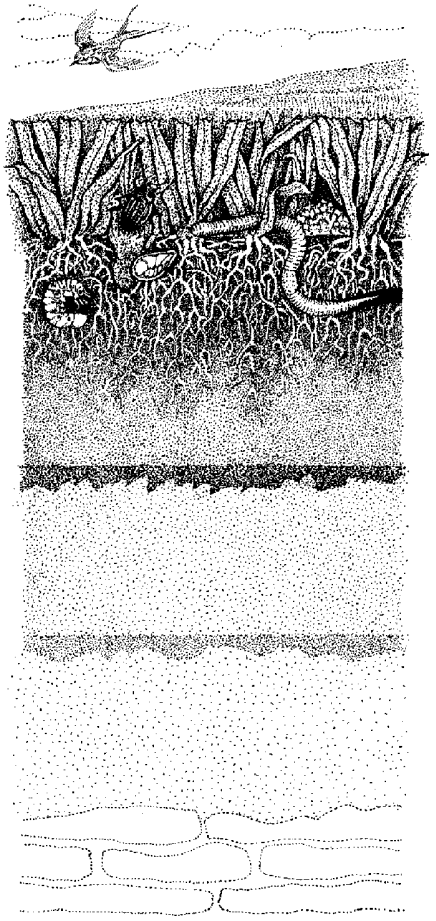
CORNELL UNIVERSITY TURFGRASS TIMES

CUTT

Fall 1999 • Volume Ten • Number Three



Developing Natural Pest Control Products for Turf

Biorational alternatives for pest control are gaining increased attention worldwide because of concerns related to pesticide usage and the environment, as well as the dwindling number of labeled products, particularly for minor-use crops such as turf and ornamentals. As a result, the science of allelopathy offers interesting alternative weed control strategies through the production and release of natural chemicals from living or decomposing plant materials. ■

The term allelopathy was first introduced in 1937 and refers to biochemical interactions among plants that alters plant growth, including those mediated by microorganisms. Allelopathy, besides including competition for resources among plants, is considered to be an important mechanism of plant interference caused by the addition of plant-produced toxins to the plant environment. Chemicals with allelopathic activity are present in virtually all plants and in most tissues, including leaves, stems, flowers, roots, seeds, and buds. Under appropriate conditions, these chemicals may be released into the environment, generally in the rhizosphere region directly around developing plant roots, in quantities sufficient to affect the growth of neighboring plants. In many cases, allelopathic interactions in the field are difficult to study, since reduction in plant growth can also be caused by competition from surrounding plants for light, nutrients, and water as well as CO_2. These interference mechanisms are often impossible to separate in field studies, but are well documented under controlled conditions in the laboratory or greenhouse.

Black Walnuts

One example of a commonly observed allelopathic interaction can be seen across New York State in homeowners' yards, golf courses and woodlands (see Figure 1). The black walnut tree, *Juglans nigra*, has been reported for centuries to inhibit plant growth through the production of a potent natural herbicide or allelochemical, juglone. Juglone is a chemical compound produced in the bark and living root system of black walnut trees.

Juglone can persist in the soil for several months after removal of a black walnut tree, and causes severe reductions in plant growth to sensitive neighboring species, such as azaleas. Juglone alters plant growth directly through specific metabolic inhibition. Sensitive species include many vegetables crops, woody ornamental shrubs and herbaceous groundcovers. The Ericaceous species, including rhododendrons and azaleas are particularly affected by living black walnuts which release juglone. You may also be familiar with tomatoes which quickly wilt when

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This Times

Short Cutts

The Almanac has a complete weather summary to help predict when pests might become a problem, and the season in review with predictions for how the 1999 season might influence what you see in 2000.

Get Ready for 2000 With the Turfgrass ShortCUTT Almanac!

What will you remember the 1999 growing season for? The worst drought in a decade, followed by a tropical storm that flooded turf areas? Poor crabgrass control? How about gray leaf spot or chinch bugs? However you remember it, the best way to deal with these challenges in the future is to be armed with the latest research based information, not what a *friend* tells you.

The Cornell Turfgrass Team offers a weekly electronic newsletter called Turfgrass ShortCUTT that addressed all the issues of 1999. For those of you who subscribed in 1999, you know the importance of timely information. Now for a limited time, we have accumulated all the weather information, cultural practices, when pests arrived in 1999, the latest in control strategies and information from international experts on the hottest topics from how to irrigate, to how to control nematodes and gray leaf spot, protecting water quality, and managing *Poa annua* in one resource.

The ShortCUTT Almanac is fully indexed to make searching for your answer easier in 2000. The Almanac has a complete weather summary to help predict when pests might become a problem, and the season in review with predictions for how the 1999 season might influence what you see in 2000. If you'd like to reserve your copy, available in January 2000, contact Evie Gussack at (607) 257-8481 or eg21@cornell.edu. Also, be on the lookout for subscription information for the 2000 ShortCUTT Newsletter, your link to the most current turfgrass information.

NYSTA's 50th: A Grand Affair!

Every once in a while you get to be part of something that makes you feel special just for being there. The 1999 New York State Turfgrass and Grounds Exposition in Syracuse, NY was that special place this year. The 1999 Conference provided the venue for celebrating 50 years of the New York State Turfgrass Association.

To mark this exceptional event, the educational program under the direction of Jim Diermier, CGM, offered a unique, in-depth approach to conference education. Instead of the traditional line up of half hour talks with little relationship to each other, the conference planners developed a topic-centered seminar format that kept attendees riveted to their seats.

Topics such as landscape problem solving through effective site assessment, winter injury of turfgrasses and selecting pesticides from an environmental perspective offered attendees the latest information on these current challenges. Some attendees remarked how they often attend for "pesticide recertification", but now expect to return in the future because it helps them address the biggest challenges they face.

This ability to empower their members to address their own challenges has been the cornerstone of the partnership between NYSTA and Cornell University for 50 years. Education and research have been the constant through the years and under the current leadership will not change in the future. It was a great celebration looking back, but the real celebration was for the incredible promise of the future. See you at the 2000 Conference, November 14-16!

