewards of the environment.

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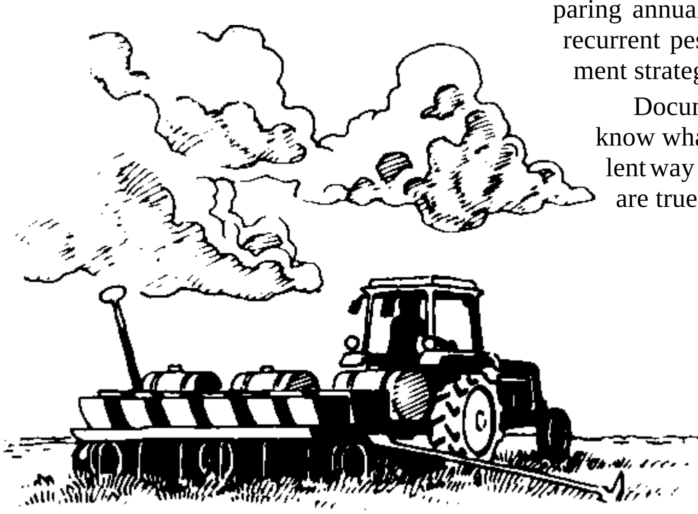


IPM Corner

Do not look at the challenge of reducing pesticide use as a risk to the turf quality or your job.

The key to reducing your reliance on pesticides is an open mind and willingness to learn. The winter is an excellent time to plan and gather turf, pest and management information.

Classifying Kentucky Bluegrasses

Kentucky bluegrasses can be classified into six groups:

- ***Aggressive types tolerate low mowing and will dominate in blends,***
- ***Common types are deep-rooted and considered to be low maintenance grasses,***
- ***Mid-Atlantic types are selected for drought and heat-tolerance,***
- ***BVMG types are high seed yielders, and popular components of blends,***
- ***North Latitude Compact types are dwarf types with high density and reduced vertical growth rates, and***
- ***Bellevue types are moderately aggressive with good color, disease resistance and summer performance.***

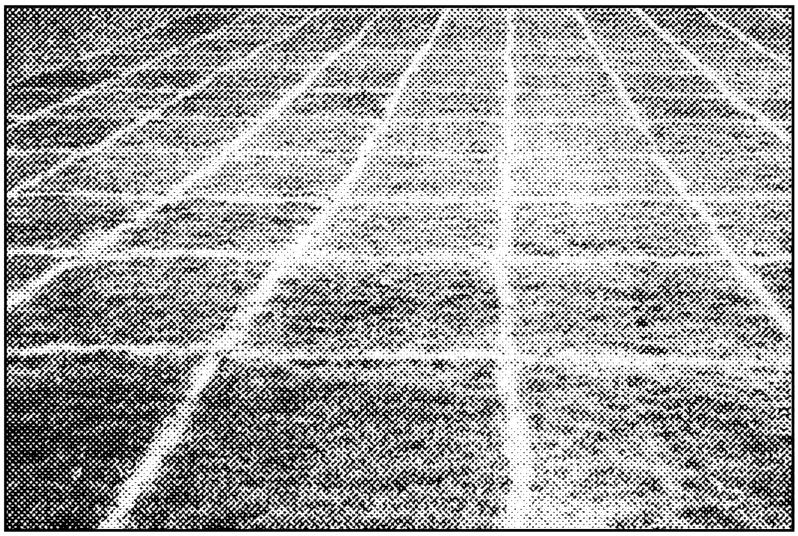
Of the several turfgrass variety trials we have in place in Ithaca, nowhere do we see greater differences in varieties as we do with the Kentucky bluegrasses. As you walk across the more than 100 varieties, you see differences in color, growth habit, texture, and density. When there are disease infestations, there are usually differences among the varieties.

A few weeks ago I heard an excellent talk given at the Illinois Turf Conference by Dr. Bill Meyer, from Turf Seed. Dr. Meyer discussed a method of classifying Kentucky bluegrasses that I was unaware of, and how he used it in developing recommendations.

He classified the bluegrasses into six groups: aggressive types, common types, Mid-Atlantic ecotypes, BVMG (Baron, Victa, Merit, Gnome) types, northern latitude compact types, Bellevue types, and other types.

Aggressive Types: The aggressive types will tolerate low mowing; as low as 3/4 inches. Therefore they are well adapted for golf course fairways and athletic fields. These grasses have high density, and will become thatchy, especially at higher mowing heights. They will dominate in blends. Examples of aggressive types include Touchdown, Limousine, P-104 (Princeton), and A-34.

Common Types: The common bluegrass types have upright growth habits, and should therefore be mowed at least 3 inches high. They are deep rooted and are often considered to be low maintenance



Low-maintenance bluegrass trial plots at Cornell.

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