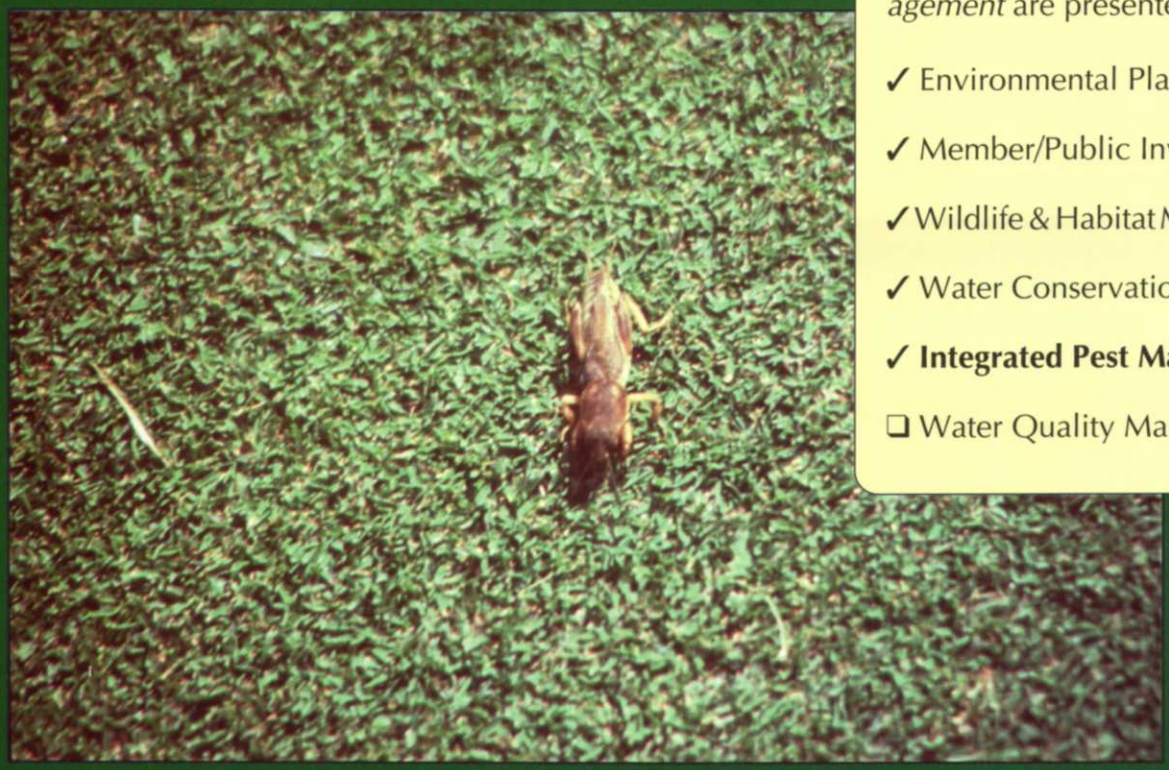
Integrated Pest Management



ACSP: Part V

In Part 5 of this series on the Audubon Cooperative Sanctuary Program for Golf Courses, ideas for fulfilling the *Integrated Pest Management* are presented.

- ✓ Environmental Planning
- ✓ Member/Public Involvement
- ✓ Wildlife & Habitat Management
- ✓ Water Conservation
- ✓ **Integrated Pest Management**
- ❑ Water Quality Management

IPM - Your Key to the Future

BY TOM BENEFIELD, CGCS

Integrated Pest Management — IPM for short — is the golf course maintenance buzz phrase of the nineties. While some groups are just now catching on to this method of controlling pests, we in the golf industry can be proud that we have been pioneering these practices for a long time.

IPM doesn't mean that you eliminate chemical treatments. Rather it means that you use a variety of methods, scouting, and control agents to minimize damage to the turf to an acceptable level. That level of acceptance will vary from course to course and budget to budget. The wholesale application of chemicals is not only a poor management practice, but it is also a tremendous waste of money.

Biological pest-specific products are the newest control agents in expanding IPM practices. Biologicals don't always work as fast as the old synthetic chemicals, but they can be just as effective and certainly more environmentally friendly when they are applied correctly. The greatest obstacle to overcome when using biologicals is the old "instant fix" or "immediate results" mind set. Dr. Vargas of Michigan State told me that successful pest suppression only comes from putting out large numbers or colonies of biologicals frequently, at night, and with water.