Sign Up for 2000 Short Courses

The Cornell Turfgrass Short Course season is nearly here. Turn to pages 12-14 in this issue of *CUTT* for further information and registration details on the Turfgrass Management Short Course, January 10-14, 2000; Golf Turf Pest Management, January 17-21; Turfgrass Management to Preserve Water Quality, January 24-28; and the Original Turfgrass Management course, now being offered in Fishkill, NY, February 21-25.

CUTT, "Cornell University Turfgrass Times" is published four times per year by Cornell Cooperative Extension and the Turfgrass Science Program at Cornell University, Ithaca, New York 14853. Address correspondence to: Cornell University Turfgrass Times, 20 Plant Science Building, Cornell University, Ithaca, NY 14853; telephone: (607) 255-1629

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Design & Production: Ghostwriters, inc., Ithaca, NY

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How Do Turfgrasses Survive Drought?

The 1999 season in the Northeast US raised the topic of water use for turfgrass management. Discussion of this topic usually includes water use issues and management to survive drought, however, rarely includes a discussion of how the plants that seem to need water, survive or persist without water. If we understood how turfgrasses respond to drought stress on a physiological basis, it might be possible to breed more drought tolerant grasses, that require less water.

Researchers at Kansas State University have been investigating the physiological responses of various tall fescue cultivars to drought stress. The researchers compared dwarf-type tall fescue cultivars (Rebel Jr. and Bonsai) and turf-types (Falcon II, Phoenix and HoundogV) to the forage type (Kentucky 31) under well watered and drought conditions (35 days without water). Surprisingly, cultivars within the same tall fescue classification responded in different ways regarding how the plants produce energy and manage their internal water content. Specifically, Falcon, Houndog and K-31 were the most effective in tolerating drought from the measured parameters. Interestingly, the cultivars that appeared the most drought tolerant were able to maintain energy production (photosynthesis) under stress. This information will be helpful in selecting drought tolerant cultivars and for breeders to develop new cultivars with specific physiological traits.

(From: Huang, B. and H. Gao. 1999. Physiological responses of diverse tall fescue cultivars to drought stress. HortScience 34: 897-901.)

Managing Turf Diseases With Fertilization

As the pressure has increased to reduce chemical pesticide control of turfgrass pests, researchers have continued to uncover the complex relationship among plants, nutrients and microbes. Historically, the use of plant nutrients for pest management was commonplace with the use of metal-based fungicides such as copper. In addition, forage grass research has provided information that has been easily transferred into turfgrass management practices.

Take-all patch of creeping bentgrass has become a more prevalent turfgrass disease in the last decade as a result of increased construction of new greens and the use of high pH sands in greens construction. Researchers at Rutgers University have investigated the relationship between take-all patch of creeping bentgrass and Manganese (Mn) nutrition. Plots were established on a sand-based fairway of Penncross and Penneagle creeping bentgrass with a history of take-all infestation were treated every 4 weeks (except Dec., Jan., Feb.) in 1996 and '97. Initial soil test information was collected to determine the influence of the regular fertilizer applications on soil pH and nutritional levels. Applications of Mn reduced take-all infestations from 20% in the untreated plots to 5% in the high rate treatment.

An important finding in this research has been the absence of an increase in levels of Mn in the soil. While this is not surprising on alkaline soils, the pH of the soils in the study were in the 6.5-6.6 range which should allow Mn to be available. It was speculated that the organism that causes take-all patch has been shown to metabolize the Mn in the soil making it unavailable to the plant. Therefore, the scientists concluded that because the take-all organism can render Mn unavailable, sustained control of take-all will require regular Mn applications, as well as a judicious soil testing and pH management program.

(From: Hill, W.J., J.R. Heckman, B.B. Clarke, and J.A. Murphy. 1999. Take-all patch suppression in creeping bentgrass with manganese and copper. HortScience 34:891-892.)

Scanning the Journals

A review of current journal articles

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Natural Pest Control

continued from front cover

Examples of weeds which are known to be strongly allelopathic include quackgrass* (Agropyron repens) *and black mustard* (Brassica nigra), *among others. Many of these plants will be found in almost pure stands or monocultures, indicating that other plants have difficulty competing successfully with them once they become established.

planted around black walnuts, hence the term "walnut wilt" which describes the appearance of sensitive plants. Yet, not all plants are sensitive to juglone, just as not all herbicides control every plant. For example, hollies, hydrangeas and daylilies are quite tolerant to black walnut's presence as I have recently observed, as well as hemlock and a variety of hostas and spring flowering bulbs.

The effect of juglone is similar to that of a persistent soil-applied herbicide and can be seen even after the walnut is removed from the growing site, giving plant growth suppression for several months after removal. In this case, up to 3 or 4 months are required after tree removal before the growth inhibition is minimized. While black walnut's allelopathic interactions have been well documented over the years, there are many other suppressive interactions occurring in nature, most of which remain largely uninvestigated.

Allelopathy All Around

During the past 30 years, the potential impacts of allelopathy have been described for certain agronomic crops and cropping systems. Much work has focused on the detrimental effects of living plants or their residues on the growth of crop plants and reductions on crop yields. Replanting problems, autotoxicity, toxicity of mulch stubble, problems with crop rotations, and direct interference by certain weeds have been attributed to allelopathy and allelopathic interactions. Examples of weeds which are known to be strongly allelopathic include quackgrass (*Agropyron repens*) and black mustard (*Brassica nigra*), among others. Many of these plants will be found in almost pure stands or monocultures, indicating that other plants have difficulty competing successfully with them once they become established.

Quackgrass can be observed throughout the Northeastern U.S. on and off the golf course and in landscapes. In pure stands, it inhibits the growth of many surrounding weeds and crops, particularly legume crops such as clovers, beans and peas. Living and decomposing residues release water-soluble toxins which are particularly inhibitory. In fact, the presence of these water-soluble toxins in the field and in the laboratory so strongly inhibited legume root growth, that root hair formation was limited and as a result, nodulation and nitrogen fixation were severely reduced. Interference resulted in the markedly chlorotic and stunted appearance of legume crops grown in the presence of dense quackgrass infestations observed in Michigan and throughout the Northeast.

