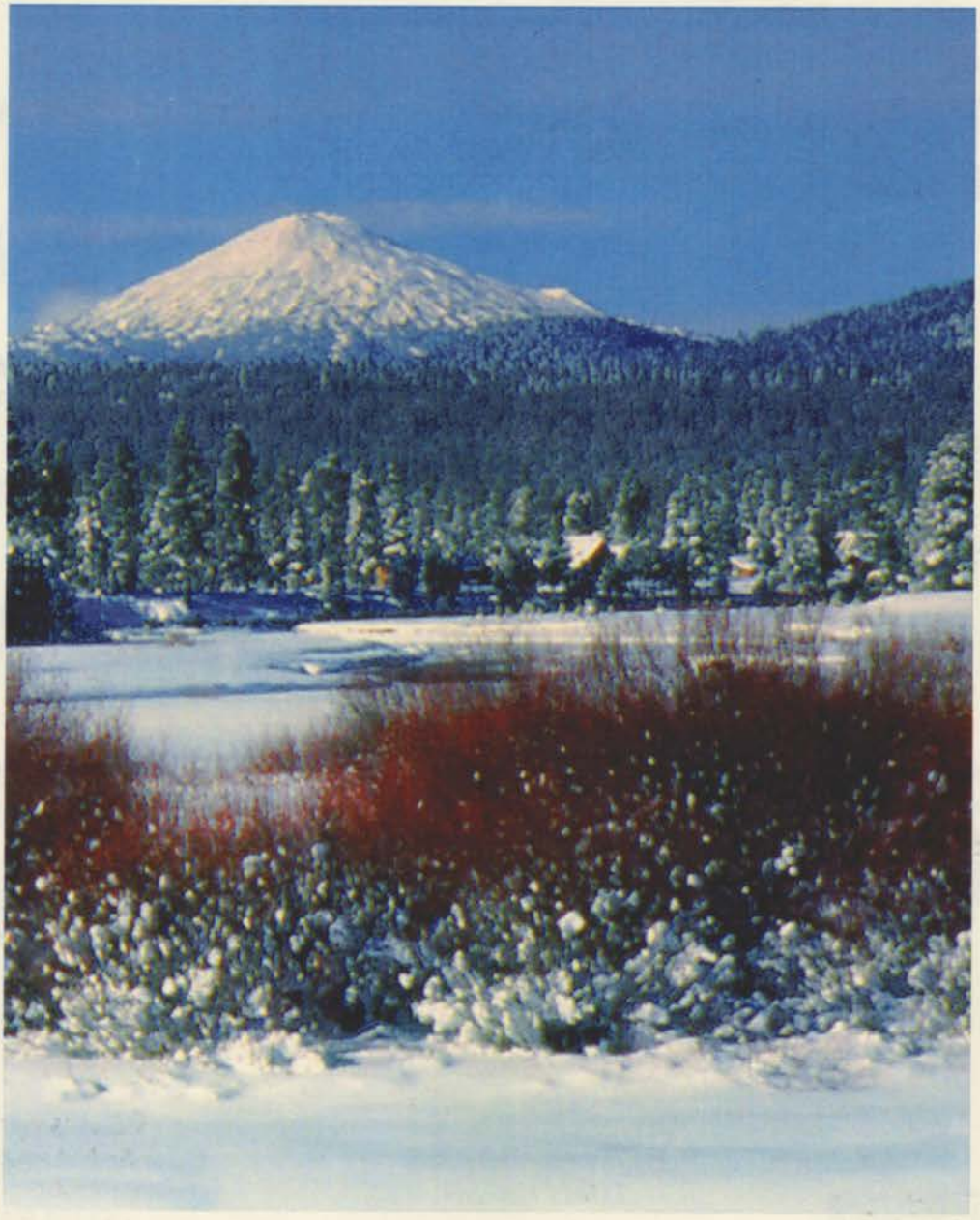
NORTHWEST TURFGRASS TOPICS

The Official Publication of the Northwest Turfgrass Association

Vol. 40, No. 1 Winter 1996-97



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EDITORIAL COMMENT:

For the first time ever, members of the Inland Empire Golf Course Superintendents Association, the Northwest Turfgrass Association, the Oregon Golf Course Superintendents Association and the Western Washington Golf Course Superintendents Association will put together a composite Membership Directory. The directory will be mailed to all members on approximately April 15, 1997. This new directory will feature a cover photo courtesy of Johnson PhotoGraphic Design (USGA calendar photographer) and have tab-separated sections for each organization.

Plans for our 51st Conference at Sunriver Resort in October are being finalized. Speaking of Sunriver…Jim Ramey, CGCS at Crosswater of Sunriver received the American Society of Golf Course Architects' Golden Anniversary Challenge Award in Las Vegas at the GCSAA Conference. (See "We Can Say We Knew Him When" on page 6). Ramey received a framed version of his golf course design entry in the national contest. Jack Nicklaus' presentation to him of his award was certainly a memorable highlight of his year.

Coeur d'Alene Resort will be our conference site for 1998. John Anderson will be our host. The USGA has agreed to fund a special research project to be known as the "Coeur d'Alene Floating Green Leachate Study" adding $24,000 more to the NTA-influenced research projects for 1997.

The North American Turfgrass Foundation meeting in Las Vegas was well attended. Western Canada, Northwest, Ohio, West Virginia, Nebraska, California, Florida, Michigan, Pennsylvania, North Carolina, New York, USGA, GCSAA, and others were in attendance. Funding for research grants, Web pages, distance (satellite) education, and innovative problem-solving were among the hottest topics of discussion.

Environmental issues still occup much time and discussion. Which reminds me of a quotation framed on the wall near my phone…the quote reads:

"This we know…the earth does not belong to man,
man belongs to the earth.
All things are connected, like blood which connects one family.
Whatever befalls the earth befalls the children of the earth.
Man did not weave the web of life -
he is merely a strand in it.
Whatever he does to the web, he does to himself."