As we look to the next century which is quickly closing in on us, researchers are giving us hope for new solutions to old problems. I think it safe to say that there are biologicals in your future. As you can see from the following articles, the future is "now" for some of us.

Properly watered turf is more resistant to insects and diseases.

IPM STRATEGIES
for golf course maintenance

BY DR. KIMBERLY ERUSHA

DIRECTOR OF EDUCATION USGA GREEN SECTION

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The ultimate goal of any turfgrass management system is to establish and maintain a high quality turf at a reasonable cost, without being detrimental to the environment. With increasing concerns from regulatory agencies and the public about the environmental impacts of pesticides on surface and ground water, and on people, wildlife and other organisms, an understanding and application of integrated pest management (IPM) principles to turfgrass management programs is essential.

What is IPM?

IPM is a management plan that utilizes a variety of control measures to keep turfgrass pest populations below levels that are economically and aesthetically damaging, without creating a hazard to people and the environment. These control measures include:

1. Inspection and monitoring
2. Proper cultural control methods
3. Biological controls
4. Using adapted species and resistant cultivars
5. Practicing proper sanitation measures to prevent the spread of disease
6. The use of the most appropriate pesticide when necessary

An important point to remember is that an IPM plan does not preclude pesticide use, but seeks to reduce dependency on pesticides. The objective of any IPM program is to reduce pest populations while keeping pesticide applications to a minimum.

IPM control strategies

A variety of control tactics are available to the turfgrass manager. IPM involves understanding how these control tactics interact to influence the overall health of a turfgrass system. The primary objective in any IPM program is maintaining strong, healthy, actively-growing turfgrass that can resist and recuperate successfully from environmental stresses, pest damage, and weed infestations. IPM control strategies include:

Species and cultivar selection

Introducing a species outside its range of adaptation increases its susceptibility to pests and stresses. Turfgrass species and cultivars must be selected to match local environmental and playing conditions. Where possible, select adapted species and cultivars that minimize water and pesticide use.

Mowing practices

Mowing height and frequency are directly related to the turfgrass species and growth rate of the plant. To minimize stress on the plant, no more than 1/3 of the leaf blade should be removed with any one mowing. On greens, cutting heights consistently 1/8 inch or less can place the turf under severe stress during weather extremes. Use of lightweight mowers on greens and fairways tremendously reduces soil compaction effects on turf growth.

Irrigation practices

Properly watered turf is more resistant to insects and diseases. Excessive irrigation is one of the most common problems observed in the field. It is important to survey the irrigation system to ensure that all irrigation heads are working and set

Spot spraying, one form of weed removal, puts the chemical only where it's needed.

Some weeds are best removed by direct pulling.

IPM means using a variety of control measures

properly to obtain uniform coverage.

Irrigation frequency should be dictated by meeting the evapotranspiration (ET) requirements of the plant. Irrigating deeply and less frequently produces a turf with a deeper root system and improved overall turf health. Care must be used when irrigating shallow-rooted turfs. Monitor root depth, soil moisture, ET conditions, and use visual inspection to determine turf irrigation needs.

Fertility and pH management

Fertility is a necessary component of turf management. No one fertilizer program or fertilizer can suit all situations. The type of program must be decided on by the golf course superintendent based on the specific conditions of the golf course.

Fertilization should be scheduled to meet the nutritional and growth requirements of the plant. The frequency of fertilizer application will vary depending on the turfgrass species and the type of fertilizer. Slow release fertilizers such as IBDU, sulphur coated urea, or natural organic materials, should be used on golf courses when possible. Use low rates of inorganic fertilizers with any one application.

A soil test is the best diagnostic tool available for assessing soil pH and phosphorus and potassium needs of the turf plant, as well as other nutrients. Soil test results serve as a guide for proper application of nutrients, avoids the waste of excessive fertilizer applications, and insures that nutrients are applied in the proper proportions. Once the turf has become established, soil tests should be conducted every 1-3 years.

Thatch control

The potential for thatch problems varies with turfgrass species, intensity of culture and traffic. Thatch becomes a problem on fairways and greens when it accumulates to a depth that increases potential for puffiness, mower scalping, disease development, and localized dry spot formation.

Avoiding excessive fertilization is an important consideration for preventing excessive thatch formulation. For greens, light vertical mowing at intervals dependent on the growth rate of the plant can be effective in controlling thatch formation. Topdressing is also an effective tool to enhance the rate of biological degradation.

