Proceedings

of the

Thirty-first Annual Texas Turfgrass Conference

TEXAS A&M UNIVERSITY

and

THE TEXAS TURFGRASS ASSOCIATION

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P R E F A C E

The 31st annual Texas Turfgrass Conference sponsored by the Texas Agricultural Extension Service in cooperation with the Texas Turfgrass Association was a success as measured by an attendance of over 500 people. A new session for this Conference - Parks and Grounds Maintenance - contributed to this success. Workshops, exhibits and other educational programs provided opportunities for everyone to select a session of interest to them.

These Proceedings were produced thanks to the many speakers who took the time to prepare a written paper. We are indebted to each of these authors for their contribution to these Proceedings.

Special appreciation is also extended to Barbara Stipanovic for her assistance with the Conference program and with the production of these Proceedings.

Richard L. Duble
Program Chairman

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WELCOME

by

Dr. R. C. Potts*
Associate Dean, College of Agriculture
Texas A&M University

About thirty years ago on such a morning as this in January, some 200 people met in a little auditorium over at the YMCA on the campus of Texas A&M. That meeting was the beginning of the professional turf-grass association in Texas. I have been privileged to be associated with this organization through all these years, and it is a pleasure to know many of you here today. I have had the opportunity to watch the membership of the Texas Turfgrass Association grow. Those of you here today have taken responsible positions in the turfgrass industry throughout this state and the nation.

We are meeting on the campus of a grant Land-Grant University. Such universities are the envy of the world. Land-Grant universities were created more than 200 years ago for the purpose of educating the common people in the United States that normally could not afford an education in the then classical universities.

After the creation of the Land-Grant University by the National Congress in 1862, two other acts were passed, one establishing the Agricultural Experiment Station; the other the Agricultural Extension Service. Together these creations have developed into what is now known as the Land-Grant System.

In Texas the formal education is given on the campus of Texas A&M University. Research in areas related to agriculture, including turf, is conducted not only on this campus, but also at several locations throughout the State of Texas. In every county in Texas and in most counties in the nation, there is an agricultural agent whose responsibility it is to take research information to the producer and consumer. With the three parts of the Land-Grant System, progress has been made in these United States that has benefited all peoples.

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A&M University has just celebrated its centennial birthday. If you have not had an opportunity to read A&M's history, I would suggest that you do so.

Periodically I have people tell me that the young people are "going to the dogs", and that young people are no good; that they won't work and are lazy. I don't believe this. Every generation has made such statements. We only need to look at our nation and see how much progress it has made in all areas in the last 100 years, and see how false these statements have been.

If one has the opportunity to travel in some of the countries in the world and compare the United States with these countries and see the freedoms that we have in the United States, one would appreciate what we have. In visiting among the members of this group here this morning, I hear you say that all our freedoms are being taken away from us by the Federal Government, and you will not be able to operate in the years ahead. Some of these statements may be partly true. On the other hand, you are part of the government because you are a citizen, therefore, it is up to you to do something about it. On a relative basis, we still have many freedoms: freedom of assembly, freedom of the press and freedom to worship God as we please and to do many other things that citizens of other countries cannot do. We have had problems in the past, and we will have problems in the future. From a professional standpoint, if you continue to attend conferences such as these, keep your eyes and ears open, be aggressive and take leadership to solve problems on a day to day basis, your lot will be better in the years ahead.

Now, I have the rare privilege of being associated with many of the fine young people that this state produces. They don't think like I do. I don't expect them to. They may not think like you do, but they're well trained. They've had a good education. They're dedicated people. They have their goals before them and they are seeking out new goals and opportunities. The students at Texas A&M and at many other universities have made great changes in the last few years. They have begun to listen to adults again; they don't tell us how to run the university as they did a few years ago. I've seen youngsters complete a full cycle in their attitudes in the last ten or fifteen years. Somewhere between running the university and listening to adults, there's a happy medium. The young people are going to accept responsibilities they encounter tomorrow with vigor.

We have today at Texas A&M University some 28,000 students. The enrollment in the College of Agriculture is 5,454, and that's about six times that of ten years ago. To teach these young people, we have on our payroll this fall over 300 faculty members.

Along with an increase in enrollment, we have maintained quality. Let me give you one or two statistics that may be of interest to you. Seventy percent of the young people who enroll at A&M are in the upper quarter of their graduating class. We have this fall in the College of Agriculture some 60 valedictorians and salutatorians. Now, I point these statistics out to you to talk about quality. But let me tell you this. Grades are not the thing that makes a young person successful. It is something that is immeasurable. At least I don't know how to measure it--maybe it's motivation or the ability to do a day's work and a little bit more, or the determination to stay at the job until it's done.

We have some of the finest facilities in the world to train young people. However, if you will give me good, dedicated students to go with our dedicated faculty, and allow these people a chance to interact over a period of time, in my opinion, you will have an educated person. You cannot measure that kind of education by the number or size of buildings; you cannot measure it by the number of laboratories or classrooms. You measure it by the degree of interaction among dedicated people seeking a common goal. We are going to make an effort at this university--actually it's your university--to continue to bring together the finest students and the finest faculty.

Now, let me speak a little bit about your organization and the turf program in this state. I have had an opportunity to watch the turf program grow. At the present time there are four individuals working almost entirely in the field of turf in Texas: Dick Duble and Jim McAfee, Jim Beard and Wallace Menn. This is ten times more than you had 30 years ago. Under the leadership of these people, and through your support, Texas A&M's program will continue to grow and develop in the field of turf in the broadest sense of the word. I assure you that from the standpoint of research and education, this university will do its best to serve you as consumers of the information we develop here. You won't be spoonfed. You've got to seek it; you must apply it to your individual operation, if you are to use it to the fullest. With people like Dick Duble and Jim McAfee and others, as research is developed throughout the south or throughout the country, you'll know about it. As we move to another year and maybe another decade, it looks bright to me even though you do have problems. Don't give up, keep working, accept the challenge, and I assure you that Texas A&M University is behind you.

TURF, LANDSCAPE AND PEOPLE

by

Philip Huey*
Assiatant Director
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In the informational section in the front of our program it states that the Conference is open to anyone interested in turfgrass management. It is oriented toward the professional in the turfgrass industry, and it states that this includes landscape contractors, professional lawn and grounds maintenance personnel, golf course superintendents, park and cemetery maintenance personnel, commercial lawn maintenance personnel and, I might add, manufacturers and distributors of turfgrass products and supplies.

All of us are involved individually and collectively in producing a commodity or product for people and that product is turfgrass, good turfgrass. This turfgrass must be attractive enought, appealing enough, inviting enough to encourage people to use it and to enjoy it. Certainly, then our goal is good turfgrass as individuals and as an organization.

But our end product may not be just that good turfgrass. It very well could be what people say about our industry. How people react to what we do. Saying things, perhaps, such as how great that golf course is to play, what a good soccer field that is, if it is. What a pretty landscape that is including flowers, shrubs and turfgrass; or what a well maintained median that is dividing the boulevard or thoroughfare.

So it may not be what we say about ourselves or our product, but what our customers, the people, say about our product, turfgrass. But, we, too, say some things about ourselves. I think all of us are guilty as professionals of saying "how great that lawn or green or park or field looks at this particular time". But then we get very upset and discouraged when it's used, as we planned it to be, and its appearance begins to deteriorate. I think we take the

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attitude, sometimes, that it's often just for our pleasure and accomplishment to see how good that turfgrass can look. But isn't rejuvenation of turfgrass also one of our talents? That's one of the reasons we are needed as professional turfgrass managers. And that's one reason we're here at this meeting - to learn more about maintenance and renovation of lawns, parks, athletic fields, golf courses and other turfgrass facilities.

Well, just how important is turf? We can say it's a multi-million dollar industry, but a lot of industries can say that. Just what is its importance? What is its real place in our lives as we relate it, turfgrass, our product, to people? What is the relationship of turf to people and how do we fit as professionals in that relationship? What are we as professionals doing to make this a good and attractive relationship? How do we combine all our talents and all our facilities to create a product or a setting or a service that invites people in, that says "here it is for you to use". Well, I'm not going to answer all of those questions and those aren't near all of the questions we could ask about ourselves and about our profession. I won't answer these specifically nor do I believe they can be fully answered at any one time. Also, no one can answer these questions for us. We have to answer them for ourselves. But I believe we are here to work on this sort of thing among other things. And because I believe that, for the next few moments, I want to work on it through the use of some pictures to show what we are and how our product, turfgrass, relates to people and landscape.

A beautiful landscape setting can be inviting as well as inspirational such as this entrance to a golf course. Golf has long set the standard for all of us in high quality maintenance. Golf superintendnets have shown the way in high quality turf maintenance and shown those of us in other areas how to achieve that goal. When I see a scene like this, I wonder if Eleanor Farjeon in 1931 when she wrote "Morning has Broken" might have seen a scene like this when she penned these words:

"Sweet the rains new fall
Sunlight from heaven
Like the first dewfall
On the first grass".

Let's not sell ourselves short. We are involved in more than planting and mowing grass.

One of the things we're involved in more than that is creating good athletic fields. Athletic fields that will invite people in to play, that are safe to play on and that are attractive to fans.