-Chief Seattle 1854

NORTHWEST TURFGRASS TOPIC

COVER PHOTO:

Provided Courtesy of Sunriver Resort

The Golf Industry - 2000 and Beyond

By Jim Gibbons

In order to obtain a proper perspective on the future, it is usually best to look back and review the changes that transpired over the last few years. As we look into the possibilities for the next many years, there will be some ideas presented that may seen realistic while others will be more obtuse. It is my hope that this presentation will trigger a thought or idea that might promote or develop a new product in the industry. If what is presented today helps inspire someone to invent a new turfgrass product that should make a lot of money, we could possibly create a millionaire.

What was the past like? There have been meetings such as this for many years. I found a picture of the 1913 Scottish Section of Golf Greenkeeping Association meeting. They certainly were concerned along similar lines as today in the effort to produce the best possible playing surfaces. Early on the equipment was primitive. Often animals were used for power for construction and maintenance. In his 1912 *The Book of the Links,* Martin H. F. Sutton wrote about sheep grazing on golf courses: "Unless cake-fed, sheep return no benefit to the ground, but in sufficient number, they help to keep down the expense of mowing and rolling. In this sense they prove an asset, especially to a struggling club. Against this must be set the damage done to the greens by "scalding" the turf, the breaking down of the face of the bunkers and the objectionable fouling of the fairway, to which must be added the nuisance they invariably are to players, Altogether the advantages of sheep are far outweighed by the disadvantages."

Also, take note of the present. The industry has made great strides over the years. We have modern facilities and equipment to make the job more efficient. The ability to groom courses is available to most everyone. The northwest is to be congratulated for being recognized as capable hosts for the US Amateur, US Junior, US Public Links, US Senior Women's, US Senior Men's, US Mid Amateur and next year the US Women's Open.

The game of golf reaches all segments of society from presidents to celebrities to the general public. Golf is for women and men, junior and seniors. It is a game of traditions ranging from caddies, juniors, amateurism, and a basic respect for the game that will hopefully continue to be important in the future.

And what of that future. It is an opportunity for making money by creating solutions to problematic situations that occur within the industry. Creative thought can make it happen. Let's look at some possible future innovations. In order to open the thought process, some of these will be very unusual, others reasonable.

Let's approach this in three areas relating to turf and golf: equipment, turfgrass and the industry in general. First, look at where equipment might be evolving. In mowing, there could be remote controlled mowers programmed for greens that would be housed in underground shelters. They would elevate for mowing and would be controlled by programming and an "invisible fence" similar to pet control fences. The same process could be expanded into some type of bunker rake apparatus. With the changes in vehicle tires to larger sizes, (tires have gone from 8 1/2 to 10 1/2 inches), it only seems a matter of time until most maintenance vehicles will operate on cushions of air like hovercraft. Additionally, all equipment will be operable at night time. It will be ergonomically designed and climate controlled with electric power rather than gas. Imagine working on the course in the recliner chair behind the wheel inside the temperature controlled cab.

These pieces of machinery will have computer diagnostic capability and the capability to hook up to the maintenance shop computer which will go online to order any part directly from the supplier. Also, all communications will be far more sophisticated than present. Everyone on site will be able to communicate with everyone else.

Other innovations might include automatic controlled hazard and OB stakes which pop up and retract through a garage door opener type control with a 40 foot range. The mower operator can press a button before and after passing by. Irrigation heads will not just pop up when watering, but someone will invent an adapter to trim the grass at the edge of the plate using the power of the motion of the sprinkler. There will be a laser grid system similar to that used on boats for locations that would send an exact cup location back to a computer in the pro shop to be printed out on a hole location sheet for all golfers. Speaking of hole locations, if you refer to the handout, I'd like to explain how the chart we give the golfer relates to where you as the hole cutter would locate the hole. Remember the golfer views the target green as a circle. That player wants to know the hole locations in yards relative to the front of the green and how close to the edge of the green the flagstick is. The accurate way to find the correct spot is to walk straight back from the front center of the green the number of paces from the front. After that, count from the side the right amount of paces. You're there.

There is a great opportunity for new ideas to take effect in the area of disease treatment and prevention. How about new dynamic temperature sensors that, through inline applications, would sense changes in weather or plant levels that would trigger automatic applications of materials to reduce or eliminate problems prior to them being observable. Or why doesn't one of the chemical companies invent a clear benign product that could be spread over a turf area. When a pathogen or other designated problem initiates, this product would turn a bright color to alert staff of pending problems with an early warning.

As related golfing associations are becoming aware of the aspects of the turfgrass industry, more of these organizations will be allocating funds to assist with improved playing conditions. These will support new and continuing studies to reach those goals. Now insects are being used to combat problems. With the major earthworm dominance for years on golf courses, why not reach some way of reducing the earthworm population. Since worms eat organic debris, why not develop a sterilizing agent that would be mixed into that debris to reduce the reproduction levels.

Artificial turf in certain playing areas will possibly become more popular. Quality may be improved and stress taken off other turf areas. There may be a movement to center the problematic cart path, moving it to the middle of the fairway. Then a green artificial surface would make a nicer view that the regular paved surface.

As the industry advances, we start to see new technologies emerge like the weather tensiometer stations to assist with irrigation. Why not have nutrient analyzer capability on site along with complete soil and disease analyzing potentials. There should be computers that have the complete "as builts" of the course irrigation system with a complete parts and equipment inventory. If a break in the system occurs, the computer shows what happened where, and which parts are needed for repair. Even the supply companies would be logged onto the network and you could highlight the parts and order them directly through the computer. The same situation could be in place for maintenance equipment with CD disks for a blow up diagram of the tractor or other piece of equipment broken down. Again, go on line to order the parts needed without leaving the comfort of the office.

Other annoyances are solved with better inventions all the time. And more will come. There will be some easy effective way of marking out of bounds and hazard lines more permanently. Other markers will help with pace of play. Upright 150 yard posts in the middle of the fairway are in use at some courses. They locate the center of the driving target as well as giving distances. With the increasing demands upon daytime play, there will be a trend to night time only maintenance. Also, there will be more compact facilities being built. Complete courses are now designed on 15 acres with separate sections for driving, approaches, chipping and putting. As the availability and cost of land put pressure on developers, these compact courses will start to show up.

There will be more cooperation among all golf related organizations. Environmental situations will become very favorably tied to golf. We are seeing the adversarial role being reduced as golf courses place more areas into Environmentally Sensitive Areas. This procedure is allowing courses to be built where consideration in the past was declined.