On fairways, excessive thatch can be avoided by preventative cultural practices, such as use of appropriate turfgrass cultivars, maintaining appropriate soil pH, utilizing soil cultivation techniques to enhance soil oxygen levels, proper irrigation, moderate nitrogen fertilization, and use of pesticides only as needed. Corrective measures for thatch control, including verticutting and core aerification must be used if accumulation exceeds 0.5 inch. Verticutting and core aerification are best accomplished during periods of active turfgrass growth.

Rootzone management

Improving soil characteristics can have a positive impact on turfgrass health and can decrease the need for chemical inputs. Proper soil drainage is critical for root growth and overall turf health.

Water movement through the soil is disrupted when layering occurs within the soil profile or when compacted soil conditions exist. There is no single solution to all soil problems. Methods to help solve the problem include core cultivation, high pressure water injection aeration, and deep tine aeration. It is important to determine the cause of the problem and then select the best corrective measure.

Good surface drainage through surface contouring alleviates ponding of water created from runoff, although it does not correct underlying soil problems. Properly installed subsurface drainage is an effective way of keeping a golf course in play and avoiding turf damage.

Traffic control measures

With the rising number of golfers on golf courses and the increase in the use of golf carts, traffic must be carefully monitored on the golf course to decrease potential wear and soil compaction problems. Rotate traffic patterns by planned movement of cup and tee markers. Distribute cart and foot traffic over wide areas and use cart paths where traffic is highly concentrated.

Tree management

Trees play a strategic role in golf course design and style and are a valuable asset in the golf course landscape. Tree placement should be carefully considered and turfgrass cultural practices

IPM strategies —

need to be closely monitored in shaded areas. Increase light penetration through the tree canopy by selectively thinning the crown and pruning lower tree limbs. Enhance air movement in pocketed areas by judicious removal of shrubs and trees in the avenue of prevailing winds. Along fairways and greens, root prune trees that are competing excessively with the turfgrass for water and nutrients.

Pest forecasting techniques and equipment

Many tools are now available to the golf course superintendent to aid in forecasting potential problems on the golf course. Weather stations aid in monitoring potential weather conditions that are conducive to disease development. Diagnostic kits are available to the golf course superintendent to provide rapid, on-site test for disease detection and monitoring pathogen levels. New computer forecasting models aid the superintendent in disease, insect and weed control applications.

Alternative pest control measures

Biological controls regulate pests by introducing natural enemies to the turf environment to combat turf pathogens. Some biological products are now available for turf, and research shows that the potential of such products is bright.

Spray only when necessary

There may be times when the use of a pesticide is the most effective way to control a turf problem. Select a pesticide that provides the most effective control of the weed, disease, or insect, while presenting the least possible hazard to people, wildlife and the environment.

Control measures used should be evaluated periodically to determine if the desired results are being achieved, and the control plan should be adjusted if necessary. Diagnosing, evaluating and controlling a turf pest problem follows a logical sequence. Each situation is unique, however, and adjustments should be made to the overall program as circumstances change on the golf course.

Consistent cultural programs keeps turf healthier and reduces need for chemical applications.

Communication and education

Communicate with and educate course officials and golfers about the IPM strategies that are taking place on your golf course and explain why they are being undertaken. Letting golfers know you practice IPM helps them understand and accept your management decisions.

Success with an IPM program depends on being alert to potential problems, following proper cultural practices, carrying through with a well-conceived maintenance plan, and selecting the best corrective measures to ensure the best quality golf course conditions with the least impact on the environment.

The golf course monitoring program

The first step in establishing an IPM program should be developing and maintaining a regular monitoring program to collect information about pest activity occurring on the golf course. Regular monitoring provides a record of active insect, weed, and disease populations, and any resulting damage, and also provides follow-up information on the success of particular control measures. Monitoring can be done by a golf course employee who has formalized training in field diagnosis of weeds, diseases, and insects. This person, often referred to as a scout, examines the golf course on a regular basis and although they may have other duties to perform on the course, the primary responsibility should be the IPM monitoring program.

Monitoring frequency varies for each portion of the golf course, depending on available time and operating budget. The greens and tees usually require the greatest attention and initially should be monitored daily or every other day. Fairways and roughs may be monitored less frequently if labor and time are a concern. The time spent monitoring will be reduced significantly once indicator areas, or "hot spots," for particular pests are identified. Early morning monitoring is preferred, as disease symptoms and signs are most conspicuous prior to mowing, and this time interferes least with play.