Black mustard is a common weed which often invades the grasslands of coastal California and other areas in the Northeastern U.S. and forms pure stands over time. In areas adjacent to mustard infestations, grass seeds do not germinate and seedling grass populations never emerge, despite optimal water supplies and high densities of grass seeds. Nearby, one will find dense stands of various annual grasses, but never beneath black mustard stands. Large quantities of sulfur-containing compounds were found to be produced when mustard vegetation is crushed. In addition, water soluble compounds were leached from dead leaves and stems of mustard and were found to be very inhibitory to grass germination. One can observe other densely planted stands of cultivated Brassica species with relatively few if any grass weeds.

Another interesting weed which is invasive in nature and a serious problem in New York's nurseries and landscapes is mugwort (*Artemisia vulgaris*). This perennial weed reproduces by underground rootstocks and spreads easily with cultivation throughout a field site. Once established, it forms dense stands, often with few other weeds. Nurseries in Western New York have referred to mugwort as their worst pest control problem, due to its invasive nature. In appearance, it resembles chrysanthemum and is sometimes referred to as chrysanthemum weed.

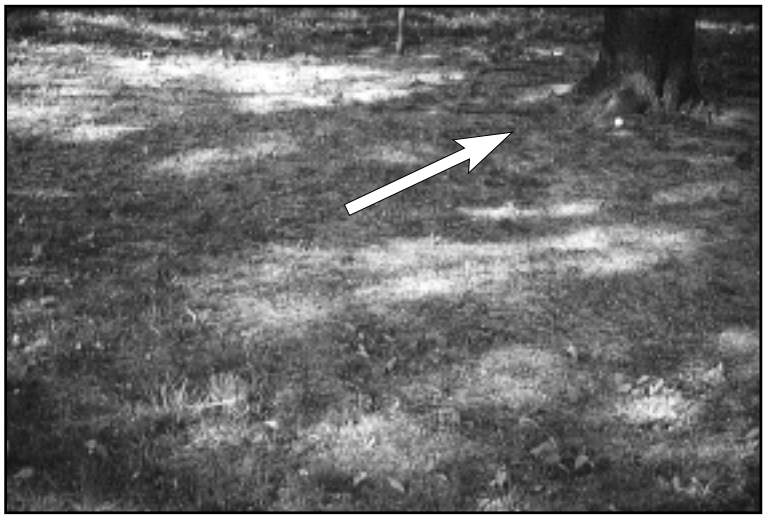

Figure 1. *The lack of plants around the base of this walnut tree is an example of allelopathy.*

One can easily find this weed in landscape settings, fallow fields and even the rough surrounding the golf course.

The genus *Artemisia* includes the wormwoods, sagebrushes, the mugworts, the sageworts, and tarragon. This genus has been the source of folk medicines, spices, flavorings, and insect repellents throughout history. All of the *Artemisia* species produce a diversity of chemical compounds. The function of these chemicals is almost certainly protective, forming a barrier to insect and pathogen attack.

Numerous compounds from *Artemisia* species are also very active as plant growth inhibitors. In fact, two commercial herbicides were developed based on the *Artemsia* chemistries. The herbicide Cinch or cinmethylin is utilized in Europe for weed management. It acts by inhibiting cell division in sensitive plants. We are currently evaluating the allelopathic potential of mugwort in an attempt to understand its biology and develop more effective postemergence control strategies for this difficult-to-control weed.

Synthesizing Natural Products

Researchers first explored the possibility of utilizing allelopathic crops to dominate or inhibit weed growth in agricultural sites in 1974. Why not utilize an allelopathic cover crop or row crop to suppress weeds throughout the growing season? This area has recently received increased attention as crops and cultivars are now being selected for enhanced allelopathic or weed suppressive activity and breeding programs are starting to select for these useful traits. In addition, the diversity of allelochemics produced by higher plants as well as microorganisms is vast.

Recently the chemical industry has spent much time and effort identifying novel secondary products isolated from plants and microorganisms as these compounds may have medicinal or pharmaceutical value as well as pesticidal value. Many of these compounds do exhibit herbicidal activity and consequently, interest exists in using these natural products as models for synthetic herbicides. In many cases, natural products offer novel modes of action for herbicides and other pesticides. With resistance to pesticides causing numerous problems for producers, the development of novel products with completely different modes of action makes natural product screening of increasing importance to the chemical and pharmaceutical industry.

Natural product screening has paid off for DowAgroScience, who recently developed an entire line of environmentally sound insecticides from microbially produced natural products, Spinosad A and Spinosad D. Because of the relative safety and selectivity of Spinosad, new product lines are currently being introduced in turf and ornamentals, the first being called Conserve. Because of the structural complexity of the Spinosads, this product is produced only by microbial fermentation of the fungus *Saccharopolyspora spinosa*. Numerous other smaller biotech firms are also evaluating plant-produced and microbially-produced products for development since these products are able to be fast-tracked through the EPA registration process.

Figure 2. *Debris from killed turfgrasses can have weed suppressive properties.*

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Cover Crops for Landscape

Rotational or green manure crops that provide weed suppression can be an effective cultural means to control weeds with minimal applications of pesticides. In areas to be established as nurseries or landscape sites not under current production, one can easily establish a cover crop or smother crop to eliminate specific weeds or reduce weed populations. Smother crops such as winter rye (*Secale cereale* L.), wheat (*Triticum aestivum* L.), buckwheat (*Fagopyrum esculentum*), black mustard, or sorghum-sudangrass hybrids (*Sorghum bicolor x Sorghum sudanese*) can be very effective in reducing weed populations (see Figure 2).

Many of these crops can be quickly established the season before turf, nursery sites or landscape beds are established. The crops suppress weeds through a combination of competition and allelochemicals produced by the decomposing crop, once it is turned under or killed. These crops could be effectively used in areas bordering a course or field, which is currently not in production, to minimize surrounding weed populations and prevent weed seed dispersal into production sites. For example, sorghum sudangrass has been used throughout the U.S. by nursery producers before planting ornamental crops. A dense stand is established, allowed to grow for about 6 to 8 weeks, and then turned

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Natural Pest Control

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The year following sorghum establishment, over 70% reductions in small seeded broadleaf weeds have been observed compared to areas receiving normal tillage or other cover treatments.

under as a green manure. This adds organic matter to the site over time, and contributes to weed reductions the following season. The year following sorghum establishment, over 70% reductions in small seeded broadleaf weeds have been observed compared to areas receiving normal tillage or other cover treatments.