Golfers may push for ways to make the game more enjoyable. Placing larger holes on the greens for higher handicaps might be one thought. Building a complete course inside a biosphere-type building is a possibility. Controlled climates and perfect playing conditions all the time would garner higher fees. The tolerance for spiked shoes will decrease as more non-metal spike options are created. Some inventor may find a new material that will gently cling to grass plants to be used on the soles of golf shoes. The recent USGA Journal has an in-depth article relative to this topic.

And the future may answer one of the often asked queries, "Do we put the rakes in or out of the bunkers?" Miscellaneous Decision #2, page 593 in the USGA Decisions on the Rules of Golf Book, strongly recommends that rakes be placed OUTSIDE bunkers. Putting rakes in bunkers can cause situations for playing that create extra penalties for players when the rakes are at the edges of the bunkers. (See following handout information.)

From the USGA *Rules of Golf*

Book, "Rule 24 Obstructions, 24-1. Movable Obstruction

A player may obtain relief from a movable obstruction as follows:

If the ball does not lie in or on the obstruction, the obstruction may be removed. If the ball moves, it shall be replaced, and there is no penalty provided that the movement of the ball is directly attributable to the removal of the obstruction. Otherwise, Rule 18-2a applies.

If the ball lies in or on the obstruction, the ball may be lifted, without penalty, and the obstruction removed. The ball shall through the green or in a hazard be dropped, or on the putting green be placed, as near as possible to the spot directly under the place where the ball lay in or on the obstruction, but not nearer the hole. "

"20-3d/2 Ball in Bunker Moves Closer to Hole When Obstruction Removed and Ball Will Not Remain at Rest When Replaced; All Other parts of Bunker Are nearer Hole.

A ball came to rest against a movable obstruction, a rake, in a bunker. When the rake was moved the ball rolled nearer the hole. According to Rule 24-1, the ball had to be replaced. Due to the slope and the fact that the sand was firm, the ball, when replaced rolled closer to the hole.

Under Rule 20-3d, if a ball will not come to rest on the spot where it originally lay, it must be placed at the nearest spot not nearer the hole where it can be placed at rest. The spot where the ball originally lay was farther from the hole than any other part of the bunker. This, there was nowhere to place the ball at rest in the bunker which was not nearer the hole. What is the proper procedure if:

The only way the ball would remain at rest at the spot where it lay would be to press lightly into the sand?

The sand is so hard that it is impossible to replace the ball?

There is nothing in the Rules of Golf Permitting a player to press his ball lightly into the sand or ground to make it remain at rest. Accordingly, in either case, since the player could not place the ball in conformity with the Rules, he should, in equity, (Rule 1-4), have dropped the ball, under penalty of one stroke, outside the bunker, keeping the point where the ball lay directly between the hole and the spot on which the ball is dropped. (Revised)

Miscellaneous Decisions

Misc. 2 Whether Rakes Should be Placed In Or Outside the Bunkers

Should rakes be placed in or outside bunkers?

It is recommended that rakes be placed outside bunkers, as far away from the bunkers as is practical and in positions where they will be least likely to affect play.

We Can Say We Knew Him When!

This year at the annual GCSAA meeting held in Las Vegas, Nevada, one of our own was honored. The American Society of Golf Course Architects, celebrating their 50th year, presented their Golden Anniversary Challenge award to three Golf Course Superintendents who participated in a golf course design contest and whose designs were selected by the golf course architectural firms headed by Arthur Hills, Rees Jones and Jack Nicklaus. Each contestant submitted one golf hole designed to yardage and other specifications set out by the ASGCA.

Hills presented the award to David Anderson, CGCS at Evergreen Country Club in Haymarket, Va; Jones presented the award to Bruce Scott, a turf student at Colorado State University and Jim Ramey, CGCS, member of the NTA and superintendent at Crosswater Golf Club, Sunriver, Oregon, was presented his award by Jack Nicklaus.

Jim said later that it was the highlight of his career, first to win such an honor and then to have it presented by the world's greatest golfer. You will find Jim somewhere 6 feet off the ground if you'd like to add your congratulations to ours. CONGRATS, JIM!!!

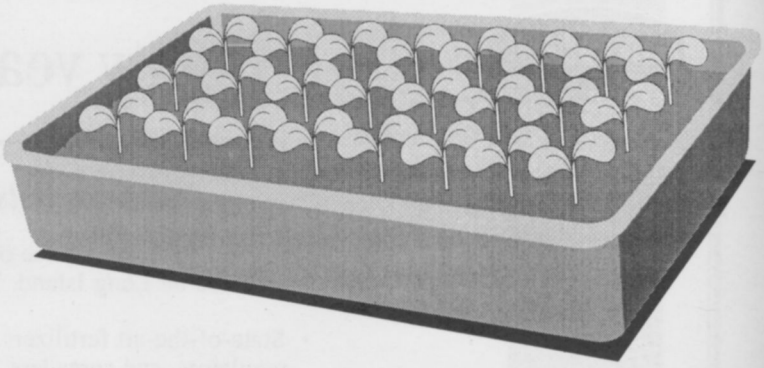
Vision for the Future of Turf Research, Extension and Teaching in the Pacific Northwest

By Dr. Thomas A. Lumpkin

Turfgrass in Washington is approximately a $2 billion industry. We have about 260 golf courses, 1.75 million homes, 470 lawn care companies, 4,500 sports fields, 14,050 miles of roadsides, 24 sod operations and 40,000 acres of Kentucky bluegrass seed production. The turfgrass industry has been represented by a tri-state organization (WA, OR, and ID), the Northwest Turfgrass Association, which has worked closely with WSU for almost 50 years.

State and federal support for turf research and extension has diminished significantly over the past ten years. All current support for turf research comes from proposals funded by groups such as the Northwest Turfgrass Association. Governmental support for personnel has diminished again this year and will necessitate a reduction in technician support for the turf program. With continuing cuts anticipated, the Department of Crop and Soil Sciences (CSS) must decide to either eliminate the turf program or develop it as one of our few areas of excellence, with support from the turf industry. WSU is holding discussions with the turf industry and would like to develop a strong turf program in the Pacific Northwest if the industry can organize a system of financial support significantly beyond current levels.