Keep accurate records as each site is monitored. Scouting records can be used to make pest control decisions. Look for trends that suggest pest numbers are increasing to levels that warrant control measures being taken. Early detection can often minimize damage and severity.

Several years of monitoring records will establish pest threshold levels specific to your golf course, further improving pest control decision-making. A monitoring program may not always reduce the number of chemical applications, but it will assure that pesticides are being used in the most judicious manner.

— Dr. Kimberly Erusha

IPM for Audubon
Cost Effective and Smart

ROB KLOSKA, GOLF COURSE SUPERINTENDENT
THE CHAMPIONS CLUB AT SUMMERFIELD

Most golf course superintendents have some kind of integrated pest management program at work on their course, even if it isn't a specific written program. It could be their aerification program, their vertical mowing program, or their method and frequency of pesticide application.

One of the requirements to earning Signature status in the Audubon Society of New York State's Cooperative Sanctuary Program is the creation of an integrated pest management program. Our program here at Summerfield, as anywhere else, is a function of our budget. Therefore, we stress the "basics" in our program, and we practice "tolerance" when it comes to certain pests. We try to let particular problems run their course so to speak, while staying on top of others to prevent them from becoming "budget killers." Because we don't treat any area on the course on a preventive basis, we must be extremely attentive to day-to-day changes on the course.

With an annual operating budget well below the average used by private facilities in the area, the centerpiece of our program is our basic cultural practices. Aerification of greens, tees and fairways, and vertical mowing of greens and tees are the cornerstones of our cultural practices. Our greens are topdressed one or two times per week, year round. The use of slow release fertilizers is also important. The computer irrigation system, in combination with all of these programs, has allowed us to gain maximum root growth and turf density.

Our herbicide program is where we practice the most tolerance. Greens are obviously a priority, however problems in the fairways and roughs are left to run their course unless catastrophic. When we do spray, we try to use chemicals with the least residual values. This year, we will use a nematode product to control mole crickets.

Fungicides are only used during overseeding establishment. Our choice of fungicides is one that has contact and systemic control.

Because of these programs, our chemical budget was well below $20,000 last year. We are expecting an increase this year due to the 100 inches of rain that fell on our site in 1994. Our turf vigor has suffered drastically in the early months of 1995 and the cool temperatures have hampered our recovery efforts.

Our equipment maintenance program is another key part of our IPM program. The reels of the greens mowers are ground once per week and the tee mowers every other week. This insures the best possible mowing results and at the same time helps minimize the amount of mechanical stress exerted on the turf. Back lapping has been completely eliminated.

In 1995, we are hoping the introduction of growth regulator treatments on our tees and fairways will further help our IPM program. The objective here is to minimize mowing requirements and thatch while not compromising turf quality.

IPM programs are as different as the courses they are used on, but their goals and effects on the environment are the same. Our program has served us well and will undoubtedly be refined throughout this year. For this Signature Cooperative Sanctuary Golf Course, our IPM program is truly cost effective and smart.

Editor's Note: *The Champions Club at Summerfield is the first "public" golf course designated a Signature Audubon Sanctuary.*

ACSP Certification Tips

When applying for certification through the ACSP for your IPM category, you are asked to obtain a signed statement from the Green Committee showing the course management's commitment to IPM and proper turf management. This statement of support will help you gain the backing of the Green Committee.

Here are some examples of IPM Statements:

The Jiminey Cricket Golf Course is committed to the management of the golf course through the use of integrated pest management (IPM) techniques. It is our intent to continually upgrade this management approach with new information, equipment, or materials which will reduce the need for pesticides.

Pesticide use has been, and remains, a last resort decision due to membership concern, environmental unknowns, and economical reasons.

Mr. Tom Bird, President
Mr. Jon Cage, General Manager
Mr. Joe Bone,
Golf Course Superintendent

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The Blue Bird Country Club is committed to the principles of integrated pest management. Current practices and future plans are compatible with the concept of maintaining adequate playing surfaces while keeping our use of chemical fertilizers, pesticides and herbicides to a minimum. We will continue to educate ourselves in IPM methods and apply management strategies that promote a high degree of environmental quality on our golf course.