"Don" Sorgoleone

We are currently looking at sorghum species which produce large quantities of sorgoleone, exuded directly by the living root systems. This compound is an extremely potent inhibitor of photosynthesis and is more active at the site of action than commercial herbicides such as atrazine. Over time, sorgoleone is released into the soil rhizosphere, where it persists for up to several weeks at concentrations capable of suppressing small seeded grasses and broadleafs.

Our laboratory is currently focusing on ways to enhance sorgoleone production in sorghum species to more effectively utilize this cover crop for long term weed suppression in horticultural cropping systems. We are currently attempting to isolate and identify the genes responsible for production, so this trait might be introduced into other crops such where chemical and cultural practices for weed management are less effective.

Figure 3. *Current NTEP trials being evaluated for weed suppressiveness.*

What About Turf?

Turfgrasses also show promise as weed suppressive crops with apparent allelopathic potential. Fescues—especially creeping red fescue and chewings fescue, and tall fescue—have been reported to be both allelopathic and weed suppressive. In research from Kentucky, creeping red fescue was slow growing with less biomass accumulation than other cover crops, but was most highly weed suppressive when living and up to 8 weeks after kill. Not only did red fescue have up to 95% fewer weeds than other cover crop treatments, it also inhibited later establishment of no-till crops, indicating some persistent suppressive properties. Fescues have also interfered with the growth of seedling trees and perennial legume species. Recently, while observing the NTEP Fine Fescue Trial at the Cornell Turfgrass Research Center, it was clear that certain creeping and chewings fescue cultivars were exceptionally weed suppressive while others allowed invasive species to take hold (see Figure 3). The turf density alone was not responsible for enhanced suppression, since less dense, fine leaf cultivars were also weed free. It is likely that suppression is associated with the production of allelochemicals by *Festuca* species.

Extracts of fescue shoots have also been shown to be phytotoxic to seedling germination. In past experiments, we have shown that red fescue extracts were highly suppressive to weed seed germination and growth. These extracts contained various compounds, several of which were markedly active as inhibitors. Our studies with cover crop establishment also showed that perennial ryegrass was quite weed suppressive as well, with up to 85% reduction in weed populations in the residue. Our current challenge is to develop screening procedures to accurately predict which turfgrass cultivars interfere most with weed establishment at the seedling stage of growth and also as a well established, mature turf stand. In this way, we can evaluate allelochemicals produced by active turfgrasses, determine how they act to inhibit plant growth and try to discover genetically and environmentally how suppressiveness is regulated.

The Future

Crop germplasm serves as a source of material to screen in an attempt to enhance weed suppression in crop plants through conventional or nontraditional breeding programs for enhancement of the crop itself. Current evaluation for weed suppression is occurring in turfgrasses, rice, rye, sorghums, and sunflowers.

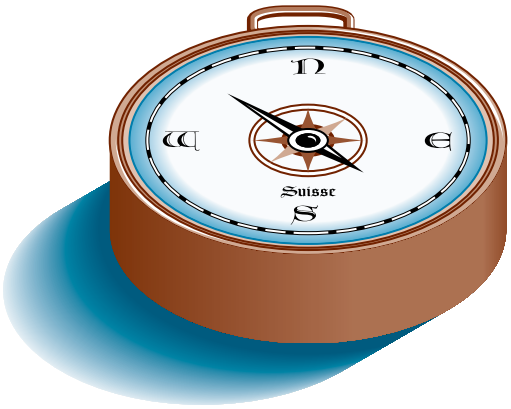
Allelopathic crops and weeds offer exciting new opportunities for the development of bioactive herbicides, pesticides and pharmaceuticals. The chemical industry is very interested in novel natural products which can be used as templates for pesticide development. Most recently, Zeneca discovered a new family of herbicidal compounds with a completely novel mode of action by working with extracts of the Australian bottlebrush plant. With all this attention, the turf and ornamentals industry will soon see a variety of new herbicides, fungicides and insecticides that are naturally produced or developed from natural products.

Leslie Weston
Cornell University Turfgrass Team

Thriving in a Time of Unprecedented Change

The internet, distance education, environmental stewardship, globalization, continuous improvement, pesticide-free. These are all topics we had not even heard of five or ten years ago that are now, or soon will be, a part of our everyday turf business life. Change is occurring at unprecedented rates. We must be prepared for that change both psychologically and organizationally. Let's begin by addressing how we view change. We often think about responding to change. "Responding" is a very reactive word. To be most successful in a time of great change, we must individually and organizationally be proactive. A more proactive view is portrayed by the title of this article: Thriving in a Time of Unprecedented Change. A proactive view better prepares us for the change and facilitates our viewing change as an opportunity rather than as a threat.

Individually and organizationally we must also focus on our resilience. Darly Conner in his book, Managing at the Speed of Change: How Resilient Managers Succeed and Prosper Where Others Fail, suggests that we each have a rate of change with which we are comfortable. When the rate of change is greater than that rate, the rate of change exceeds our resilience. At that time our ability to reactively or proactively respond is diminished, as we become—at a minimum—uncomfortable, to—at a maximum—dysfunctional. In order to thrive in times of change we must increase our resilience to manage at the speed of change.



Resilience can be defined as the ability to bounce back from the consequences of change. Individuals who have great resilience have the following five characteristics:

1. They are positive: The positive person is optimistic and focuses on opportunities while recognizing the threats.

2. They are focused: The focused person has a clear vision of what he or she hopes to achieve and is striving toward that achievement.

3. They are flexible: In Everyone's a COACH, Ken Blanchard and Don Shula argue that great performers must overlearn their key tasks to be prepared for crisis situations and they must be audible reading, meaning they must be able to adjust to meet changing conditions even in a crisis. The flexible person is always audible ready and is comfortable calling "audibles."

4. They are organized: The organized person sets priorities, has a plan, knows when to ask for help in defining a plan, and is working to implement the plan.

5. They are proactive: The proactive person is actively seeking change opportunities that can benefit himself or herself and the business.

As you plan for your less busy season, I suggest you think about ways to increase your personal and organizational capacity to thrive in a time of unprecedented change. Perhaps you should invest time in reading or taking workshops in personal improvement skills like time management, interpersonal skills, or conflict resolution. Perhaps you should redouble your efforts to keep current on technical developments in turf. Perhaps you should take a more creative and longer range view as you interact with other leaders in your organization to plan for next year and beyond.