The NTA has made a remarkable improvement in its financial support though fund raising efforts of the T.U.R.F. program and a major commitment from the Washington State Golf Association. The current NTA support to WSU has been committed towards hiring a research associate by January of 1997 to be housed at WSU-Puyallup and shared by WSU and OSU. The associate will further scientific and practical research on golf courses in the Pacific Northwest. This associate will work closely with Dr. Stahnke and Tom Cook on designated projects such as limiting detrimental earthworm populations and diseases of annual bluegrass. If Dr. Brauen's position is refilled with a scientist in July of 1997, the research associate will work with his replacement as a team. We expect this research team to be only the beginning of an enlarged WSU effort.



Unfortunately, by making the decision to support the hiring of a research associate, other research proposals at Pullman, Puyallup and UBC were not able to be entirely funded immediately. This hard choice needed to be made at this time, but efforts are under way within the NTA to strengthen programs in Pullman and the eastern portion of the Northwest by improving ties with Montana and Wyoming to help fund research efforts with Dr. Johnston in areas where problems are similar to those of eastern Washington, Oregon and Idaho. Uniting our dollars between state organizations to make a stronger research effort without duplication of research projects will be a great benefit to all our respective turfgrass organizations. Our goal is to build a strong working team of interdisciplinary professionals (turfgrass, entomology, plant pathology and soils) to conduct practical and basic research for the turfgrass industry's needs.

Our alliance with British Columbia

and the WCTA has been in existence since 1958, and this bond has continued to grow. We are working on a closer alliance of research projects with Dr. Holl and his fellow researchers to create a combined research project with WSU and OSU. This would be an important step towards building a strong integrated turfgrass program in the Northwest.

Currently, turfgrass management is the fastest growing field in agriculture and there is a need to enhance our teaching programs. Programs without strong undergraduate teaching are being targeted for elimination. Fortunately, this is not the case with turfgrass at WSU or OSU. Turfgrass management is the most popular option in the CSS Department at WSU with approximately 30% of our undergraduates. During a major curriculum revision this summer, the CSS teaching faculty determined that a strong Turfgrass Option and turfgrass teaching program were critical to our department and should be an area of emphasis and support. Industry demand for our students is high and should continue to remain so in the future.

In this light, we are in the process of revising our turfgrass teaching program. At WSU, a need has been expressed for an advanced turfgrass management course (400 level) to be taught. This will be developed and put in place by Dr. Johnston in the spring of 1998. The basic turfgrass course (300 level) is being reconfigured by Dr. Johnston so the lecture and laboratory portions of the course can be offered as separate courses. This will allow a portion of the course to be offered as a 2-credit correspondence course. The course would be available not only for college credit, but also CEUs for golf course superintendents and as a beginning turfgrass course for turfgrass professionals, master gardeners, etc. The basic course may be transmitted via microwave to western Washington and via the Internet. WSU is also making links with community colleges for turfgrass training so community college students can continue their education at WSU while living at home.

Another addition for continuing education and/or college credit will be 3 - 1 hr. modules on golf course management, lawn care and sports field management. These will be developed and taught out of WSU-Puyallup by Dr. Stahnke and Dr. Brauen's replacement via microwave and/or via the Internet for students and professionals to upgrade their skills.

Future Possibilities - we will attempt to bring information to the industry more quickly. A Northwest Turfgrass home page will be set up for research and extension information for turfgrass managers. We are already testing a system for video conferencing from the field where some problems identified by golf course superintendents and others can be dealt with on-line and even brought live into classrooms and labs or placed on CD's for teaching.

In conclusion, WSU is ready to work with the industry and our sister universities to create a competitive regional turf program that solves problems and creates opportunities with turf. This offer can only succeed in today's political climate with organized and enthusiastic industry support. All possibilities for expanding the turf research, teaching and extension must be pursued to develop this goal.

Balancing the Physical Characteristics in Sports Fields

By Norman W. Hummel Jr.

The physical properties of natural turf sports field soils profoundly impact the performance of the turf growing on them. Soils that are compacted, have poor structure, or are fine textured will likely be poorly drained, have high water retention, and poor aeration. Because these soils are poorly aerated and wet, the turf develops shallow roots and has low density.

The physical properties of a soil such as infiltration rate, aeration porosity, and water retention are influenced by three factors: soil texture, soil structure, and soil density. Modifying any one or more of these will result in a better soil environment for your turf.

Soil Texture

The soil texture refers to the percentage of sand, silt, and clay present in a soil. Sandy loam soils, which will contain from 50 to 85%, are generally preferred for topsoil sports fields. Finer textured soils tend to be very prone to compaction and poorly drained.

It is commonly thought, then, that simply by adding sand to a soil that you will improve the drainage and performance characteristics. Unfortunately, some of the worst sports fields we have seen were where people made attempts to modify the texture of the soil through sand additions.

Small additions of sand to a soil will actually do little good in terms of improving soil physical properties. In fact, we have seen sports field soils

with as much as 85% sand in them that were better suited for road bases than sports fields. What went wrong, and why don't sand additions make the expected improvements in a soil?

In order to see any improvement in a soil by adding sand, you must add a sufficient amount so that the sand particles bridge or come in contact with one another. When this occurs, you get the creation of large pores between the sand grains. It is only then that you see improvement in the physical performance and compaction resistance of the soil. In most cases, you are looking at having to add at least 80% sand to soil; in other words a sand based system. Failure to do so will almost always results in very hard, compacted fields that don't drain.

The particle size distribution of the sand you use to modify the soil is important as well. Coarser, uniform sands will do a better job of bringing about improvement in your soil. We would recommend a sand with the following particle size range:

Sand Class.	Particle Dia. (mm)	% retained
Gravel	> 2.0	0 - 5%
Very coarse sand	1.0 - 2.0	5 - 20%
Coarse sand	0.5 - 1.0	30 - 60%
Medium sand	0.25 - 0.5	30 - 60%
Fine sand	0.10 - 0.25	0 - 15%
Very fine sand	0.05 - 0.1	0 - 3%
Silt and clay	< 0.05	0 - 3%

Aside from selecting the best sand for modifying your soil, you also need to know how much sand to add to the soil to bring about improvement. Soil physical testing labs such as Hummel & Co. specialize in this type of testing. Performance testing involves making mixes with different proportions of your sand and soil (and perhaps organic matter), and running them through standard tests for infiltration rate, porosity, and the distribution of air and water filled pore space.