We are involved in far more than producing a turf and getting those kids or adults or whoever out there, on it. We can be and we are involved in helping those kids learn a new sport, to learn to be a better person and to learn competition. But as we're doing that, we may end up like this, too, with a worn-out situation that I was referring to earlier. This calls on our talent to rejuvenate the field. And if you have two soccer seasons and you play on a field like this, that will really call on your talents of rejuvenation. But if we can't do it, then who can?

And then there's the park responsibility. A great park attracts many thousands of people, many millions of people through the years. Some very concentrated parks require year round care, as you know, and for a scene like this in the spring, it requires among other things, overseeding.

This kind of situation invites people in whether it's for a spring festival or just to walk among the plants. But I contend they come to a park to enjoy the color of the flowers as well as the color of the grass. At another season, this same park has had quite a bit of wear through the season. It's preparing for the great influx of people for a fair in the fall. Here is a proper relationship between turf and water and people. We found that no matter where we have water, people want to walk up to it and one of the best things to walk on is good turf.

Well, the grass is going to get worn out when crowds come to a park, or golf course or other turf area. But, again, isn't this what we ought to expect if we've done a good job with what we produce in attracting people?

Or we can handle it in another way. We can fence it to keep it green all through the busy period. Or, we can have this kind of situation where people can walk right up to it. But, you can see the concern here of having to rejuvenate the area. But it's been used; it's attracted people; and they've enjoyed the visit.

Turf is important in a quiet place. And a park is just such a place - a quiet place. In this oriental garden turf is the primary landscape feature. I think we need to remember that we can use turf to create an attitude and a mood and, I think, we can create quietness with it.

We can use turfgrass in noisy places, too. And, this boulevard is one of the noisiest places we'll find where turf can be effectively used. Are we insisting on the importance of turf and landscaping as a part of our street improvement program? That center strip of turf and landscaping can be just as important as the surfacing down the street. It ought to become just as much a part of that bond program or that sale as the street. We also need to consider what impact the turf has on an individual who travels this street to and from work. What do we do to that person by having an attractive median planted with crepe myrtle versus one that's concrete or not one at all. I think we have a more positive impact on him than we do if it wasn't planted.

On a downtown boulevard we recognize the importance of planting, but not with just flowers, because a good turf highlights that downtown planting.

When talking about a mood that we can create with turf, I'm convinced we can have a significant impact. Kennedy Plaza, that name or that sight in itself is going to create some kind of mood with most people, but I think that mood is enhanced and helped by the kind of maintenance the turf around the memorial receives. It looks like a golf green. People say it looks like that.

They say the same thing about the historic plaza just across the street from it which has the same kind of turf. The mood of respect that people show here is unlike any other area that we have, I believe. I think the appearance of the turf keeps people from cutting across the turf here. They respect it as much as they respect anything in the area. I think it's important to remember that we can, with proper turf and with good maintenance, create a mood.

What about turfgrass as a land sculpture? In some parks turf is the prime feature. Two undulating mounds of turf highly maintained and, although new, I believe that the same kind of respect will be shown to this particular planting that is shown the Kennedy Plaza.

I suppose this is the ultimate in what we would call grass sculpture. It's the use of grass laid over a metal sculpture. It's laid up and over the metal frames. I am very pleased to say that this is not part of the maintenance responsibility of the Dallas Park and Recreation Department. But, I commend the individual that was brave enough to do it because it does attract attention. I don't know how they mow it.

There is no other way to create the feeling of great open space with warmth as well as we can with turfgrass. I think that turf is the one material we have that can create great open space for us and retain the feeling of warmth.

Flowers are dramatic and important in all of our landscape planning, but unless we have turf in proper perspective I see no use in planting them. A former boss I had always said that "there's no point in planting flowers unless we also have good turf before we begin". And I fully agree with that. We must have the proper setting for the colorful plants.

In the winter, obviously, the most important landscape feature we have is the grass except for a few evergreens. And this points up the importance to me of green grass in a facility that gets use all year round. Perhaps color is the first thing you see in a landscape, but I think the color of the turf is just as exciting. And if you didn't see the turf first, surely you saw it second. I think the turf, as much as anything, invites people in to walk on this area and to enjoy this setting to its fullest. If the turf wasn't as good, I don't think people would come away with as good an impression of this area.

Well, we're back almost to where we began. This is a golf course out of play and for most of us who come to this Conference, this doesn't happen very often, but it can be looked upon as a negative thing when it does happen. But in talking about inspiration, I think this kind of thing can be inspirational to a lot of people. When I see a scene like this I wonder if it were something like this that Simon and Garfunkle were singing about when they sang: "Freshly fallen silent shroud of snow" in the song "I Am a Rock". Well, if you know that song, sometimes you think that we need to be a rock in our profession - in a lot of ways.

But we didn't assemble here today just to see pretty pictures of turfgrass. We came here with a chance to learn to be better turfgrass managers and better professionals. And whether it is a session that is listed in our program on groundcovers or tree care or weed control in bermudagrass turf or soil fertility and pH, there is something we can learn here. There is something we can take back with us - something we can use back home that's been provided for us here. That's what we came here for.

But one last question. What did we bring here? I hope we brought a desire to help this association; to be a help as it has helped us. I recently heard a person in a speech describing three groups of people that live in a city: those who live off the city, those who live in the city and those who live <u>for</u> the city. We can apply that to a lot of situations. We can apply it to a lot of organizations - <u>this</u> organization. We all must have a determination to help and work for the success of the Texas Turfgrass Association. It's our lifeblood as professionals in the turfgrass industry.

This association and this university cannot help us learn to be better professionals and/or better turf managers without our help, and that is what I hope we bring here - our help. To help as we are being helped. So now let's prepare ourselves for what we have the opportunity to learn for the next three days. Let's keep in mind we need to see our responsibilities as much more important and involved than just planting and mowing grass. And one of those other responsibilities is understanding the importance of properly blending, as only we can, turf and landscape and people.

PARKS AND GROUNDS SEMINAR

Athletic Fields

Lawns

Ornamentals

PRESCRIPTION ATHLETIC TURF

Purdue University's Patented Natural Grass System

by

Melvin J. Robey
Superintendent of Athletic Facilities

"God blew it when he gave us grass", is a statement attributed to one sportswriter at the conclusion of the first game played on the Tartan Turf at the University of Tennessee. From 1967 through 1974, over 200 high schools, colleges and professional teams installed synthetic turf, giving a vote of confidence to one man's opinion about the natural grass playing fields.

Today there is a movement under foot at Purdue University to show that God's choice of real grass for athletic fields just may have been the best answer after all.

Two Purdue agronomists, Melvin J. Robey and W. H. Daniel, became disenchanted with the synthetic turf early in it's development and set a course which would reverse this trend towards the use of "phony grass". In response to the challenge of the synthetic carpet becoming supreme in the sports world, they have developed a new, revolutionary natural grass playing surface called <u>P</u>rescription <u>A</u>thletic <u>T</u>urf (PAT for short). This innovative surface is said to have solved all the old ailments of the grass fields--muddy conditions, poor footing, thin grass cover, water standing on the field. After three seasons of use in Ross-Ade Stadium at Purdue, it appears the PAT field may be the answer to everyone's dream of the near perfect natural grass playing field.

Basically, PAT is a natural grass sod placed over a pure sand base. A plastic liner is placed 16 to 18 inches below the sand and turned up at the perimeter to form a basin holding the sand. A grid of special drainage pipes, all interconnected, are placed directly on top of the plastic liner, and are connected to two suction pumps located outside the playing area. Heating cables are placed 6 inches down into the sand and are used to keep the grass growing and the ground thawed in cold weather. This heating system works similar to that of an electric blanket, the heat can be turned on and off or regulated to meet the needs of the grass and the team.

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The pumps are the "heart" of the system and are capable of handling 25,000 gallons of water per hour or approximately one inch of rainfall. However, the pumps are only a back-up system to be used before or during a game. The natural drainage of the sand will handle the rainfall at any other time.

How does the price of the PAT system compare to the synthetic surfaces? The difference is astounding!

It should be pointed out when comparing PAT and artificial turf, the total price tag of an installation must be considered, not the cost per square foot. The reason for this is all the grass surface inside a stadium is usually removed when the synthetic rug is placed down on the floor. A PAT system needs only the field's playing surface replaced because the grass blends perfectly into the existing turf around it, thus a huge savings by reducing the square footage of the total installation.

With the price of everything skyrocketing, the artificial turf costs have gone out of sight, too. In 1968, a field could be installed for as little as $2.50 per square foot. Today, one square foot of Astro Turf costs $4.50 plus an additional $1.50 per square foot for excavating and the blacktop base.

At current prices, a stadium installation would run approximately $500,000. It has become increasingly difficult for athletic departments to justify an expenditure of this magnitude to the public, not to mention the trouble of raising such a sum.

A PAT field, with all the accessories, can be installed for between $2.50 to $3.00 per square foot or in the neighborhood of $150,000 to $180,000 for a football field. That's one third of the cost of an artificial turf installation.

Interest is building in the sports world. Very few people are really happy with the synthetic grass and what it has done to the game and players. The PAT system has arrived on the scene at an opportune time. Everyone is willing to give grass one more chance and the PAT system has risen to the challenge!