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Robert A. Milligan
Cornell University Turfgrass Team

Human Resource Update

Individuals who have great resilience have the following five characteristics:

- ***They are positive.***
- ***They are focused.***
- ***They are flexible.***
- ***They are organized.***
- ***They are proactive.***

Wondering About Golf Course Ecology

Editor's Report

This curiosity about biological relationships on a golf course and the broader relationship of the golf course to an increasingly developing world, may prove to be the inspiration that saves the game as natural resources become limited.

It is impossible to discuss the golf course ecosystem without recognizing the human dimension, however, it all begins with the soil-plant continuum.

Now that the 33rd Ryder Cup is in the books as one of the great comebacks in golf history, I am filled with a sense of how relationships are formed among players, fans, a golf course, and a game. Important parallels can be drawn from what occurred at The Country Club to the ecology of a golf course. Ecology is defined as the relationship or the response of an organism to the environment. Clearly, the players responded to Ben Crenshaw's leadership, followed by fan reaction to the player's success and it was clear that for a moment in time, fates converged and left us in awe.

While golf seems like a singular challenge (human against course), in my mind it is in fact the player's ability to work with, or manage their game in accordance with the course, that brings success. "It's the little things", as is often said by golf purists that allow the great things to occur. The same is true for the plants, the soil and the environment in and around a golf course. Yet, while we seem to know much about the mechanics of playing successful golf, we know precious little about the golf course ecosystem.

This curiosity about biological relationships on a golf course and the broader relationship of the golf course to an increasingly developing world, may prove to be the inspiration that saves the game as natural resources become limited, (e.g., remember the energy crisis of the 1970's and the regular droughts of 1990's?).

The Context

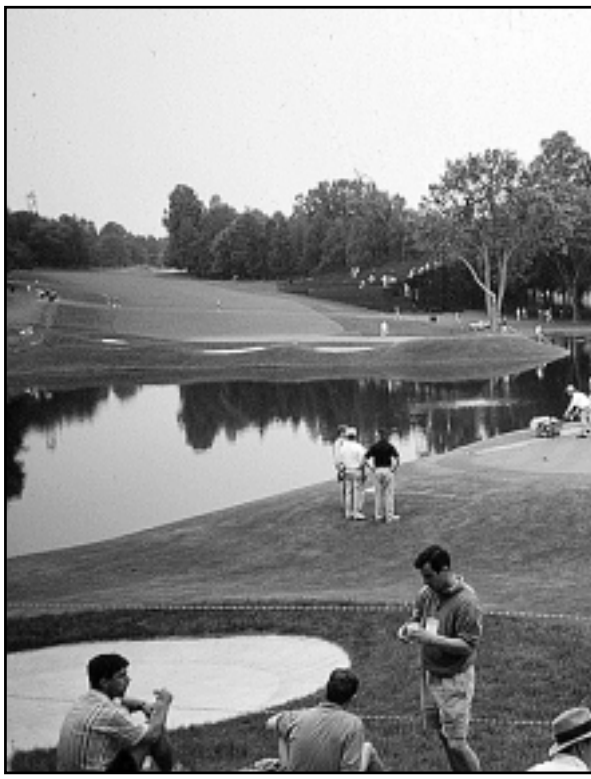
From an ecological perspective, an individual is the foundation of the system, followed by the species (group of individuals), then a population (group of species), community (groups of populations), and finally at the top of the pyramid is the ecosystem (a group of communities). Within this context, there is the plant-soil dimension that we manage, the water and wildlife that is impacted and finally the human dimension that includes the 12% of the US population that plays golf and the remaining 88% that care about the open space, the water and wildlife, not the game.

For many years, advances in turfgrass research have developed management techniques and systems that have increased course performance to meet an increased demand for golf. The increased demand is both from participation and from visual and performance expectations for championship conditions. Therefore, it is impossible to discuss the golf course ecosystem without recognizing the human dimension, however, it all begins with the soil-plant continuum.

Talking Plants?

One of the great ecological challenges that plants face, is their inability to move, i.e. they are immobile. Of course from a reproductive sense, plants are mobile in that the seed or other vegetative organs can be transported by wind, water or wildlife. However, once a plant is established in an area, it does not have the ability to move itself. Therefore, it is in the best interest of the plant to develop a relationship with its immediate surroundings. This would include, neighboring plants, microorganisms in the soil and the soil solution that contains nutrients.

Aboveground, to a certain extent, grass plants are in regular competition for space. If an individual plant can colonize a space (whether purposely seeded or invasively), it will be able to harvest light energy to manufacture food for growth. This competition can be within a species (bermudagrass) or between species (bentgrass and annual bluegrass). Research has shown that grass plants have the ability to sense the proximity of each other through alteration in radiance from nearby green leaves. We have seen this recently in our research with bentgrass seed rates that significantly alter plant density and morphology (leaf width, rooting, etc.).



Broadcasting golf on television has significantly influenced g
nonrenewable

What about underground communication? There is a substantial body of plant biological research that has shown how roots exude chemicals that effect the growth of other plants (allelopathy), signal microorganisms (some of which cause disease) in the soil and alter the chemical properties of the rootzone (rhizosphere) to make nutrients more available for uptake.

Stealth Technology

One of the more interesting examples of this "underground chatter" was demonstrated recently by Dr. Eric Nelson, here at Cornell University. Eric has been studying seedling *Pythium* diseases for more than a decade. He was able to elucidate the relationship between chemicals released from a germinating seedling and *Pythium* spores. As a seed takes in water and begins to germinate, chemicals are released around the seed. This chemical sphere around the seed is sensed by *Pythium* spores, causing them to germinate and attempt to infect the seedling. Eric used this information to discover how yet another microbe would use the chemical released from the seed as a food source, thereby reducing the chemical sphere and making the seed more "stealth" to the *Pythium*.

golf course maintenance and increased the consumption of energy sources.

Wouldn't it be great if we did not need to spray an herbicide again for weed control? How about being able to short circuit the chemical signals sent from stressed plants to microbes that initiate infection? Finally, what if we bred grasses that released chemicals that increase the efficiency of nutrient uptake from the soil and reduced the need for synthetic fertilizers?