The bottom line is that modifying the texture of your soil is an all or nothing proposition. Failure to follow the steps outlined will likely result in a disappointing outcome.

Soil Structure

Do you ever wonder why some native soil fields perform well while a poorly conceived and constructed sand based fields don't? It is probably due to the native soil field having good soil structure, where sand based root zones are single-grained structureless soils.

Soil structure is the arrangement of the finer mineral components of a soil into larger clusters or aggregates.

A granular type structure, which is very desirable, has the soil particles arranged into pea sized or smaller little aggregates. Collectively, these particles act much like a coarse sand would, the pore space between the aggregates providing aeration and infiltration. Unlike sand, however, these soil aggregates also have small pores within them that hold water. How nice it would be if we could all have granular structured soils in sports fields.

Unfortunately, as these finer textured soils become compacted because of heavy use, the soils lose their structure or actually develop into undesirable blocky or platy type structures. Routine core aerification will help break these larger aggregates up. At some point in time, however, it may become necessary to plow, disk, and harrow the soil to restore good structure. This obviously will put a field out of commission for a while, but if you can work out some type of rotation, even if its on a ten year cycle, it may be one of the best long term practices for reinvigorating your soils.

The addition of organic matter to a soil, especially one that is low in organic matter, will help in the long term to maintain aggregate stability. Well decomposed organic matter, or humus, is actually a good cementing agent that holds the aggregates together. Working coarse textured organic matter sources such as sphagnum peat or good quality composts will actually help open the soil matrix up some.

Density

The third physical property that influences the soils ability to support good turf is the soil density. Soil density is another term for compaction; the denser the soil, the more compacted it is. It is also one factor that you have some degree of control over.

Very dense soils have a low total pore space within them. In other words, a larger percentage of the volume of soil is made of the sand, silt and clay, and less is pore space. Of the pore space that is present, the majority of it will be smaller capillary pore space, which tends to be occupied by water. The larger, air filled pore space occupies a very small percentage of the soil volume. Therefore, roots remain very close to the soil surface where they can obtain at least a small amount of oxygen. In some severely compacted fields, turf shearing may be a problem because of a lack of rooting.

The most common approach to managing soil density is core cultivation. Core cultivation alleviates compaction by physically removing a soil core. If the cores are allowed to dry and they are dragged back in, the soil placed back into the hole is of a much lower density than the soil removed. Any part of the hole not filled will eventually cave in, which will lower the soil density in the area around the aerification hole.

A 1/2 inch diameter tine on 2 inch spacings removes only about 7% of the surface area; a 3/4 inch tine about 12%. You can see then how little area is actually affected by conventional aerification, pointing out the need to do it frequently.

In time, conventional core cultivation may not be enough. We have seen hard pans develop in fields and greens at about the depth of the core cultivation tine. This is where deep tine aerification, using machines such as the VertiDrain can be a great help. Utilizing longer tines (up to 16 inches) and a pitch fork type action, the VertiDrain appears to be affective for relieving sub-surface compaction.

As mentioned earlier, despite your best efforts, there may come a point in time when aerification is not enough. Again, total reestablishment, to include cultivation of the field may be the best approach to reinvigorating your soils.

Getting a Grip on Pythium Root Rot and Turf Stress

By Leslie MacDonald, P.Ag.

The symptoms of Pythium root rot can be severe. It is in your interest to understand this disease so you can take measures to prevent it.

What is Pythium?

Previously, Pythium species were grouped in the Fungus Kingdom along with many of the other turfgrass pathogens. However, taxonomists decided it had less in common with fungi and recently moved it to the Kingdom Protista, which includes organisms such as brown and red algae. This explains why fungicides such as metalaxyl and etridiazole that are effective against Pythium are not effective against fungal diseases such as Fusarium Patch or Red Thread. There have been many species of Pythium isolated from symptomatic turfgrass. *Pythium graminicola, P. aristosporum, P. ultimum, P. vanterpoolii* and *P. aphanidermatum* are some of the species that are pathogenic on bentgrass (1,3,4,6).

One of the reasons that Pythium is grouped into the Protista Kingdom is because it has motile spores called zoospores. Zoospores have small "tails" that propel the spore through water. Zoospores can detect root exudates and respond by swimming towards them. You can appreciate that wet soils would make it easier for the zoospores to swim. In addition, anything that increased root exudates would improve the chances for the zoospores to target in on a root. The abrasion of sharp sand particles against the epidermis of roots

is one way for cell exudates to leak out.

Pythium species also produce a tough overwintering structure called an oospore. This type of spore has a double wall that protects it against extremes of temperature and other adverse conditions. Oospores are produced in root tissue in the latter stages of infection. When the root tissue is further broken down by other organisms, the oospores fall into the soil where they can survive for years. Pythium is also adaptable when it comes to food sources. It will survive on dead organic matter if there are no roots to infect. Cool temperatures slow down Pythium but it will still grow at 43 to 45°F (10) when root growth is limited.

How does Pythium spread?

The Pythium species associated with root rot spread in the soil via growth of the mycelium and movement of zoospores. However, zoospores can only swim short distances through the soil and a trip of a few inches would be a long one. Pythium also produces reproductive structures called sporangia that either germinate and infect plants directly, or else they function as containers which produce zoospores which then infect plants. Sporangia, zoospores and mycelium can spread with soil water as it moves through the root zone. Pythium is present as mycelium and spores in many native soils, and spreads as soil is moved during construction. It may be present in sand or in irrigation water pumped from surface sources although this has not been thoroughly examined.

The Pythium that causes foliar blight during hot, humid weather produces abundant mycelium and spores on turf foliage that are easily picked up and spread by equipment or traffic.