Presently, there are eleven schools or teams that have made the switch to PAT-Purdue, the Washington Redskins (RFK Stadium), the Denver Broncos (Mile High Stadium), the Miami Dolphins (Orange Bowl), Mississippi State University, Saginaw Valley (Michigan) College, Grand Valley (Michigan) College, Goshen (Indiana) High School, Evansville (Indiana) Reitz High School, Lansing (Michigan) High School and an intramural field at the University of Wisconsin (Milwaukee).

But the Orange Bowl trial may prove to be the main testing ground nationally for PAT.

Five years ago when Larry Csonka, then a Miami Dolphin, was asked what he thought of the artificial turf in the Orange Bowl, he said "they should bring in a jackhammer and rip the ____ stuff out." Earlier this year, Miami officials took his advice and bulldozed over $500,000 of plastic grass.

The Orange Bowl is the first stadium to rip out artificial turf in favor of PAT. The others are simply conversions from natural grass fields. The move by the Miami city officials is important. By changing, they admitted the artificial surface wasn't what it was once thought to be. The precedent for ripping out the phony grass has been set.

MAINTENANCE & RENOVATION OF ATHLETIC FIELDS

by

James A. McAfee*
Area Turfgrass Specialist
Renner, Texas

Athletic fields using turfgrass as a cover include football fields, baseball fields, soccer fields, polo and tennis courts. Intensity of management of these various fields will depend largely on how often the field is used. While use and economics will have a large influence on the maintenance level, all athletic fields need proper fertilization, mowing, watering and aeration in order to maintain a good playing surface.

Proper maintenance is essential in maintaining a dense turfgrass cover on athletic fields. This includes proper fertilization, watering, mowing, pest management and aeration. Of these essential maintenance practices, fertilization probably has the largest effect on quality of the turfgrass.

All fertilization programs should be based on the results of soil tests. These soil tests can be conducted by the state lab or by private commercial labs. Results of soil tests will show level of nutrients present in the soil as well as the soil pH. Soil reaction (pH) is a measure of the acidity or alkalinity of a soil. A pH of 7.0 is considered neutral, while anything below 7.0 is acid and anything above 7.0 is alkaline. Most turfgrass plants grow best at a slightly acid pH (6.5-) and as the soil pH deviates from this range, it becomes harder to maintain quality turfgrass. Lime can be used to raise the pH, while sulfur can be used to lower the pH to the proper level. NOTE: All applications of lime and/or sulphur should be based on the results of soil tests.

Turfgrass plants do best when fertilized at a N-P-K ratio of 3-1-2 or 4-1-2. Only soil tests can tell how much of these major nutrients are needed to supply the plants with the proper ratio. Apply a complete fertilizer (one containing nitrogen, phosphorus, and potassium) to the entire field in the spring and again in the fall at a rate

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to supply 1½-2.0 lbs. actual nitrogen per 1,000 square feet or 90-120 lbs. actual nitrogen to the entire field. During late spring and summer, apply nitrogen only at a rate to supply 1.0 lbs. actual nitrogen per 1,000 square feet or 55-60 lbs. per entire field. Apply at 3-4 week intervals. Total number of fertilizer applications will depend mainly on type of turf being used as well as amount of traffic on the field. Common bermudagrass needs about 4-5 lbs. nitrogen per 1,000 square feet (230-280 lbs. nitrogen to entire field) per growing season, while the hybrid bermudagrasses need around 6-7 lbs. nitrogen per 1,000 square feet (340-400 lbs. nitrogen for the entire field) per growing season. Make all fertilizer applications when field is dry and then water the field thoroughly.

Proper mowing is another essential maintenance practice for maintaining a good, dense turf. Turfgrass on athletic fields should be mowed often enough so that you never remove more than ¼ of the leaf material. This usually requires about 2 mowings per week during the growing season. Common bermudagrass should be cut at a height of 1-1½" while the hybrid bermudagrasses should be cut at a height of 0.5-1.0". A reel type mower with 5-6 blades per reel is best for mowing bermudagrass. It is especially important that football fields be kept mowed during the spring and summer months. This helps to force the bermudagrass to spread and cover thin or bare areas in the field.

A third important maintenance practice is irrigation. Proper application of water coupled with aeration and proper fertilization develops deep-rooted turf that is wear-resistant, resilient, and not easily torn by the players' cleats. Excessive water as well as too frequent application leads to soil compaction which produces a shallow root system. Water should be applied only when plants show signs of needing water, i.e., wilting, and then enough water should be applied to soak the field to a depth of 5-6 inches. Do not apply the water to run-off. If run-off occurs, turn off the sprinkler and allow the water to percolate downward and then apply additional water.

A major problem with all athletic fields is soil compaction. Athletic fields should be aerified at least twice a year; at the end of the playing season and again in early spring. Use a hollow-tine aerating machine and go over the field at least twice lengthwise and once crosswise. Aerify to a depth of 4-5" for maximum effect. Tines will penetrate a moist soil much easier than a soil that is dry.

Aeration helps to alleviate soil compaction and thus permit a free interchange of gases, particularly oxygen and carbon dioxide, between the soil and the atmosphere. Aeration likewise permits placement of phosphorus and potassium in the zone of root growth, thus aiding in the development of deep root systems.

Weeds often invade the thin or bare areas in athletic fields. Unless these weeds are removed, they will prevent the turfgrass from filling in and forming a dense turfgrass cover. It should be noted that the best means of effective weed control is a vigorous, healthy turf. Broadleaf weeds can be controlled with 2,4-D, MCPP, dicamba or other post emergence herbicides. Annual or perennial grasses such as crabgrass or dallisgrass can be controlled with the methylarsonates, such as DSMA or MSMA. Annual grasses can also be controlled with one of several pre-emergence herbicides, such as benefin or DCPA. Remember, always check the label for proper use and rates.

Due to the heavy amount of traffic on athletic fields, most of them develop a thin, weak or bare cover of turfgrass after a few playing seasons. Once these thin areas develop on the field, the necessary steps for proper renovation should be conducted to help re-establish a dense, healthy turfgrass cover. First, it should be determined whether renovation will completely solve the problem or if complete re-establishment of the field is necessary.

Renovation of an athletic field usually involves the removal of all unnecessary plants (weeds), aerification and topdressing, better drainage of the field, and the replanting of certain parts of the field.

Good drainage, both surface and internal, is essential for maintaining turfgrass on an athletic field. Soil compaction occurs much faster on wet soils. To provide good drainage, the field should have a 12-18" crown in the center with smooth slopes toward the sidelines. On heavy soils, it may be necessary to tile drain the fields to help the downward movement of water from the playing surface. Some means should be provided for movement of water from the sidelines.

Once the field is properly prepared, seed, sprig or sod into the bare thin spots. Apply fertilizer every 10-14 days and keep moist until newly planted grass starts to spread. Once grass reaches 2" in height, start mowing at about 1½" and then gradually lower the height of cut until the grass is at 3/4-1". As newly planted grass matures, decrease the frequency of watering and increase the amount of water per application. Apply nitrogen every 3-4 weeks until the playing season starts.

COMMERCIAL LAWN SERVICES

by

Robert W. Miller*
ChemLawn Corporation

Lawn service companies as they now exist are relatively new and are just beginning to find their place in the turfgrass industry. Although lawn care companies in some form may have existed for many years, it is safe to say that they did not become prominent until pesticides became a major factor in agriculture. Early lawn services were largely an extension of other horticultural activities and it has only been in the last ten years that lawn care companies have operated on a regional or national scale.

Lawn Services Today

There are several types of lawn care companies now in operation. Perhaps the most numerous type is mowing and grooming which may be operated either by students and others on a part-time basis, or by full-time commercial companies that may offer other services in addition to mowing. Mowing services are mostly local and small, however, the total expenditure for this type of service is undoubtedly large.

In some areas of the country, lawn service companies specialize in pest control. Many times these operations are a part of structural pest control services or other related businesses. These services are prominent in Florida and other locations where chinch bugs or other insects are especially troublesome.

Several regional and national companies sell franchises to someone to operate a lawn service business in one location. The parent company usually helps in establishing accounting and operating procedures and may sell chemicals to the franchise. However, a recent court decision ruled that a franchise had the right to purchase materials on the open market and is not obligated to purchase from the parent company.

Franchise operators offer a wide range of services. Most of them apply fertilizers and various pesticides. Some of them overseed, spike, aerify and do other operations. Many times, special equipment that does several operations at one time is included in the franchise cost. In

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most instances, an individual franchise remains small because of boundary restrictions that are a part of the franchise agreement.

Another type of lawn care service is operated by the owner on a local level. This type of company may be small to medium in size, and may service from a few hundred to ten thousand or more customers. These companies offer a wide range of services depending on the individual operation. Mowing, landscape maintenance and other services may be included in a base price or may be offered as optional services at additional cost. Local lawn service companies operated in many different ways and it is impossible to place them into a common category.

In the last ten years, some lawn care companies operate in several cities on a regional or national level. Each branch is company-owned and is operated by company employees. Some of these companies utilize part-time employees, others do not.

The type of service offered by the regional or national companies varies almost as much as service options of local firms. Most of them, however, apply fertilizer, herbicides and insecticides according to the needs of local conditions. A few companies apply fungicides on a programmed basis but most do not unless there are unusual disease problems.

Some companies offer the complete package at an annual cost. Others charge separately for each component of the program.