Mr. Jim Dandy
Green Committee Chairman

Biologicals and organic/natural products —

Soil microbial enhancement

BY CHIP FOWKES
GOLF COURSE SUPERINTENDENT
EMERALD DUNES GOLF COURSE

Superintendents that would like to incorporate the use of biological enhancement into their management programs will find it difficult to find empirical data to guide them. There are more companies everyday claiming that various combinations of bacteria, organic amendments, bio-stimulants and other bugs in a bottle will solve most of the problems associated with the management of fine turfgrass.

The most common claims are:

1. Thatch reduction
2. Disease suppression
3. Nematode control
4. Control of black layer
5. Sodium reduction-increased percolation
6. Increased nutrient availability, especially nitrogen
7. Improvement of irrigation water quality

The chance of these benefits without the use of chemical applications or mechanical manipulation sound too good to be true... and they are. We have all been around long enough to know that there is no easy way to manage turf at the level we maintain today. When the water injection aerifiers arrived, they were never meant to replace core cultivation, and the increased effectiveness of growth regulators is not likely to put mower manufacturers out of business soon. These new developments are tools to be used in conjunction with the tried and true methods that experience and science have proven effective over the years. The use of biological agents to improve the health and quality of our turf should be viewed the same way.

These techniques can only be effective if they are part of a truly integrated plant management system. The difference between the use of organic materials and biological agents, and the other techniques mentioned is that they have been in use for many years. Where a plant is growing in its native environment and is not subjected to artificially induced stress, this is the normal equilibrium of the rhizosphere, and the application of fertilizer and pesticide is not necessary. In turf management, we generally give the plant the opposite conditions, subjecting it to unnatural soils and demanding quality at the expense of resistance to stress. The goal that we are pursuing at Emerald Dunes is to modify the soil environment to make it the most efficient natural growth medium for the turfgrass. The practical results of these efforts are hoped to be an increased ability of the plant to resist debilitating stress factors under normal growing conditions.

While there is not a lot of available research on the use of plant growth rhizobacteria (PGPR) on turfgrass, there has been work in this area as early as 1890 in regard to agricultural crop production. Studies were done first in Russia and Eastern Europe with inoculating seeds with cultures of bacteria to improve plant growth. Work in this area progressed into the 1970s in India and the U.K. with the introduction of bacteria into the growing medium in the greenhouse and positive results were observed on growth promotion.

In Australia however, field trials using the procedures showing success in the laboratory did not produce the same results.

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Practical Application I – Seminole Golf Club

The concept behind humic acid is that it allows the bermuda plant to be more receptive to taking in needed nutrients

HAL HICKS
SUPERINTENDENT

As with a lot of golf course superintendents, I have been experimenting with various "materials" in hope of finding a way to reduce the need of applying various chemicals and fertilizers to the turf. Humic acid is a great example. Just ten years ago, this product was probably not used very much. Today, I know many superintendents that use humic acid in combination with topdressing or through direct spray applications. The concept behind humic acid is that it allows the bermuda plant to be more receptive to taking in needed nutrients, which in turn allows for higher efficiency.

In line with this concept, I have also been experimenting with the injection of microbial bacteria and nematode suppressing materials through our irrigation system. Again, the idea behind the use of these "materials" is that they supposedly enhance nutrient release from fertilizers, improve soil structure and water infiltration, suppress disease and nematode activity and reduce thatch.

But in reality, what does all this mean? The bottom line is that — to date — I cannot dispute or verify any of the claims these products make. I have not witnessed any great change in our turf that I can definitely state is a result of these "natural" products. But what I do know is that we have moved into a new environmental age. As a result, probably more and more "natural" products will be introduced into the market in the near future. Time will tell what does and does not benefit the turf. But, if successful, the concept of using "natural" products to reduce chemical and fertilizer use is excellent. I hope that in time these "natural" products prove successful and reduce some of the stress on the golf course superintendent.

Soil microbial enhancement

The theory developed from these experiments was that the inoculum which was not normally found in the rhizosphere could not compete with native bacteria.

The idea of a dynamic microbial equilibrium that is established in the root zone of the plant led to the belief that any introduced microorganism will not be able to establish itself in the soil.

Two important breakthroughs in recent years have brought the use of biological agents for plant management into practical use. The discovery of mutant strains of bacteria that lived off root exudates and altered the indigenous microbial populations of the root zone, to allow their colonization throughout the season, and techniques to measure their establishment. Selective breeding for host specific strains that process known plant pathogens or biodegrade organic matter has brought us the products being marketed today.