The infection process

Pythium usually attacks young roots, although in severe cases it can infect the entire functioning root system and crown. Infected roots are unable to perform their function of water and mineral uptake. Hence, plants may show foliar symptoms of nutrient defiency and water stress. These symptoms usually start to develop on the oldest leaves first. During cooler conditions, infected plants may survive if the plant water requirements stay low. However, if the evapotranspiration rate increases significantly, the plant will die if it cannot meet

the need for water. Seedlings are very susceptible to infection by Pythium, especially when they are growing slowly, or are being pushed through high fertilization and use of covers. They can die even during cool weather when water requirements are lower if their root system is damaged too much.

Pythium enters through wounds or the tips of young roots. The mycelium grows through the root tissues and secretes enzymes to dissolve or break down cells. Pythium uses the cell contents as a food source. As cells rupture they release cell contents which gives the root a light brown, "water-soaked" appearance. Young root tissues are more readily invaded than older root tissue. Generally the vascular tissue is not infected by Pythium and remains intact. One can easily slide the dead cortex (outer root tissue) off the vascular tissue to produce a characteristic "rat-tail". As the Pythium uses up the food supply of the root, it produces the overwintering oospores.

Symptoms of Pythium

Pythium root rot symptoms often start as a thinning of the turf at the collar. This may be due to extra stress on turf from the abrasion of clean-up cuts. Or, perhaps the Pythium is present in the native soil directly adjacent to the collar and the less diverse microflora in the sand root zone mix is unable to suppress its movement.

Turf can also thin out in other areas of the green. Usually the turf in these areas is under some form of extra stress such as shade, compaction, high traffic, or poor drainage(5). In some cases, *Poa annua* will be unaffected in the patches of thin, dying turf. It is possible that the *Poa annua* is more resistant to the site stresses than the succumbing bentgrass but *Poa annua* will also be infected by Pythium under the right conditions.

Making the diagnosis

To correctly diagnose Pythium root rot, one should observe signs of Pythium in root tissue under the microscope. However, a few species of Pythium do not produce spore structures in the roots which makes the diagnosis difficult. This is where the DNA probes for Pythium will be extremely useful. In addition to observing signs of Pythium in the root, ensure that overall symptoms of the turf and individual grass plants are consistent with a diagnosis of root rot. One must also look for signs of other pathogenic fungi to determine that they are not responsible for symptoms.

Plant Stress is Needed for Disease Development

In the absence of significant plant stress it is difficult to induce symptoms of root rot with Pythium. Three unsuccessful attempts to inoculate bentgrass at UBC's Pacific Turfgrass Research

Centre support this point. One must have plant stress plus a pathogenic species of Pythium to get Pythium root rot.

Pythium Root Rot = Plant Stress + Pythium

Some of the turfgrass stresses that can contribute to the development of root rot include:

nutrient deficiency
high N levels
heat stress
cold temperature
heavy traffic
shade
excess thatch
excess irrigation
drought
low mowing heights
compaction
sharp sand particles

Fertilization is very important during periods of environmental stress. It is critical to regularly provide balanced, adequate fertility when the root zone has a high sand content. Sand's low cation exchange capacity limits its ability to retain nutrients so plants will often be exposed to excesses or deficiencies of nutrients. Tissue testing is a good way to check that nutrient levels in the turf are optimal. Keep potassium and iron levels high prior to the onset of heat stress.

It is wise to avoid high levels of available nitrogen during the growing season. High nitrogen will promote shoot growth which reduces the level of stored carbohydrates. It also suppresses root growth. You end up with lots of shoot growth that you cut off anyway, few roots and low carbohydrate levels. At this point, the plant is less capable of handling significant stress.

On the other hand, late fall nitrogen fertilization has been shown to increase carbohydrate content, root development and improve turf quality (7). We know that shoot growth temperature optimums are from 60 to 75°F, while the optimum soil temperatures for root growth are from 50 to 65°F. There needs to be enough nitrogen available to the plant during these latter conditions for significant root growth and carbohydrate storage.

We may observe evidence of Pythium infection during periods of heat stress. Normally a plant will cool itself during hot spells by transpirational cooling. This requires low humidity, wind and adequate soil moisture that is taken up by functioning roots. In the Pacific Northwest, the first two conditions are usually present. However, roots damaged by Pythium cannot absorb and transport water adequately. The plant becomes water stressed. This triggers the closure of stomata which reduces transpiration. A negative cycle ensues and the plant is not able to cool itself through transpiration. Leaf temperatures increase which cause further plant stress. Syringing may alleviate some heat stress.

Shade is a problem on golf courses. Although trees enhance the beauty of a course, they are incompatible with growing grass. Not only does shade reduce the levels of photosynthetically active wave-lengths that reach the grass, but it reduces wind and causes an increase in relative humidity. These last two factors negatively affect evapotranspirational cooling. Tree roots also compete with turf roots for water and nutrients. Shaded turfgrass may have reduced heat, drought, cold and wear tolerance when compared to unshaded turfgrass (9). Pythium problems are often associated with heavily shaded turf, especially with morning shade.

The recent trend of very low mowing heights is one of the most significant turf stresses. Pythium root rot was an insignificant disease before the advent of sand root-zones and ultra low mowing heights. The closer that turf is mowed, the more frequently it must be mowed, and every time turf is mowed, there are several direct, and negative, effects (8):

- root growth stops temporarily
- reduced carbohydrate production & storage
- wound sites for disease-causing organisms
- temporary water loss from cut ends
- reduced water absorption by roots

In addition to this temporary stress, the soil temperature extremes are greater at low heights of cut than higher heights of cut. Excessive mowing frequency also has the effect of decreasing shoot and root growth, decreasing chlorophyll content and decreasing the recuperative potential of turf (2). All this contributes to a situation where there is little room for major stress.

Traffic causes wear of the turf as well as soil compaction. Small green size is one factor commonly associated with development of Pythium root rot. Soil compaction increases plant stress by limiting the movement of air and water into the root zone. Under these conditions, rooting and shoot density declines.

One can see that many stresses have a role in the development of Pythium root rot. Some, such as nutrient management, thatch management, shade and irrigation can be influenced more easily than factors such as high traffic, low mowing heights, compaction and damage from sharp sand particles. It is sound management to promote healthy turf roots as the best insurance in preventing Pythium root rot. Once the disease occurs, it can be a long road to recovery.