The amount and kind of fertilizer and other chemicals used differ among companies. Some use soluble and water insoluble nitrogen sources, while others use only soluble materials. Phosphorus and potassium may or may not be included in all applications. Lime, where needed, is applied by some companies, others either ignore it or use one of the so-called "liquid lime substitutes". Some companies include "soil conditions" in their programs. These may be anything from potassium carbonate to any one of several liquid materials on the market.

Contracts and Pricing

Lawn service companies may either require an annual contract with or without prepayment or they may operate without contracts and charge only after applications are made. Cost of services vary several hundred percent among companies. Cost for chemical applications to an 8,000 square foot lawn vary from as little as $85 to as much as $300 for 4 to 6 scheduled annual treatments. Some lawn care companies make service calls and apply supplementary applications at no additional cost to their customers, others offer limited service without additional charges, and some charge for all service calls.

Lawn Care as a Service

The most important item that any lawn care company has to sell is service. Homeowners are not particularly interested in what products are applied to their lawns. They are interested in a nice-appearing lawn, free from weeds and other problems. They expect the company to quickly respond to service calls and they expect prompt corrective action if they have problems. Many of their questions are related to trees, shrubs and other landscape plantings. Customers want qualified people with professional equipment to make applications and they expect the treatment to be made with care - care for both the lawn and for surrounding plants and properties. Service is the name of the business.

Observations about Lawn Services

Two points are obvious from the previous discussion. First, the lawn service industry is unorganized and there is little chance that it will be organized in the near future. Secondly, there is no standard of quality for the industry and it is unlikely that standards could be agreed on and even less possibility that they could be put into effect. State and Federal requirements for pesticide operators' license and label restrictions for the use of pesticide have made it more difficult for marginal operations, and some states require that the invoice must state the amount of fertilizer applied to a lawn. Other than these, the only standards are those set by leaders in the industry. An individual selecting a lawn care company should have a clear understanding of the services offered by the company, the materials that will be applied to the lawn, and the reputation of the company in question.

MAINTENANCE OF ST. AUGUSTINEGRASS

by

Ken Krenek*
Corpus Christi Parks Department

Stenotaphrum secondatum, or St. Augustinegrass, is a coarse sun-loving grass that is also shade tolerant. It grows on a variety of soils, and although it is a warm season grass, it is increasingly tolerant of low temperatures. Because of these tolerances, it has become a very popular lawn grass. It generally produces an acceptable turf with a minimum amount of care and some turf areas do well with only watering and mowing. So much for somebody else's grass; let's talk about yours and mine.

The factors with which we are working in the management of St. Augustinegrass are basically watering, mowing, fertilizing and insect and disease control. There are others, but most of the time is spent on these four.

St. Augustinegrass is watered heavily, it is watered lightly, and many times it is watered unevenly, making diagnosis of turf problems even more difficult. Overwatering increases weed growth and leaches nutrients in a well-drained soil. Frequent light watering encourages shallow root growth, which is undesirable. Frequent heavy watering disrupts the soil-air-water ratio and produces poor quality turf. Infrequent heavy watering encourages good, deep, root growth and is the preferred procedure.

A sharp reel mower is the best mower to use on St. Augustinegrass. Rotary mowers are sometimes necessary where tall weed growth cannot be cut properly. If you need a rotary mower for this reason, then you are maintaining less than top quality turf. Mowing heights and frequency can directly affect the quality of the turf. Frequent mowing at any height is probably the best practice. Infrequent mowing to a short height is probably the worst. Somewhere in between lies the broad spectrum of practically all mowing operations.

A taller cut will generally increase turf vigor, but too high a cut will increase thatch buildup. A good mowing height for St. Augustinegrass is 1½". If a shorter height is maintained, the frequency of mowing needs to be increased and careful attention paid to watering and feeding practices. A greater height can reduce attention to watering and fertilization but the resultant turf is more susceptible to thatch and the surface of the turf does not present the compact,

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smooth appearance associated with good quality turf. At any rate, sufficient leaf area must be left for regrowth and for shade for the grass and the ground itself.

Fertilization on St. Augustinegrass is as important as on any other turf grass. While there is some intermittant growth in the winter, the primary growth period will occur from February to December in South Texas with a month or so less in the areas to the north. An analysis of 10-5-5 with an organic base is a good fertilizer for St. Augustinegrass. A rate of one pound of nitrogen per 1,000 square feet per month is ideal. If fertilizer cannot be applied monthly, heavier applications can be made less frequently, but this also has a limit. Three months should be the maximum period for maintaining the one pound continuity. Longer intervals would require heavier applications which not only tend to burn the grass, but the nutrients that can not be utilized by the grass within a certain period of time are lost when they become locked up in unavailable compounds in the soil.

Insects and diseases are not strangers to St. Augustinegrass. The two insects that probably present the biggest problem are the white grub and the chinch bug. Diazinon is effective against both, to a degree. Chlordane is still effective against some of the grubs, and Ethion and Aspon are also effective against the chinch bug.

Brown patch is probably the most common disease affecting St. Augustinegrass. This fungus has an easily recognized circular pattern, and once established may persist from year to year. Terraclor and Tersan are effective in some areas while Captan still remains effective in others. Don't be afraid to try some old remedies. Where they may not be effective for someone else, they may work for you.

St. Augustine Decline (SAD), a virus, has been affecting St. Augustinegrass for about 10 years. There is no cure for it, but its effects are not serious enough for worry. A good turf management program will successfully offset the effects of SAD on the common varieties of St. Augustinegrass. Resistant strains have been introduced, but they are limited in their suitability under all conditions.

In summary, St. Augustinegrass is a grass that is not without its drawbacks, but a conscientiously applied program of turf care can produce an excellent turf that is both attractive and functional.

LAWN IRRIGATION

by

Herman R. Johnson*
Landscape Contractor

This talk is Lawn Irrigation, which could include any size area from a small home to a large park area, so I have based this on an average residential home system. Much of the material you hear at this conference and in this talk will not be new, but most of us learn by repetition, so don't ever be guilty of saying, "I heard all of that before." You're just beginning to learn.

Lawn irrigation is one of the most expensive types of irrigation in existance. Can you imagine a farmer or any other turf manager paying as much as 35¢ per square foot to apply water to produce a crop or irrigate grass? At this price the average golf course system would cost over 1¼ million dollars. Can you imagine that until only 2 years ago many of the individuals designing these ultra expensive systems had the home owner at their mercy? Now, a rigid examination and a current state license is required of anyone designing, installing or servicing a sprinkler system, which helps protect the homeowner.

If I have painted an expensive picture for a sprinkler system, just think of $1.50 per square foot for landscaping or $40.00 per square foot for a house, and in reality the cost of a lawn sprinkler system is cheap insurance to produce a healthy and beautiful lawn and shrubs. As you all know the surroundings of a home can enhance its value several times more than the cost of an underground home sprinkler system. At this point I would like to answer some of the many questions associated with home sprinkler systems.

1. How much do they cost? A manual full-coverage system usually costs from 10¢ to 25¢ per square foot. Automatic systems generally cost approximately 35% more. In Corpus Christi the average home system, automatic, will cost $1,750.00, manual, $1,250.00.

2. How long does it take to install? Most installers use a 2 or 3 man crew and require about 3 to 4 days to complete the installation.

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3. How do I know the system will work and not have dry spots? Most good installers will give you a one year warranty and within a year, surely you could determine if there are dry spots, or if the system operated properly.

4. What brand system should I have installed? Any of the brands that have been around for several years are generally satisfactory. Don't be a test station for something just on the market. Due to water conditions and soil conditions around the state, some systems suit an area better than others, but just ask around and you will determine the most commonly used.

5. Which is better, brass or plastic? Unless you are interested in buying a sprinkler system by the pound, one type can produce just as good a result and have just as long a life as the other. There are several advantages that can be a result of either system. The brass equipment is more rigid, can be ground and retain better precision, yet is generally more expensive and under sandy or corrosive conditions, has a short life. The plastics such as cycolac is less expensive, will cause less damage to maintenance equipment, yet rigidity as well as expansion and contraction is a problem.

6. Some say an electrically controlled system is better than one controlled hydraulically. This statement is generally made by installers, based on what their crews are trained to install. As with the controversy of brass and plastic, the same is true with electric and hydraulic systems. The electrical wires may be easier to install than control tubes, but shorts and breaks are more difficult to find than breaks in hydraulic tubes. Wire is more expensive than tubes. If tubes are not properly installed, freezing temperatures are sometimes a problem. Dirty water causes less problems with hydraulic systems. As you can see, there are advantages and disadvantages, whichever type is used. The key lies in how well it is installed.

7. What type pipe should I use? I know of no installers in the state that use any type pipe regularly other than plastic. Most all use P.V.C. P.V.C. pipe is cheap to install, has little friction loss, can be repaired easily, will last indefinitely and if installed properly, will be maintenance free for many years. Some installers will try to use a cheaper polyethlene pipe. The poly pipe will function well, but has more disadvantages than advantages. Some of the disadvantages are that clamps are used at connections, friction is greater, underground rodents will destroy and above ground risers are too flexable. About the only two advantages are that it comes in longer rolls than 20' lengths of P.V.C. and its cost is slightly less than P.V.C. Most city pressures range around the 50 PSI mark. Class 100 P.V.C. would be adequate to contain the pressure, but most quality installers use the Class 160 or 200 because its wall thickness is greater and much stronger. Much of the 1/2" or 3/4" pipe

may be as strong as Schedule 40 P.V.C. or Class 315. Other than Schedule 80 P.V.C. pipe all connections on home systems are glue connections. A glue connection is as strong as the pipe, if properly connected.