Energy for Living

One of the common threads for all life is the need for energy. From an ecological perspective, plants are self-sufficient, requiring only what is provided naturally (light, water) to produce their own energy. Comparatively, we produce energy internally by eating a balanced diet that relies on taking from nature and not always giving back (nonrenewable). Also, when we manage turfgrass plants we utilize energy in nonrenewable forms from petroleum based products or coal-burning power plants that produce electricity. How long can we keep this up without recognizing energy consumption and striving for conservation?

Studies have been conducted that investigated energy consumption for turfgrass management. It is important to view this discussion form a cost/benefit perspective. There are some well documented environmental, economic and social benefits of turfgrass areas, therefore, eliminating golf courses to conserve energy is not a viable option. Nevertheless, mowing, watering and fertilizing accounts for 75% of all the energy consumed for turf management. Mowing alone accounts for 50% of the energy! Interestingly about mowing, only 2-14% of the energy is used for cutting the blade, the remainder goes to throwing the blade and engine inefficiency. Electric mowers use half the energy of gas powered mowers. Dull mowers use 22% more energy than a well sharpened mower. And, a reel mower is three times more efficient than a rotary mower.

From an ecosystem perspective, there are some "hidden costs" regarding air and noise quality issues that must be accounted for at some point, as well as any other alterations of environmental quality. The place to start might be to simply reduce mowed areas on courses, reduce mowing frequency by letting certain areas grow taller or reducing obstacles in the landscape that require intensive edging or sophisticated mowing equipment.

Flowing Downhill

One of the more controversial aspects of golf course ecology is the use of potable water.

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What if we bred grasses that released chemicals that increase the efficiency of nutrient uptake from the soil and reduced the need for synthetic fertilizers?

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Golf Course Ecology

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I am regularly appalled when I hear that a community blocked a golf course and approved a shopping center with acres of impervious pavement that will negatively impact water quality and wildlife.

As discussed in previous articles, very little of the water on the planet is available for human consumption. In addition, taken in an energy context, irrigation systems require substantial amounts of nonrenewable energy for effective distribution from pumps to wiring of heads. In fact a study in California found that 69% of all energy used for turfgrass management was used to irrigate turf areas.

The human dimension of the golf course ecosystem has been softened with the increased use of plastic spikes.

There is no question in my mind that we have become less efficient in our water use habits since it has become easier to apply. I know that this might ruffle some feathers and I do not mean to criticize those who strive for efficiency or for all the wonderful advancements in irrigation technology that have improved application efficiency. Yet, I know there are "closet irrigators" out there who apply water when they are not sure they need it. It is too easy to set the percentage of ET, or too easy to hit a button. Why don't we view watering as "how much the plant can do without," rather than "how much a plant needs?"

Clearly, the golf turf industry will be facing increasing scrutiny over water use, even in the humid climates as our population continues to grow. One of the options will be non-potable, gray or effluent water. While this brings with it many new challenges, it also highlights a key ecosystem benefit that a golf course can provide for water purification. It is a clear example of how a recreational greenspace, such as a golf course could benefit the ecological health of a community.

Sustainable Development

Finally, as we move up the pyramid to the ecosystem level, we must recognize that we are an increasingly populated world with diminishing open spaces. In fact, the concept of sprawling communities has been raised to the national consciousness in the political process. I expect this to continue.

For existing facilities there will be regular examination of the benefits that are provided from having a golf course in a community, that might be easy to address. Yet, for new facility development, there are many questions from an ecological and environmental perspective that are more difficult to answer. I am regularly appalled when I hear that a community blocked a golf course and approved a shopping center with acres of impervious pavement that will negatively impact water quality and wildlife. There may not be much the golf turf industry can do about ignorance, however, there is much the industry can do to espouse the "real" benefits when development is done in a sustainable fashion.

Sustainable development is a term used often but often misunderstood. It's almost

oxymoronic. Yet, unless our society is willing to address the population growth issue, we will have more people, who need more things and development is inevitable. How can development be sustainable, i.e., done in a fashion that minimizes impact and maximizes benefits? One answer is addressed regularly in Audubon International's (AI) Signature Program.

The Signature Program is focused on sustainable development, working with golf course and community developers who want to "tread lightly" and need some guidance. The AI team has the ability to identify siting issues, land and water issues, and an impressive array of "green building" issues that can be cost effective and environmentally sustainable. As the golf turf industry grows, the housing industry and other corporate priorities will become associated with the growth in golf. These relationships must be structured in a way that makes sense for the 12% who want to play as well as the 88% in the community that have a different agenda.

When looked at from the ecosystem perspective relationships among the individual plant in the soil, to the energy and water needed for maintenance and finally the community issues of land use and housing, I am in awe as to how little we know. There is much to wonder about regarding the ecology of golf courses. I find joy in exploring the minutia of biology and I know how the golf turf manager relishes his or her morning tour of the course. When we recognize how we are all connected, we will experience the same joy as the US Ryder Cup Team did when they saw Justin Leonard's putt drop in the hole on 17. At that moment, we were all in this together!

Frank S. Rossi
Cornell University Turfgrass Team

Audubon International's Signature Program is focused on sustainable development, working with golf course and community developers who want to "tread lightly" and need some guidance.

As the golf turf industry grows, the housing industry and other corporate priorities will become associated with the growth in golf.

Cornell Turfgrass Management Short Course

CORNELL Turfgrass

Tuition:

Tuition for each course is $600 per person and includes instruction, resources, breaks, class luncheon and certificate upon course completion.

Registration:

Choose the easy payment plan if you wish! Reserve your spot with a $200 payment and send with the enclosed registration form. Then make 2 additional payments of $200 by December 15th and January 5th. You may pay by check or credit card.

Turfgrass Management Short Course
January 10-14, 2000, Cornell Campus

MON 10	TUES 11	WED 12	THURS 13	FRI 14
Introduction Soils	Grasses Grass Lab	Nutrition Fertilizer Math	Turf Diseases	Final Exam Case Studies
				Class Luncheon
Soils	Establishment and Renovation	IPM Turf Insects	Turf Weeds Weed Lab	Industry Presentations Course Certificates and Awards
Soils Lab	Irrigation	Insect Lab	Management Session	

Learn from members of the Cornell Turfgrass Team and Industry Experts.