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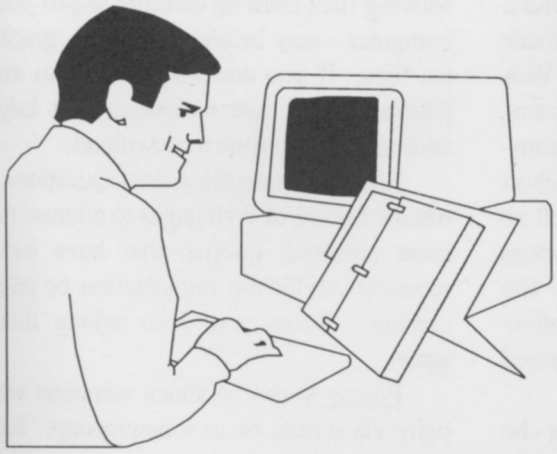
Caught in the Web - Using the Internet

By F.B. Holl, Ph.D., Pacific Turfgrass Research Program, Department of Plant Science, University of British Columbia

Seldom a day goes by that the popular media doesn't include an article relating the benefits (and necessities) of being linked to the Internet. Major businesses and institutions have established "Web Sites" and increasingly, information is being transmitted and business is being conducted over the Internet. A significant number of readers of this article may already be linked to this global network via computers at work and/or at home. For many others, the Internet remains a black box (or a black hole), clouded in mystery and confounded by the jargon related to its use. For those who have ventured onto the Web - the experience may have varied from enlightenment to total frustration. In 1997, the volume of useful information available remains a minuscule fraction of the total volume of material available. The purpose of this article is to provide complete neophytes with an introduction to the jargon and use of the Internet; for more experienced surfers, I have included some useful or interesting sites to travel to for information related to turfgrass management.



WHAT IS THE INTERNET AND HOW DO I GET ON IT?

The Internet is a network of different intercommunicating computer systems funded by governments and commercial organizations and linking more than 40 countries around the globe. That network may be accessed in a variety of ways - probably the one we hear about most is the World Wide Web (WWW or W3), also known simply as the Web. The Web arranges information in documents with connections (hyperlinks) between them. These links facilitate rapid movement between related documents. The popularity of the Web began to grow with the introduction of graphical Web browsers - these made moving around the Web much easier (just point and click) and provided a much more attractive appearance than older text-only systems.

WHAT CAN I DO ON THE INTERNET?

Of the many uses which may be made of these global computer linkages, the most common activities include:

Electronic Mail (E-mail) - a method of communication between individuals or groups (the latter route used collective "mailing lists" where all members of the group receive all communications)

File Transfer Protocols (FTP) - used to download files from other sites to your computer

Search Functions - used to search the Internet for information, contacts and databases

Discussion groups/bulletin boards - groups with more or less targeted subject matter which allow general discussion and interchange. These groups may be mediated, allowing for some control of what is acceptable and what is not. (Internet protocol may be the subject of a future article).

HOW DO I CONNECT?

For most of us, access to the Internet will be via a "dial-up connection" through a modem and telephone line. If you are looking at the purchase of a modem, buy the "fastest" model available for your computer - no matter what the capability, there will always be some days when it seems unreasonably slow! A number of improvements in connections technology will occur in the next 5 years' in the meantime, a good, fast modem represents the most cost-effective connection for the majority of users

Sympatico, etc. - but a look through your local yellow pages directory will reflect the increasing choices available - in B. C. there are almost 10 pages of Internet services and service providers. A note of caution - ask lots of questions. If you are looking to sign up with a service provider, be sure to check on the service and rates provided, how long they have been in business, whether they supply technical support, and whether Internet access is via a local phone connection (historically, some providers' access involved long distance calls whose charges were on top of any direct connections fees). Many services supply a certain number of free connect hours per month - consider carefully whether the rate structure provides adequate access at the lowest cost. Ask people you know if they have any experience with a particular service provider.

I'M CONNECTED: NOW WHAT?

The value of the Internet and the Web is most obvious if you are using a multimedia browser - this is a software package which facilitates moving around the Web and displays formatted documents, graphics, video and sound. Currently, the major market share in the network browser league is held by Netscape Corporation. Strong competition was recently launched by the introduction of the Microsoft Corporation browser called Internet Explorer. A review of these two products can be found in the *NetGuide* magazine site at http://www.netguidemag.com I can hear the groans - more software! more money! This is one time when the industry seems responsive to a need. Both the Microsoft and Netscape browsers are available by downloading from the Internet itself at no cost except for connection time. A browser makes moving around the Web both easier and more attractive as it takes advantage of the technology to display images and sound. More information about these browsers can be obtained from service providers and from the company Internet sites listed in the addresses at the end of the article.

SURFING THE WEB

For those with unlimited time, dedicated telephone lines and a large resource of patience, surfing the Web via your browser can be a fascinating experience. Most Web browsers provide one or more search utilities (search engines) which can be used to track information on very general subjects, or to look for very specific topics. To avoid too much grief and to use your time efficiently some care should be taken in setting up the terms for a search, For example - the term *turf* will produce numerous "hits". Unfortunately, many of these will not be what either you of your employer may have in mind - they will include a significant selection of information on horse racing, an international physics/math game with this title and numerous personal and business pages that describe someone's personal or corporate "turf". The same search using *turfgrass* as the descriptor will turn up a more useful selection of possibilities (though by no means without some junk).

One other hint learned from painful experience; if you are using a Web browser and find a good site, use the browser's bookmark tool to add this to your list of sites. Web addresses (URL'S) are notoriously complicated (as you will see from the examples) and using the bookmark function saves keeping a separate list, as well as reducing the need to type in the entire address each time. Clicking on the bookmark with your mouse will allow you to go straight through to the desired location.

One additional word of warning - be virus wise. As you become more familiar with being on-line, there will be times when you want to download information from distant places (not just a matter of printing out what you are looking at). Downloading allows you to store the material on your own computer, but it also opens up the opportunity to import viruses to your system. Purchase a good virus protection program and keep it updated, especially if you download a lot or borrow disks from friends. The best programs in my mind) are those that are loaded into your system so that automatic virus checks are carried out.