8. While we are talking pipe do I have to have all of those risers or pieces of pipe sticking up out of my flower beds? Until recently the answer was yes, but there are several so called high pop sprays on the market that can be hidden in the plantings and pop up only when operating. A good installer can hide most of those risers if the job cost does not prohibit his design.

9. How do I know where all of those pipes are if I decide to relandscape or add on to my house? A good installer will furnish you a completed and as installed plan of the system. He will retain the original tracing on file for future needs. You should keep your copy on file as you will need it more often than you might think.

10. If I have an automatic sprinkler system, can I add on automatic fertilize system? The answer is yes, but let me say that they have not proven very successful for most homeowners. This is due to water distribution, lack of technical knowledge of its best use by the homeowner and most feel there are better ways to fertilize.

11. Do I have to have all those big holes cut out around every sprinkler head? Absolutely not is the answer. Some brands of sprinklers depend upon a clear area around the head for free fall of the pop-up, but there are sprinkler heads available on the market that are designed for grass to grow tightly around them and have a strong spring to retract the pop-up. They can be almost invisible in the lawn.

12. I'm about to pour some new concrete and install some yard lights. Will this affect my sprinklers? Anytime you're pouring concrete, install a couple of 2" or larger pipes. Install in the most obvious place, because you never know when sprinkler changes may be desired. Always chart locations of underground lines or wire. It may save expensive repairs.

13. I can't afford all of the system now, what can I do? First have a system designed for the entire area making sure the designer knows what area you intend to have installed. He can design these add-on areas easily, but the important thing is to have a complete plan first.

14. Will a sprinkler system use more water? In some cases yes, but it could actually save water. An automatic system waters the amount of time you set on the dial, which should eliminate runoff if properly set. Automatic controllers don't come on and then start watching T.V. and forget to go off.

15. Will a lawn sprinkler system actually improve my lawn? In almost 100% of the cases the answer is yes. The reason is that if you spend enough to have a system, you will generally take more pride, doing more lawn work, resulting in a better lawn. Regular watering rather than the hit and miss method produces better turf. More even distribution, and more desirable time of application all add up, but don't get the idea it will grow grass. You must still mow, fertilize, weed and groom to obtain the results. A lawn sprinkler system is just another important aid.

We could go on for hours on do's and don'ts and still not answer all the questions, but maybe this will answer some of the major ones. The key is that anywhere you plan on growing quality plants, unless you have unlimited time yourself or can afford to hire the labor required for hand watering, then not just a sprinkler system, but an automatic sprinkler system is as necessary and valuable as the insurance you carry on your property.

Don't design it yourself and don't install it yourself, but engage some reliable firm and require that they give you what you pay for.

PLASTIC NETTING FOR SOD STRENGTHENING

by

Lewis Eberspacher*
North Texas State University

Wherever turf is used under heavy traffic conditions, such as on an athletic playing field, there almost always will be extensive damage to the root system along with removal of most of the rhizomes and thatch. Mostly what remains will be bare ground, which will require either time for new turf to develop from seeding or vegetative growth or considerable expense for sod to be introduced, especially over larger areas. This situation often occurs on portions of football, soccer and softball fields, and can cause a problem when the surface is used constantly throughout the year, with little opportunity to let the turf recover.

In seeking a possible solution to such a situation, some form of protection to the root system of turf (in this case, bermudagrass) to permit quick recovery was the goal. An analysis of exactly what was happening to the root zone showed that both football and soccer shoe cleats lifted out pieces of turf, roots included.

The turfgrass industry press began to report in 1973-74 on techniques of sod production using a plastic net to reduce growing time for turfgrasses. Investigations of this net suggested that turf could be made more wear resistant by incorporating it into the root zone. Accordingly, a net consisting of 1/4" x 1/4" ultraviolet inhibited plastic mesh called "Vexar" by DuPont was used in a test installation on a football practice field.

Actual installation consisted of cross cutting an existing common bermudagrass field with a rototiller at a 4" depth, smoothing the surface and shaping it exactly to grade and applying fertilizer and 1" of sterilized pine bark soil conditioner. Tifway 419 bermudagrass sprigs were broadcast by hand at 10 bushels per 1,000 square feet on the surface. Immediately after sprigging, Vexar netting in 10 foot wide wolls was applied to the surface with a 2" overlap on strips.

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The ends of the Vexar were buried in a 6" x 6" trench to hold it down. If soil surface is smooth, the net will not require any additional tieing down unless wind is a problem. This can be controlled by using #10 wire staples pressed into the surface as required. Irrigation was started immediately, and within six weeks of a June 1st, 1974 planting date, the ground was completely covered with runners which had grown through the net, leaving it barely visible and securely anchored.

Observations since installation have showed that turf was not torn out or severely damaged where protected by plastic netting, the 1/4" mesh size preventing root zone penetration by shoe cleats while at the same time not adversly affecting playing conditions. The turf therefore was able to recover quickly and replacing of turf in worn areas has been eliminated. Maintenance, including aerifying and mowing operations, was the same for the net reinforced areas as for untreated turf.

Conclusions to date include a modest investment of approximately $0.06 per square yard for the "Vexar" material to be worthwhile considering the protection provided. This cost could compare very favorably to any expenditures that relate to replacing even a portion of a playing surface, especially in situations where usage is constant.

EARTH SCARS

by

J. Alton Enloe*
University of Houston

Some people paint living pictures on the earth's surface like artists paint on canvas. They mar grounds temporarily as they make the transition from one ornamental changeout to another and even then, good gardeners can artistically cultivate bare ground. We have four crews (Lawn Care, Plant Care and Nursery Operations, Shrub Care and Tree Care) in our Grounds Department whose chief concern is aesthetics, so they are very careful about the way they scar the earth on our campus. There are other groups on campus (Plumbers, Electricians and Contractors) besides our own Auxiliary Services Crew who are more concerned about utility than aesthetics. Earth scars bother them very little. In the brief time available for discussion today, I would like to illustrate some of the scars that poor backfill create for grounds supervisors. Some solutions are obvious (when small volumes are involved) or where long-standing procedures have evolved because backfill failures are more than just nuisances (as in highway construction where they can be downright dangerous). The slides which depict backfill failures under concrete aprons around our campus buildings and under our streets and parking lots certainly deserve comparable, adequate base preparations. In the case of parking lot establishments where base preparation is a major construction cost and large areas are involved, a secondary precaution against backfill failures is establishment of proper crowning and drainage inlets that function even when backfills fail.

Cemetery and former solid waste disposal site managers undoubtedly face the most serious backfill failures because of inordinately long time factors involved in natural settling of their management sites. The grounds manager who inherits or builds the currently "in thing" recreational facility over such fillings should budget for irrigation and drainage pipe failures in such areas. Cemetery managers can use tamping devices such as the one in our slides taken in Houston and combine these tools with other management techniques to live with troublesome scars.

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The remaining slides I would like to present illustrate small "manageable" backfill problems that perennially scar the grounds of unwary landscape supervisors. The last two slides illustrate the magnitude of possible backfill failures even with homogeneous, "marriageable" soil mixtures like dry, pulverized material dug from and replaced in the same hole. Mounding, tamping or mixing with smaller, expensive void-filling materials like sand are the only ways to make these backfill problems "go away" and not persist for the normally accepted six month to one year aesthetic disturbance. Prevention of repeated backfill maintenance also includes protection of areas and vegetation surrounding the excavation site and includes adequate stocks of ornamentals needed to cover even proper backfills. Inspection and standardization of these procedures by aesthetically inclined parties and not holedigging, utility fixers is the only sure answer to minor but persistently nagging backfill scars that create a lot of work for groundskeepers all over this land.

FOLIAGE PLANTS

by

Neil Sperry*
Texas Agricultural Extension Service

Interest in interior landscaping has grown tremendously in recent years. The reasons? Many new and interesting foliage varieties have been introduced to the marketplace, and high quality plants of all sizes are readily available. There is also increasing awareness of the beauty plants can add to a living area.

Plant Selection

Like any other part of the interior decor, plants lend form, color and texture to their surroundings, and these factors should be considered before a plant is actually purchased. Plants indoors should complement not only one another but also room furnishings.

Plant sizes vary according to the variety and age of the plant. Since indoor conditions are seldom ideal for normal and vigorous plant growth, most gardeners would do well to select plants already grown to the size they desire, rather than trying to grow plants indoors. It is relatively easy to maintain a large plant indoors. It is most difficult to grow one.

Each plant variety has its own characteristic habit of growth. Some are upright, while others are spreading or vining. Each form has its usefulness in the home.

Green shades dominate the indoor plant scene, since green foliage is best able to cope with low-light conditions. Highly variegated plants and flowering plants often can be maintained indoors, but usually must be given the brightest site possible.

Plant texture is dependent on the size, shape and arrangement of leaves. Coarse-textured, large-leafed plants provide bold accents, while fine-textured foliage gives a softer effect.

Potting Plants

Many types of decorative containers are available for the indoor gardener. The container should accent the colors and beauty of the

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the plant itself, and should also be compatible with room decor. Gaudy, ornate pottery draws undue attention away from the plant.