The area most likely to be successfully colonized by beneficial microbes is a newly constructed USGA style green. This is basically a sterilized soil medium where the inoculum can be more easily established. Along with the microbes, it is important to supply a food source until the root system becomes sufficient to support their growth. The supplier of the microbes should be able to recommend an available substrate.

If the supplier can't provide this information, you should reconsider using the inoculum he is selling. Some bacteria are inoculated onto fertilizer carriers that supply an adequate food source for a short time.

Another important consideration is that the inoculum must be delivered to the rhizosphere, as bacteria are not all mobile and must have moisture present to survive and move to the desired location. The incorporation of bacteria and a food source into the soil before planting may provide the best opportunity for establishing healthy colonies where they can do the most good.

The application of products through irrigation systems is an efficient method for moving the microbes into the soil, however may not be cost efficient due to application in non target areas. If the entire course is to be treated, this is probably the best way available to move the bacteria into thatch or the root zone.

Core cultivation before inoculation should greatly improve their ability to reach the intended destination. It is important to know the part of the plant the microbes are designed to work, as applying them incorrectly or without a sufficient food source will ensure their failure to establish and compete.

Once the colonies become established, there are products available to be applied in granular form or through fertigation that will aid in their survival and efficient growth.

There are additional factors that directly affect the life processes of the microbes and their ability to perform the task they were applied for. Extended wet periods or very compacted soils can rob the bacteria of oxygen necessary to remain in an anaerobic state and some re-inoculation may be necessary after the poor conditions are alleviated. There is conflicting data on the effects of chemical pesticide on non target microorganisms, so the manufacturer of the bacteria should be consulted as to when re-inoculation can safely take place. These factors indicate that the most efficient way of encouraging the establishment of beneficial microbes would be a system that provides a constant source of inoculum, with the proper food source, through a well-designed irrigation system.

The ability to do this is available today, but the cost is high and the results are difficult to quantify and cannot be expected to give rewards for two or more years. There are also products that can be applied with spray equipment on specific areas like greens or trouble spots and watered in.

At Emerald Dunes, we feel that we are receiving benefits from our management program that justifies its continuance. The use of chemical pesticides and amount of fertilizer applied has decreased gradually over the past three years. There has not been a significant cost reduction in the fertilizer budget since the nutrient sources used are more expensive per pound, however less frequent applications provide for some labor saving and less disruption of play.

The course seems to recover more quickly from poor weather conditions and stand up better to heavy traffic. Overall, we feel the quality of the turf above and below the ground has continued to improve with no corresponding budget increase since our biological enhancement programs were begun. Our knowledge of the symbiotic relationship of the plant, soil and microbial populations is

Continued on Page 59

Practical Application II
Banyan Golf Club

DAN JONES, SUPERINTENDENT

At Banyan Golf Club we have been working on biological control agents for many years. We started with the white amur fish in our lakes to reduce the undesirable aquatic vegetation. We have not had to conduct mechanical removal or herbicide applications for 15 years and our lakes remain weed free.

We have introduced the red eye fly and the *steinernema scapterisci* nematode for mole cricket control. The results are inconclusive at this point.

A strict IPM program has reduced our pesticide usage by 40%. We spray for curative control only.

We are currently in the process of setting up a program to control diseases and parasitic nematodes with microorganisms.

The future of biological and organic control of pests is exciting, and Banyan Golf Club plans to stay on the cutting edge.

Metamorphosis — Maintenance barn to maintenenace facility

BY TIM SEVER
SUPERINTENDENT
THE SANCTUARY GOLF CLUB
SANIBEL ISLAND

As golf course superintendents are trying and succeeding in improving our professional image, it's time to also improve and update the image of the old maintenance barn.

Although this article is geared more toward the design and building of a new maintenance facility, there are areas that could be useful in renovating or upgrading of an existing facility.

The first thing you need to do in planning a maintenance complex is to be as up to date as possible on all of the local, state and federal regulations pertaining to this type of facility. Most of the time, you would take your layout to an engineer or construction consultant and let them put the finishing touches on your plan, making sure it conforms to all of the pertinent regulations. They will come up with a set of working drawings and a set of specs for the proposed builders.

Remember that you don't often have a second chance to design or build the facility. Take your time and think through all the different aspects of the facility, from adequate parking, equipment and fuel storage to office space. I'm no expert in the field of design, but I have been fortunate enough to have been involved in the design and construction of three maintenance facilities. If there is a single most important thing I brought to these facilities, it was convincing the ownership that this was a very important piece of the development puzzle. This is the hub of all maintenance that is performed on the project. It has to be efficient, well designed and well run, with safe operation as the foremost aspect of the facility.