One of the daunting aspects of computer use is the associated jargon - just remember that many computer junkies probably don't know a topdresser from a triplex mower. Here are a few examples of common terminology and their meaning:

Bookmarks: A feature of browsers that allow you to save the text strings(addresses) of sites of interest. Save the ones you want and you will save a lot of time typing.

Browsers: The software programs that provide a graphical interface to surf the Web pages.

Download: Moving files from an external site to your computer - may be text, programs, graphics files. If you are using a modem and telephone line, just remember that large files take a long time to download.

FAQ's: Frequently Asked Questions - often a feature of Web pages to address the most common queries that have been received about the organization or page content. Saves you from asking them again.

Flame: Verb - to attack someone verbally via e-mail or in a newsgroup. Not

good etiquette. A special note: upper case (capitals) are easier to read for some people. SENDING MESSAGES IN CAPITALS IS THE EQUIVALENT OF SHOUTING AT SOMEONE! It is quite amazing the effect that this unintentional slip may have on the recipient. Avoid - unless you intend to yell (flame).

Home Page: The introductory page of a Web site. It usually had hyperlinks to other pages and/or other sites.

Hyperlink: The connector that facilitates moving from one page or one site to another. Usually indicated by highlighting text or graphics. Just point and click to move to the new link.

URL: Uniform Resource Locator. An address for a Web site which allows the browser to access the particular pages on the Web. Several URL's are shown in the list below.

For those of you who are already on the net - or nearly there, the following are some useful addresses to look for (and at):

http://home.netscape.com Netscape Corporation home page with information on downloading the Netscape Navigator Web browser, net directories and a variety of search engines.

http://msn.com Microsoft Corporation home page.

http://www.gcsaa.org/gcsaa - Golf Course Superintendents Association of America home page - various resources, some accessible to the public - others for members only.

http://www.usga.org - United States Golf Association providing a variety of information resources about the USGA, its activities, research and development and the Audubon Program.

http://www.turfnet.com - TurfNet

This is a small sample to start some of you looking. The Pacific Turfgrass Program will have its own home page up and running in 1997. We hope to provide a forum for some discussion of northwest turf problems, ideas and suggestions. I am also on the lookout for sites that address some of the non-golf turf questions that sports turf managers have to solve. In the meantime, "keep on surfing".

Associate in Research Selected for WSU/OSU T.U.R.F. Position

After a very competitive search, Mr. Paul Backman was recently selected as the candidate to fill the three year Associate in Research position that will be funded by the T.U.R.F. (Turfgrass University Research Fund) monies provided by the Washington State Golf Association and the Northwest Turfgrass Association. Paul is from Olympia, Washington, and is an Oregon State University graduate currently finishing his Masters degree at the Pennsylvania State University with Drs. Peter Landschoot and David Huff. Paul's previous work experience includes assistant superintendent at Everett Golf and Country Club and crew member at both Overlake Golf & Country Club and Indian Summer Golf & Country Club. He will finish his degree in July and begin his position at WSU-Puyallup in August. We look forward to adding Paul to our turf team. Join us in welcoming Paul back to the Pacific Northwest.

JB Comments:

A comment that one hears from some turf managers involves criticism of high-sand root zone mixes and that native soils are better. The latter may be as good under low to minimal traffic conditions if a loamy sand to a sandy loam soil is available. However, under high traffic situations, high-sand root zones of the proper particle size distribution are the only alternative to successfully maintaining turfs on a continuing basis.

The difficulty these frustrated individuals are having is probably a failure to achieve a living soil balance in terms of beneficial soil micro-flora and fauna, especially the fungi, bacteria and other microorganisms that permeate a living soil. The key substrate that supports these organisms is a continuing supply of organic matter which occurs primarily from the grass roots. If one fails to achieve an adequate rooting depth over time, then the lack of a food substrate will not allow the development of a balanced living soil profile ecosystem. The result will be increased use of fertilizer and pesticides. In the case of the latter, the lack of beneficial organisms that are antagonistic against the pathogenic fungi, nematodes, and insects dictates an increased use of pesticides. To repeat, one of the keys in developing a living soil ecosystem involves cultural practices that ensure the development of a deep, dense root system and resultant organic matter food source.

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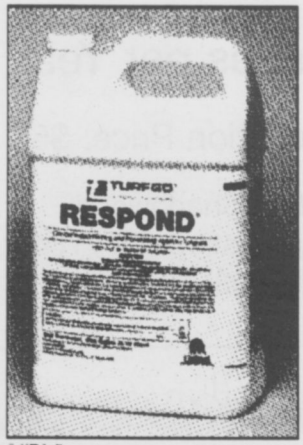

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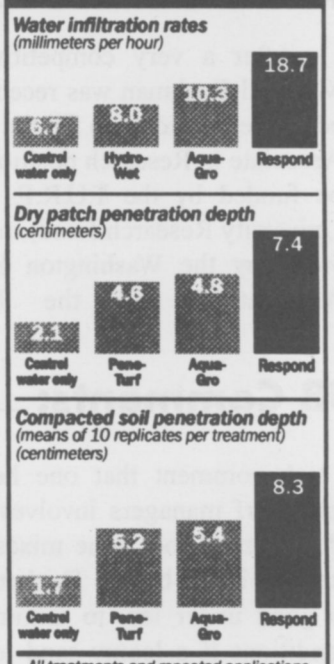

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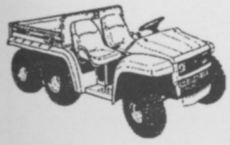

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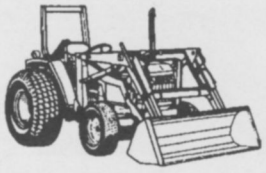

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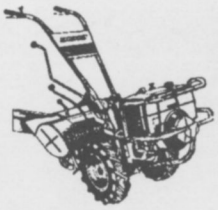

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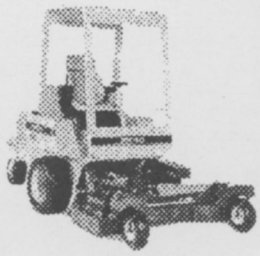

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