Container size should be proportionate to the size of the plant. A container whose height or diameter is one-third to one-fourth the height or width of the plant usually will be adequate. Thus, a plant growing 3 to 4 feet tall or spreading 3 to 4 feet wide should have about a 12-inch pot.

Drainage holes are a must for proper plant maintenance, not only because they improve soil drainage, but also because they allow mineral accumulations to be washed out during waterings. If the container has no drainage hole, either drill a small hole carefully in the bottom or set another pot with a drainage hole down inside before planting. Double potting allows you to remove the inner pot during waterings.

Many types of commercially prepared potting soils are availabe. Potting soils usually are highly organic and have been sterilized to kill insects, diseases and weeds. Such potting soils may be costly to use in large quantities, but are usually the least expensive means of planting one or two plants.

For larger volume needs, potting soil can be prepared using two parts of peat moss or well rotted compost to one part of sand, perlite or vermiculite. Native soils should be avoided because of their great variability in texture, organic matter content and fertility, and because of potential insect, disease and weed problems.

Plant Care

Of all the environmental factors indoors, light is the hardest to modify. Spotlights or fluorescent tubes can be installed, but usually it is simpler to choose plants whose needs match existing conditions. Fortunately, most plants can be maintained well under the usual low-light interior conditions, provided they are kept a bit dry and are seldom fertilized.

More foliage plants die from overwatering than from all other causes combined. Soil should be allowed to become fairly dry before watering, even if it takes 10 or 15 days. Then the plant should be watered until water drips out the bottom of the container. Under low-light conditions it may be advisable to water this heavily only every fourth or fifth watering so the soil won't stay wet for prolonger periods.

Water, like soils, varies from area to area. Rainwater does not vary greatly and is reliably free of harmful chemicals and alkalinity. But collecting and storing rainwater may be a needless chore if tap water is free of high levels of dissolved mineral salts or if the soil is periodically leached by heavy watering.

It is usually best to water your plants from above. Sub-irrigating by setting pots in pans of water tends to saturate the soil air spaces and cause root deterioration.

Many indoor gardeners increase the humidity of their foliage plants' surroundings by setting plants on trays of moist pebbles or by misting them frequently. Actually, most plants tolerate interior humidity quite well provided their other growing needs are all met.

Many brands of specially prepared houseplant fertilizers are available in liquid, dry and pelletized forms. But fertilizers should be used infrequently under average lighting conditions. High nitrogen (first number of the analysis) fertilizers that encourage weak, spindly growth should be used with care. More balanced fertilizer analyses may be preferable.

Insects will likely present more problems than diseases or weeds. Mealy bugs, scales, spider mites, whiteflies and aphids may infest houseplants. Many general purpose insecticides such as malathion or diazinon can damage tender foliage plants. Always read the label before spraying, and if the plants are not listed on the label, try the chemical on a small plant or unnoticeable leaf before spraying or dusting the entire plant.

Several brands of leaf-shining chemicals are offered for sale. These are good for gardeners who want waxy, glossy foliage, but many prefer to use them at half strength for a more natural lustre.

Plants should be regularly washed, wiped or brushed to remove dust from the leaves. They can be sprayed in the tub under the shower, at the sink with the hose spray or (in warmer weather) under the lawn sprinkler. Or they can be dusted with a feather duster.

Preparing Plants the Move Indoors

Plants grown outdoors under bright light conditions will need proper conditioning before they can survive inside. Move them to gradually darker surroundings outside and begin withholding water. Condition the plants to get by with medium-dry soil. You can expect a certain amount of leaf droppage when plants are brought in. Follow the reverse pattern when taking plants back outside. Gradually condition them to brighter surroundings.

GROUND COVERS

by

William C. Welch*
Texas Agricultural Extension Service

Ground Covers - The term is usually associated with any plant or group of plants used to cover ground areas. Plants having a sprawling, creeping or prostrate habit of growth fit into this category very well, although more erect plants may also be utilized. Plants selected for ground covers seldom attain a height of more than two feet.

In addition to using plants as ground covers there is also considerable interest in using such non-living materials as gravel, rocks, bark, pine needles and pecan shells.

Why do we use ground covers?

Practical reasons

a. Effective for erosion control.

b. Reduce maintenance in problem areas such as on steep slopes, under low branched trees or shrubs where large roots may protrude, in confined areas where grass will not grow. Ground covers may also serve as a mulch, conserving moisture and reducing weed problems.

Aesthetic reasons

a. Provide variation in plant height, texture and color.

b. Give strong definition to ground patterns and are often the most significant unifying element in a total planting composition.

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Some Possibilities for Living Ground Covers

Shade or Partial Shade	Full Sun
Vinca (green or variegated)	Asiatic jasmine (Trachelospermum asiaticum)
Algerian Ivy	Monkey Grass
English Ivy	Creeping junipers
Monkey Grass	"Hen and Chickens"
Liriope (green or variegated)	Purple leaf Honeysuckle
Aspidistra	Liriope (green or variegated)
Holly Fern	Daylillies
Pachysandra	Santolina (green or gray)
Hosta	Hypericum
Ardesia (A. japonica)	Cotoneaster species
Violets	Sedum species
Ajuga	Lantana species
Hypericum	Dwarf Bamboo
	Cinquefoil (Potentilla)
	Rosemary
	Carolina jessamine

Initial Planting and Maintenance

Since ground cover plantings may cover relatively large areas, weed control may be a problem during the establishment period. It is suggested that a soil fumigant such as methyl bromide be applied prior to planting. Soil fumigants can be dangerous and strict adherence to label instructions should be followed. Several inches of a good mulch material such as wood shavings, cane pulp, bark, pine needles or leaves can significantly reduce weed growth as well as retain moisture in the planting area. Many ground cover plantings are relatively low in maintenance.

Spacing

It may be desirable with some ground covers to purchase small plants such as 2" pot size and space them closer together. Others are best started from gallon container or larger size specimens. For most species spacing of from one to two feet apart are optimum except for dwarf or low growing materials such as sedum, ajuga, liriope and monkey grass which are frequently planted on six inch spacings.

GOLF COURSE SEMINAR

Soils

Maintenance

-Bermudagrass

-Bentgrass

DRAINAGE

by

John Biddy*
Lakeside Country Club

As a golf course superintendent you are the one that can improve the drainage on your course better than anyone else, because you know the problems from a maintenance stand point. The best way to sell any project is on a small basis whether it be a few feet of drainage ditch, a cart path or one sand trap.

Drainage Surface:

No. 1. Survey the area that needs better drainage. You should have a minimum fall of 6 inches in 100 feet. If not, you will have to fill in (if possible) to obtain proper elevation.

No. 2. You should make drainage swales or ditches in the roughs or areas less used. Set your station stakes for main ditch, start from area needing drainage work. Start with the first station stake 0+00, the next station stake would be 0+25 and 100 feet would be 1+100. Under each station stake should be a blue top stake set a desired grade at a minimum fall of 6 inches in 100 feet. If other areas horizontal to the drainage ditch need work, you can make smaller swales to take care of those areas. On all swales or ditches try not to make straight lines. Contour to make a more natural look. The extra soil should be used for mounds and contour with swales. It costs a lot to haul off the extra soil.

Drainage around Cart Paths:

No. 1. One should survey areas where you are going to make a cart path. Find the areas that the water will be going over or under the cart path. In either swales or pipe set the grade one inch in 10 feet for fast water movement. I prefer swales-concrete swales for longer lasting.

No. 2. Around greens and tees special care should be taken. If you have to, move the cart path closer to green or tee, for better

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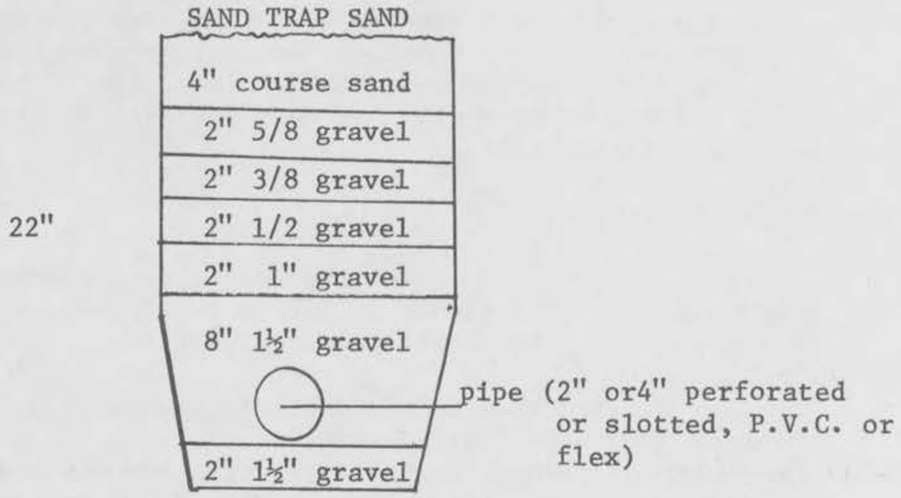
elevation to provide dryer areas around cart paths. You may have to raise cart path and blend with topsoil to green or tee.

Drainage around and in Sand Traps:

No. 1. For better internal trap drainage all sand trap bottoms should be built higher than existing elevations.