With that said, I would like to touch on certain design criteria that should be considered.

Office, lounge and restrooms

It is important that each person on your office staff has a place to do his or her paperwork and reports.

The lounge should be sized so that it will allow the entire crew to sit and eat, or attend staff/safety meetings. It should have a minimum of a refrigerator, microwave and sink. We sized ours so that we could include lockers for employees. This keeps the jackets, rainsuits, etc., from laying around. We also have a TV and VCR in this area to help us in training and safety meetings. This is also the area where we keep our haz-com plan and other important information.

Restrooms should be designed to accommodate maximum staff size.

Equipment, small tools storage

The equipment storage area should be well thought out. Every piece of equipment should have its own place. Nothing is worse than having to move 2 or 3 pieces of equipment to get to the one you need. Also, the more equipment you can keep under cover, the longer it will last.

Small tool storage is also in this building. We have a 15 x 15 caged area that can be locked and is adequately sized to store hand tools.

Mechanics office, shop and parts

These areas should be adequately sized according to your equipment inventory. The mechanic needs to do his paperwork, parts inventory, parts ordering, preventive maintenance reports and fuel reconciliation and monitoring reports. Most important, it should be an area that can be secured, or at least out of the main flow of traffic. Employee accessibility to this area should be restricted to eliminate potential liability and insurance risks.

Chemnical, fertilizer storage

There are a couple of options pertaining to these areas:

Continued on Page 60

Practical Application III
Fiddlesticks Country Club

LOU CONZELMANN, SUPERINTENDENT

Currently there are two beneficial nematodes available for the control of mole crickets: Steinernema scapteriscus (Proact) and Steinernema riobravis (Lesco, Vector). I have not had experience with the Vector product, therefore I cannot comment on its performance. My experience with Steinernema scapteriscus began several years ago when Fiddlesticks Country Club became a site where research through the University of Florida was conducted using these nematodes. Through the years I have seen this product effectively kill many mole crickets.

The nematodes carry a bacteria which is released into adult mole crickets. After entering the nematode, the bacteria kills the mole cricket within a couple of days. They are most effective against adult mole crickets, so are best used in the spring and fall when adults are present.

I have seen mixed results with Proact applications. I attribute this to application methods. Since ultra violet radiation is harmful to the nematodes, they need to be applied at dusk or later. Also, the turf should be irrigated before and after application. Fertigation systems can also be used to apply nematodes. I haven't used the fertigation system for nematode application, but I'm beginning to do some experimenting with it. I feel that is may be an excellent method of nematode application.

As with chemical insecticides, nematodes need to come into contact with the mole crickets. Timing of application and thatch now come into play. Recently, I

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Fiddlesticks

From Page 58

have seen some low pressure injection systems which may be a good option for applications.

Nematodes are environmentally safe. No protective clothing is needed for applications. They do not harm humans, fish, or any other animals. Hopefully we will be using many effective products in the future that have absolutely no negative affect on the environment.

Scouting and mapping can be an effective cost saving procedure for nematode applications. Mole crickets seem to congregate in the same areas year after year. Limiting treatment to these specific areas can provide acceptable control and be cost effective.

Beneficial nematodes have proven to reduce mole cricket populations while being completely safe to the environment. As we fine tune application methods and find a way to insure contact between nematodes and mole crickets, this will become a more popular method of control.

Soil microbial enhancement

From Page 56

increasing as we continue to research this exciting aspect of our profession.

Finding reliable information to assist you can be obtained by asking sales personnel to provide you with studies that support the effectiveness of their products. If you have access to the Internet, there are papers available through the Turfgrass Information File at 20676POC@MSU.EDU. Or, use a gopher to find topics under agronomy, sustainable agriculture, biological research, or any other catch work you think might work.