Accommodations:

A block of rooms has been reserved for Short Course students at the Clarion Hotel: University. To obtain the discount rate of $49 per night (for a single or a double room), mention that you are attending the Turf Short Course. To secure this low rate be sure to make your reservations by December 20th (call 607-257-2000).

More information, including a detailed course agenda, will be sent with your confirmation packet. Questions? Contact Joann Gruttadaurio, Director of Turfgrass Education at 607-255-1792 or jg17@cornell.edu.

Cornell University's Turfgrass Management Short Course, January 10-14, 2000

Please Return form to: Cornell University, Turfgrass Short Course: Campus, P.O. Box 6634, Ithaca, NY 14851-6634

Sign up early and pay using our new installment plan! Register early to reserve your place.

CORNELL Turfgrass

◯ Full Payment Enclosed: $ 600

◯ Yes, I want to pay using the Installment Plan – If you choose to pay by installment plan, you may pay for the course by check or credit card. If you are paying by check, you will be invoiced for the remaining payments as they become due. If you are paying by credit card, the card number provided will be automatically charged. Payment deadlines follow:

$200 due with Registration Form,
$200 due December 15th, and
$200 due January 5th

Method of payment:

◯ Check (make check payable to Cornell University)

◯ Purchase order / requisition: P.O.# _____

Credit Card: ◯ VISA ◯ Mastercard

Credit Card number _____ Expiration Date _____

Signature _____ Date _____

Name _____

Address _____

City _____ State _____ Zip _____

Phone _____ Fax _____ E-mail _____

Find out everything from Why to How at Cornell's Golf Turf Short Course for Golf Turf Professionals.
The wealth of expertise of the Cornell Turfgrass Team joins with international experts and industry leaders to give you the latest research-based information, helping to solve your major turf challenges.

Tuition:
Tuition for each course is $750 per person and includes instruction, resources, breaks, class luncheon or banquet and certificate upon course completion.

Registration:
Choose the easy payment plan if you wish! Reserve your spot with a $250 payment and send with the enclosed registration form. Then make 2 additional payments of $250 by December 15th and January 15th. You may pay by check or credit card.

Accommodations:
The host hotel for the both Golf Turf Short Courses is Cornell's Statler Inn, which is located right on campus. The fee is $55 for a single or a double per night. To secure this low rate be sure to make your reservations by December 19th (call 607-254-2602) and state that you are attending one of the Cornell Golf Turf Short Courses.

Golf Turf Pest Management
January 17-21, 2000, Cornell Campus

MON 17	TUES 18	WED 19	THURS 20	FRI 21
Introduction Cultural Management of Pests	Turf Diseases	Turf Insects	Turf Weeds	Final Exam Selecting Pesticides from an Environmental Perspective
Annual Bluegrass Management	Turf Diseases	Turf Insects	Nematodes Case Studies	Course Certificates and Awards
Integrated Personnel Management		Banquet		

Guest Speakers: Fred Baxendale, University of Nebraska, Mike Boehm, Ohio State University, Bruce Clarke, Cook College, Rutgers, Pat Vittum, University of Massachusetts

Cornell Turfgrass Team:
Tom Maloney, Bob Milligan, Eric Nelson, Frank Rossi, Karen Sirois, Mike Villani, Leslie Weston

Golf Course Management to Preserve Water Quality
January 24-28, 2000, Cornell Campus

MON 24	TUES 25	WED 26	THURS 27	FRI 28
Why are We Here? Understanding Water	Principles of Soil Related to Water Quality Protection	Pesticides and Water Quality Selecting Pesticides	Managing Water Features Setting Up a Monitoring Program	Writing an Environmental Plan Documenting Success Final Exam
				Class Luncheon
Golf Design to Preserve Water Quality	Nutrient Management and Water Quality	Point Source Issues	Success Stories	Course Certificates and Awards
	Management Session: Employee Focus	New Spray Technology for Pollution Protection		

In partnership with Audubon International

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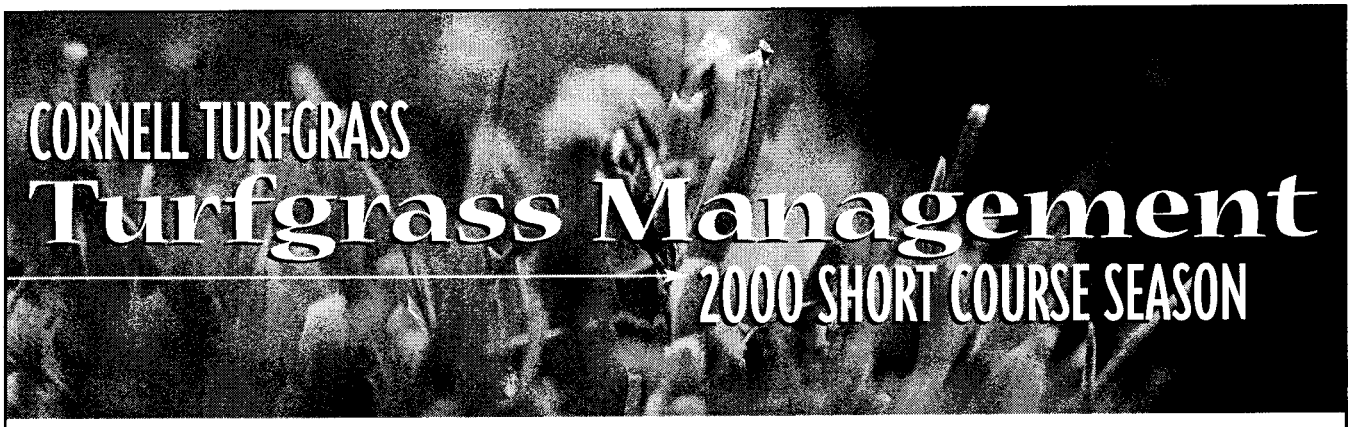
If you would like information on the Golf Turf Management Short Courses, contact: Joann Gruttadaurio, Director of Turfgrass Education at 607-255-1792 or jg17@cornell.edu.



Find out everything from Why to How at Cornell's Original Turfgrass Short Course for Turf Professionals, in the Hudson Valley. The wealth of expertise of the Cornell Turfgrass Team joins with industry experts and Cooperative Extension Educators to give you the latest research-based information, helping to solve your major turf challenges.