For a more effective internal drainage system you should set up a filter system as described below:



A filter system grade should be set one inch in 10 feet. The length of the filter system should be determined by the trap. A large, flat trap will need a longer filter system than a sloped, smaller one. You will need a drain line from the filter system to drainage area where it will have an open end.

No. 2. Drainage around sand traps is just as important as drainage in the sand trap. You should contour and lip traps where water will not run into traps. If not lipped, the trap will have extra water for internal drainage. The sand washes down first then the soil. This creates a lot of extra maintenance problems.

CHANGING BERMUDAGRASS GREENS TO BENT AND BACK TO BERMUDA

by

L. W. DuBose*
The Houston Country Club

In the summer of 1974, it was decided by the Greens Committee and myself after having a meeting with Dick Duble and Albert W. Crain that we would try two bentgrass greens. The reason was that we have so much trouble with mutations of other bermudagrasses on our greens.

It was decided that we would use Penncross bent. On October 13, 1974 we sprayed No. 17 and 18 greens with Tupersan at the recommended rate. On October 14, we seeded Penncross at the rate of 2 lbs. per 1,000. The Tupersan will kill bermudagrass or at least some strains. About two months later, I could find some green bermudagrass so we sprayed the greens again and did not kill some of the strains of bermuda.

We had good bentgrass greens all through the winter months and did not have too much trouble holding the bent through the summer. It did require water about one or two o'clock in the afternoon on hot days. We found that we could grow bent but I feel that it is much more trouble than bermudagrass and actually I don't think it is better to putt on than a good Tifdwarf green. We decided to change the greens back to Tifdwarf so on June 3, 1976, I sprayed No. 17 and 18 greens with Round Up at the rate of 5 quarts per acre. We did not water the greens for several days. It was our intention to leave the greens ten days before we removed the sod. After ten days, I could find some green bermuda so we spot sprayed the greens with Round Up using 1/2 oz. to one gallon of water. The next day we got a rain so I went back and sprayed them again. We had no rain this time and after ten days we removed 1-1/4 inch of sod from the greens. We could find some rhizomes that looked like they were alive but could not find any live roots.

We then took a Rogers Aero Blade with a new set of knives and on 1" spacing and cut into the seedbed a good 3" deep. After going over the seedbed one time, we added 5 lbs. of sulphate of potash per 1,000, then topdressed the green with straight sharp sand and cut it in. We kept doing this until we had worked about fifteen yards of sand into the top 3" and the green had been cut with the Aero Blade five times. We then used a 6' x 8' wooden drag to smooth the green back like we wanted it.

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*L. W. DuBose, The Houston Country Club, P. O. Box 22184, Houston, Texas 77027.

Then we used Scotts Starter Fertilizer on the seedbed at the regular rate. On July 2, 1976, we planted the No. 17 and 18 greens with certified Tifdwarf sprigs from Milburger's Grass Farm. Sometime before we were going to make the change, Monty Moncrief was visiting us at the Club and I asked Monty how much grass he thought I should plant per 1,000 square feet and he said 15 to 20 bushels. I did not say anything, but I thought that was too much grass. We did plant 15 bushles per 1,000' and on one little nursery area we planted 20 bushels and we found out that was not too much grass. The more you plant up to about 30 bushels the quicker you can play the greens.

We told our members it would be eight to ten weeks before we would be able to play the greens just to be on the safe side. In five weeks and one day they were opened to play with a good putting surface cut at 1/4". In seven weeks the height was lowered to 3/16" and was combed every day. Our members love them and so do I, if I can just keep them from mutating like the other greens have.

We are trying to watch the new greens very closely, and if we find off-type grasses, we plan to remove them immediately.

DAILY MAINTENANCE SCHEDULES

by

Jerry Allums*
Lakewood Country Club

Schedules are a method of laying plans for the work or projects to be accomplished and when they are to be done. They are tools that we can use to perform turf management jobs more efficiently, orderly and economically.

Daily maintenance schedules are for a week or from day to day basis, but before an effective daily schedule can be planned, there are other schedules that should preceed it. These are a "long range plan" and a "yearly maintenance schedule".

A "long range plan" should be worked out or developed for the next 5 or 6 years ahead of time and with the ideals of the Governing Board or Members as they, and you, look ahead into the future to plan the goals to be accomplished. It should be broken down into each major part of the Golf Course and Club House area as greens, tees, fairways, traps...etc. Although projects may overlap years, at least it is a plan to set out to accomplish.

With this plan, a Turf Manager can then plan and work up a "yearly schedule". This "yearly schedule" should be broken down month to month and into each major section of the area or Golf Course. This is where the Turf Manager should outline for each month what projects and maintenance jobs that he plans and proposes to accomplish. With this outline the Turf Manager can propose a yearly budget and plan a daily schedule. In working out or planning the yearly schedule, the Turf Manager must have a yearly schedule of the Club tournaments so that maintenance can be planned around them and causing the least amount of interference as possible.

With the "long range plan", the "yearly maintenance schedule" and "tournament schedule", the Turf Manager then can set about planning a "daily maintenance schedule". From the outline of the yearly schedule he can see what is planned for that month and work it into

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*Jerry Allums, Lakewood Country Club, 6600 LaVista, Dallas, Texas 75214.

his weekly plan. Along with these schedules comes the daily checking and observation of the Golf Course and listing items that need immediate attention. A Turf Manager must be aware of everything that is taking place in his area of responsibility not only through his personal observation but also his men should be encouraged to watch and suggest jobs that need to be done.

A weekly maintenance check list schedule can be set up so that jobs in each major section of your area are listed so that a week's work plan can be seen by all the men on what the plans are for the coming week in advance. A weekly maintenance schedule can also be divided into two seasons of summer and winter, so that all check list items can be listed for all areas for that time of the year. Items that should be included in the daily check list are preparing irrigation systems for sub-freezing weather, locking shops and gates, heating system, ball washers....etc.

Maintenance schedules for equipment should be planned out and scheduled to show when each piece of equipment is to be in the shop for major overhaul, painting....etc. This way the Turf Manager can plan his work schedule to fit in with the equipment maintenance schedule. Also preventive maintenance check list for equipment should be watched closely by the mechanic to make sure each piece of equipment is checked for minor repairs, oil change, filters, etc.

Along with preparing daily maintenance schedules, a daily record of what is being done is a must. Before a daily maintenance schedule can be planned for the week ahead, you must know what has been done the prior weeks and should not rely on memory. There are several daily maintenance record books and diaries that can be used for this purpose.

One of the best aids that I have seen in assigning daily maintenance jobs is a chalk board with all the men's names listed and a space beside each name to write in the job he will be doing. With an assignment board like this, a Turf Manager can assign and keep up with jobs much easier and the employee can check his next assignment from the board rather than running to the boss to find out what it would be. An assignment board is a must for me.

LONG RANGE PLAN

	1976	1977	1978	1979	1980	1981
GREENS						
TEES						
TRAPS						
FAIRWAYS						
ROUGHS						
EQUIPMENT						
CLUB HOUSE AREA						
SPECIAL PROJECTS						

GOLF COURSE MAINTENANCE SCHEDULE FOR 1977

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
TOURNAMENTS												
GREENS												
TEES												
TRAPS												
FAIRWAYS												
ROUGHS												

WEEKLY MAINTENANCE SCHEDULE

		MON	TUE	WED	THR	FRI	SAT	SUN
GREENS	MOW		✓		✓		✓	
	WATER	✓				✓		
	FERTILIZE	✓						
	AERIFY - TOPDRESS							
TEES	MOW	✓			✓			
	WATER	✓						
	FERTILIZE							
	AERIFY - TOPDRESS							
FAIRWAYS	MOW							
	WATER	✓						
	FERTILIZE							
	AERIFY							
TRAPS	RAKE SOLID		✓			✓		
	EDGE							
	ADD SAND	✓						
	PAINT RAKES							
ROUGHS	MOW							
	WATER							
	FERTILIZE							
	PRUNE TREES		✓	✓	✓	✓		
SPECIAL PROJECTS	CART PATHS	✓						
	BRIDGE							
	PLANT TREES							
	STAKE OF NEW LAKE			✓				

ASSIGNMENT BOARD

NOTES	MESSAGES

NAME	JOB
1. BILL	MOW TEES
2. JACK	MOW ROUGHS
3. QUINTON	CHANGE CUPS
4 DWIGHT	MOW GREENS
5. MELVIN	MOW PRACTICE GREENS
6. MIKE	WATER NEW SOD
7. CHARLES	MARK G. U. R.
8. DAVID	RAKE TRAPS
9. BOB	" "
10. TOM	MOW FAIRWAYS
11. JERRY	SPRAY GREENS
12. ROMEO	SPOT SEED

SPRING TRANSITION

by

Wallace Menn*
Texas A&M University

We who overseed spend all winter pampering and grooming our greens; and, just about the time they reach perfection, we must think of converting back to bermuda. It seems like such a waste. I, for one, cannot wait until the research people develop a grass for year round use on our golf greens in the South. I am certain that many of us will welcome the deletion of overseeding from our schedules.

But then, I am not here just to dream; but rather, to talk about the transition from a cool-season turf back to our basic bermuda greens. Being able to forecast the weather will aid immeasurably in determining how soon and to what extent we may begin discouraging the cool-season grasses on our greens. An abrupt weather change can certainly "foul up" a nice, smooth transition.