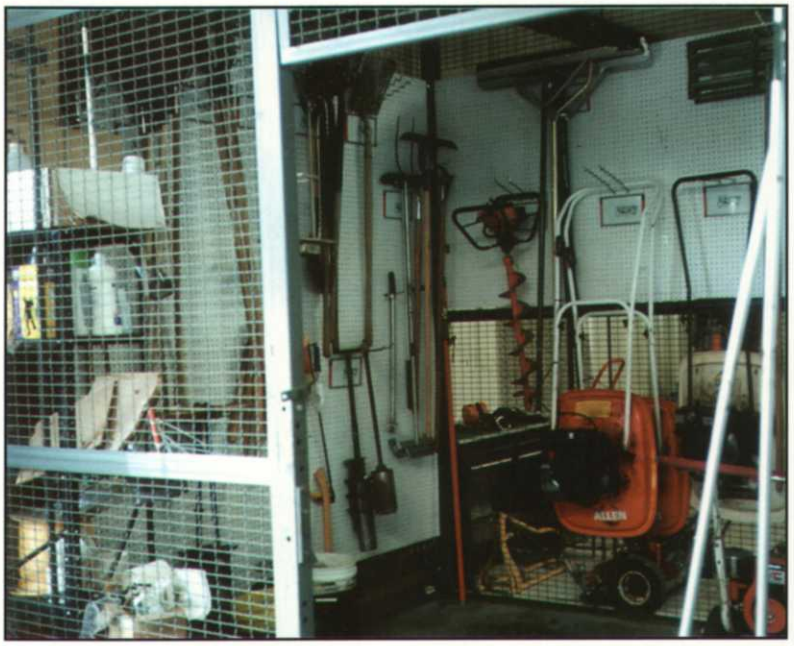
Two additional sources are:

Turf Grass Trends 1775 T. St. NW Washington, DC 20009-7124

Many good book titles are available through:

CRC Press, Inc. 2000 Corporate Blvd. NW Boca Raton, Florida 33431

The Sanctuary maintenance facility (left). Note the required containment around fuel tanks (background) and the fertigation tanks (right). Below, are indicated proper storage of chemicals (left) tools and equipment (right).



1) Prefab metal type building, or
2) Concrete structures

We chose the concrete structures. An article in the *Leader Board* from the GCSAA is a good guideline for this area. You need to have a dedicated storage building, not vulnerable to flooding, and accessible to fire engines and delivery vehicles. It should have an Impermeable concrete floor with bermed perimeters to catch and hold spills. Good ventilation fans and spark-proof wiring help prevent explosions and fires. Security, particularly locks and inaccessible windows, emergency supplies and first aid station with emergency shower immediately accessible should also be available. The size of this structure would depend on your operation. There should also be an impermeable surface outside the chemical storage area for your mixing and loading.

Fuel storage

There are three basic options:

1) Above ground storage tank (AST) with self-containment (e.g. Convault) steel tank that is encased in concrete.

2) Underground storage tank (UST). You gain more space with this type, but there is more monitoring and record keeping.

We chose the third option:

3) An AST with a containment wall around it. With this type of fuel storage, the area has to have impermeable floors and walls. Walls should be poured solid and reinforced. The containment area should be sized so to hold at least 110% of the largest tank.

All of the different types of storage areas should have overfill protection, leak detection and an impervious surface for filling of equipment and vehicles. For any of these tanks, you must meet the insurance requirements for financial responsibility.

Storage bins

Storage bins for topdressing, mulch and sand are probably not considered a necessity, but I recommend that if space permits, you should make this part of your plan. Separate bins for each will considerably cut back on the amount of contamination and waste of these materials. It will also add to the overall cleanliness of the facility. Usually these bins have reinforced concrete floors and walls and graduated side walls from front to back. These areas can have a roof added, but have to be designed so large trucks can have access.

Signage and safety

This area pertains not only to new facilities, but existing ones as well. You should have a hazard communication plan set up and operational and all pertinent signage in place.

Cleanliness

Once again, this applies to all maintenance facilities, new and old. This goes hand in hand with the safety of your maintenance operation. Everything should have its place, not blocking a fire exit, safety signage, etc. You should practice what you should be preaching. There is a certain image that we need to promote. We are professionals and should look the part. I can remember being told by a superintendent that I worked for that first impressions were important. We have a lot of vendors and other professionals that visit us on a daily basis. Some never even see the golf course. I know what my first impression would be, "I sure hope this guy doesn't take care of the golf course the way he takes care of his maintenance facility."

It doesn't take that much time to keep the maintenance areas clean. We have two people who clean the lounge, offices and equipment area daily. It takes approximately 30 minutes. On Fridays, we remove all of the equipment from the shop and vacuum, blow and sweep the entire complex. It takes two hours to accomplish this. I do think that good housekeeping procedures carry over to the golf course.