Tuition:

Tuition for each course is $600 per person and includes instruction, resources, breaks, class luncheon and certificate upon course completion.

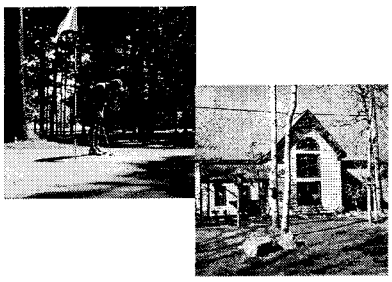
Registration:

Choose the easy payment plan if you wish! Reserve your spot with a $200 payment and send with the enclosed registration form. Then make 2 additional payments of $200 by January 15th and February 15th. You may pay by check or credit card.

The Original Turfgrass Management Short Course
February 21-25, 2000, Hudson Valley

MON 21	TUES 22	WED 23	THURS 24	FRI 25
Introduction Soils	Grasses Grass Lab	Fertilizer Math Irrigation	Turf Diseases	Final Exam Case Studies
				Class Luncheon
Soils	Establishment and Renovation	IPM Turf Insects	Turf Weeds Weed Lab Review Session	Industry Presentations Course Certificates and Awards
Soils Lab	Nutrition	Insect Lab		

This Turf Management Short Course is given in partnership with: The New York State Turf and Landscape Association.



Accommodations:

The host hotel for the Turf Management Short Course is the Holiday Inn, Fishkill, New York. A block of rooms has been reserved for Short Course students. To obtain the discount rate of $69 per night, mention that you are attending the Turf Short Course. To secure this low rate be sure to make your reservations by January 20th (call 914-896-6281).

Learn from members of the Cornell Turfgrass Team, Industry Experts and Cooperative Extension Educators.

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Sprayers

continued from back cover

cleaning of spray machinery. Scrub clean with a soft brush.

7. Part fill the tank and pump out to flush all parts. Ensure you open/close boom valves during the flushing procedure to clean out crevices. Do this more than once if necessary.
8. Refill the tank with clean water or a recommended cleaning agent, there are about a dozen commercial tank cleaners designed to remove or neutralize most of the modern low rate chemicals. If no cleaning agent is recommended, one gallon of household ammonia per 50 gallons of water may be used. Do not use chlorine-based cleaners such as Clorox. Recirculate for 15 minutes, then pump a quantity through the pipes and spray bars. Leave the remainder for as long as practical, overnight if possible.
9. Discharge at least one quarter of the contents of the tank through the system and spray bars. Drain off the rest.
10. Check that no deposits remain in the tank or filters. If there are any, they should be hosed down and scrubbed off.
11. Repeat steps 8 to 10 using clean water with the appropriate cleaning agent.
12. Safely store nozzles and filters, leave valves open and the tank lid loosely closed. Ensure that the sprayer is completely empty of water, particularly the pump. If you are unable to completely drain the system, you may consider using an antifreeze solution. An environmentally safe antifreeze diluted to 50% may be acceptable, alternatively, RV antifreeze may be used but remember it can't be diluted and so make sure the system is drained of water.
13. Hose down the outside of the sprayer, scrubbing if necessary.
14. Ensure the sprayer is parked safely and securely
15. Remove the battery and trickle charge occasionally over the winter.
16. Wash down waterproof protective clothing, apron, boots and face shield.
17. Wash inside and outside of gloves with soap and water; rinse and dry them.
18. Finally thoroughly wash hands, face and neck with soap and water.

Mechanical Maintenance

Lubrication must be carried out prior to storage; check all oil levels. Check the soundness of all mechanical components, particularly booms and boom hinges. Electrical connectors which operate boom control valves, spray monitors, etc. need to be cleaned and a nonconductive grease, available at an auto store, applied to prevent corrosion. Check wheels, wheel bearings and tire inflation.

Storage of Sprayers

Store the sprayer under cover, taking care to prevent dirt and moisture affecting the tank or working parts. Remember, sunlight softens and weakens rubber materials and can degrade plastic materials. Storing in a building also allows you the opportunity to conduct any routine or preseason maintenance.

Andrew Landers
Cornell University Turfgrass Team

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Remember, sunlight softens and weakens rubber materials and can degrade plastic materials.

Decontaminating and Storing Sprayers

The Machine Shop

Regular maintenance of spraying equipment will prolong its life and ensure accurate trouble-free operation, enabling spraying to be done with the minimum loss of time and taking full advantage of favorable weather conditions.

Sprayer Decontamination and Maintenance

Sprayers must be thoroughly decontaminated, inside and outside, after use. Regular maintenance of spraying equipment will prolong its life and ensure accurate trouble-free operation, enabling spraying to be done with the minimum loss of time and taking full advantage of favorable weather conditions.

Read the sprayer manufacturer's instructions before beginning to wash out a sprayer. Wear protective clothing appropriate to the pesticide which has been used, this may include an apron, rubber gloves, boots and face shield.

It is important to clean everything thoroughly, associated equipment such as mixers, the site where filling and mixing is done, and, of course, yourself.

Disposal of Pesticide Waste

Remember: cleaning up should be done in such a way that washings *do not* enter public sewers or any water courses, nor fields which have under-drainage and certainly not catchment areas for boreholes or wells.

The safe disposal of pesticide waste is a serious responsibility for sprayer operators. It is important, therefore, that everything should be done to keep to a minimum the amount of waste generated. Remember pesticide waste is of four types:

- concentrated products
- diluted pesticides, including washings
- empty containers and contaminated clothing
- other materials

Try to keep the volume of tank washings produced to a minimum. Special low volume washing systems are now available which comprise spinning nozzle(s), mounted in the tank. The device can be connected to a hose or water tank and water, after it has passed through the rotating nozzle(s) cascades down the inside of the tank walls.

Preparation for winter storage

1. Any spray liquid or contamination left in the tank should be disposed of correctly.
2. Remove tank drain plugs or open drain cock.
3. Hose down inside the tank and outside, including the tank top, scrub where necessary or use a special low volume washing system.
4. Replace drain plug.
5. Remove suction, main and in-line filter elements; wash them thoroughly in clean water with a soft brush and replace.
6. Remove nozzles, nozzle filters and nozzle bar end-caps if they are fitted. Soak them all in a bucket of water with appropriate cleaning agent recommended for the

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