First, let's consider differences in grass varieties. If you are still overseeding with bluegrasses or bluegrass-bent mixtures, I feel that your cultural methods of discouraging these species from your greens may be started later in the Spring (late March or early April). However, if you have followed current trends and have overseeded with perennial ryegrasses or ryegrass/fescue mixtures, I feel that you had better begin the transition somewhat earlier (early March). Exact dates will depend upon current weather conditions.

I would begin the transition with vertical mowing and/or spiking the greens thereby letting light and air get down to the grass and soil, respectively. Frequency of either of these practices would be governed by weather conditions and grass species. I feel that the ryegrass mixtures will definitely require more thinning than will the bluegrasses.

After several weeks of verticulting and/or spiking, an aerification of the greens will allow for greater air circulation in the soil thereby helping it to warm-up faster.

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*Wallace Menn, Golf Course Superintendent, Texas A&M University Golf Course, Texas A&M University, College Station, Texas 77843.

Decreasing mowing height during the transition will help to place greater stress on the cool-season grass, thereby encouraging it to fade out faster. Reducing the watering frequency will also increase the stress factor on the overseeded grass.

Fertilization during this period should be such that an adequate cover is maintained but that excessive top growth of the cool-season grass is avoided. Light, frequent applications of a readily soluble nitrogen fertilizer should be helpful. Once you feel certain that the bermuda is ready to take over, larger amounts of readily available nitrogen fertilizer may be applied to speed-up the process.

Normally by this time of the year our greens have gotten pretty "thick", however, due to this year's early cooling trend, many of our greens are still fairly thin. Unless we have some intermittent warm spells during the winter the spring transition may occur without very much cultural prodding.

I am sure that there are some of you that do not use any of the cultural techniques that I have mentioned and that some may employ all of these techniques and more in order to have a smooth even transition. Whatever your methods might be; if you have enjoyed successful transitions in years past, stick with it. If not; you might want to try some of the things that I have mentioned.

PESTICIDE USE AND PROBLEMS

by

Robert Carter*
Willowbrook Country Club

Today's superintendent has at his fingertips an innumerable amount of pesticides to control and prevent most any weed, insect, or disease problem which he may encounter. The widespread use of many of these pesticides does, however, present us with many problems. Some of these are:

1. Buying or selecting the proper pesticide for your specific problem under your management practices.
2. Application problems; to include calibration of sprayers, and understanding label instructions.
3. Environmental considerations as related to pesticide use.
4. Safety problems with pesticides to include handling, storage and disposal.

Looking first at problems related to buying pesticides, we find that the most frequent problem is

BUYING PESTICIDES AND PROBLEMS ENCOUNTERED

A. Which pesticide should I buy?

As superintendents we must be able to determine our specific problem whether insect, disease, or weed related before we can select the pesticide used for control. This in itself is not always easy. In many cases, turf damage from insects and diseases look quite similar and only by careful observation can one differentiate. Likewise, chemical spills, and thin turf from improper fertilization, may easily be misinterpreted for disease and/or insect infestation. To solve this problem, we have several sources to draw on.

1. Through your County Extension Agent or Dr. Duble and Texas A&M.
2. Contact other superintendents in your area and draw upon their experience in identification of your problem.

*Robert Carter, Willowbrook Country Club, P. O. Box 4290, Tyler, Texas 75701.

3. Make yourself familiar with damage symptoms of the most common insects and diseases and most common weed species occurring in the turfgrass variety in which you are growing and the time of year they are most likely to occur.
4. Take advantage of the many publications, seminars, and programs provided by the Extension Service, Texas A&M, and various commercial firms which provide information on identification and control of many insects, diseases and weeds.

By using all or any of these sources, one should be more prepared to identify his specific problem and select the pesticide for its control.

B. Understanding Labels

When deciding on buying a specific pesticide, use only those which are labelled for your turf species and the specific turf culture you wish to apply it on. Examples: golf greens, fairways and tees, or bermuda lawns versus St. Augustine lawns.

C. Another factor involved in buying a pesticide is the ease of application. Normally, the granular materials are easiest and safest to apply.

D. Cost or Economics of Buying

Cost may be the final limiting factor in the pesticide we use, but other things besides initial cost must be considered. For instance, one product may be cheaper than another but may have to be applied twice as frequently. Thus, in the long run, may be more expensive both in actual cost and labor cost in application. Also, brand names may be misleading. Check for formulation and concentration (A.I.). If both are the same, then logically, buy the cheaper source.

E. Another factor which may influence buying is the decision to apply your pesticides on a preventative or curative basis. If costs are prohibitive, then curative may be your only choice.

PESTICIDE APPLICATION

A. <u>Read the entire label</u> before using and be sure you understand the application procedures, rates of application for your specific purpose, and precautions regarding use; also, the environmental effects which the use of the pesticide may have.

B. Be sure that proper safety equipment is used, both in handling, mixing, applying and clean-up following application. Again, the responsibility is yours to see that your workers use the equipment provided.

C. Develop skills of sprayer or spreader calibration to insure proper application. How?

1. Through experience or trial and error. Sometimes this may be tragic due to misapplication.
2. Many manufacturers, Universities, turf publications, and others publish information containing step-by-step procedures in calibrating pesticide application equipment, and include formulas for determining rate of application. Obtain these and keep them on file as a source of information.

D. Apply the pesticide according to manufacturer's recommendations. By this I mean

1. If it is a pre-emerge herbicide, make sure the material is applied before the target weed species has germinated.
2. If watering-in after application, or avoiding of irrigation is recommended after application, make sure these recommendations are followed.

Examples: Many herbicides are foliar absorbed and watering after application simply removes the herbicide from the leaves thus affecting your results. Likewise, many herbicides need to be watered into the soil after application so they may become active, or to prevent volatilization. Insecticides which are ingested by the target insects are greatly inhibited when washed from foliage on which the insect is feeding. Likewise, grub control involves getting the insecticide into the soil. So understand and follow the recommended procedures provided on the label and your chances of success will be substantially higher and the possibility of damage greatly reduced.

ENVIRONMENTAL CONSIDERATIONS OF PESTICIDE USE

A. Damage may occur to other species whether plant or animal, other than the desired species due to improper application, failure to read entire label regarding susceptible species, or by failure to heed manufacturer's warnings.

B. Another environmental consideration of pesticide use is the danger from pesticide movementbby:

1. Drift by wind. Do not spray with wind above 8 mph.
2. Avoid use of pesticides which may be easily moved into lakes providing irrigation water or drinking water. Many herbicides, insecticides, and fungicides are extremely toxic to fish and other aquatic life. (Again, consult your label.)
3. Volatilization. Many pesticides have the property of changing into a vapor or gas at ordinary temperatures when exposed to air. Pesticides such as the ester formulation of 2-4-D are highly volatile and may easily be moved by wind to far reaching areas where rain may wash it out to be picked up

by plants and animals far removed from your initial application spot. Thus, the use of the acid formulation of 2-4-D or other less volatile formulations or pesticides is an important consideration.

C. Consider the liability.

1. You or your club may be held liable for damage to plants and/or animals due to movement of pesticides, or improper application techniques by you.
2. Usually means loss of your job -- a very important environmental consideration!

PESTICIDES AND SAFETY

A. Treat all pesticides with the respect they deserve. Pesticides used properly are wonderful tools but mis-handled they can become lethal weapons.

B. Instill in your workers the dangers of pesticides, not so much as to promote fear, but to teach them to handle them safely.

C. See that all pesticides are stored safely; if possible, in a vented, locked room, in orderly fashion. Check containers often for leaks or broken containers.

D. See that all safety equipment is used when handling, mixing, applying, and clean-up following application.

E. See that disposal of pesticide containers is carried out according to the manufacturer's recommendations.

FERTILIZATION

by

Terry J. Jungman*
Austin Parks and Recreation Department

The proper application and use of fertilizers on fine turf areas can have a significant influence on the quality which results. In addition, attempting to account for the high cost of fertilizers in order to produce quality turf is becoming increasingly difficult to justify. To simplify the above statements it is becoming significant for fertilizer usage to be convenient and cheap.

As most everyone is aware, if a person is able to apply the correct amounts of fertilizer at the proper intervals, a poor quality turf area can usually be made acceptable within a short span of time. But there are a series of problems that often prohibit such scheduling. First, and probably foremost, is justifying sufficient funds for the purchase of ample supplies of fertilizer. Secondly, are the problems of storing bagged fertilizer for any length of time. Next are the difficulties in scheduling labor during the peak maintenance months to handle this bagged fertilizer and distribute it on the turf areas. And last, but not least, is coordinating the actual fertilizer applications without the fear of turfgrass damage from subsequent traffic prior to irrigation.

For our particular operation on the Austin Municipal Golf Courses the above circumstances would have been enough to severely limit the number of fairway fertilizer applications each season. It was because of these reasons and seeking the best way to utilize the available funds that it was decided to bid out a supply/service agreement in which a contractor would be required to furnish and apply bulk fertilizer. After evaluating the various bids it was determined that this new contract would save the City approximately $10,000 and many manhours when compared to applying fertilizer by the conventional methods used in the past.

This maintenance contract has eliminated most of the problems identified with the methods we've used in the past. Yet there are other problems associated with this method, but it is felt that the convenience and economics of applying bulk fertilizer far outweigh the disadvantages.

The following is a copy of the statement of work used in this supply/service agreement.

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*Terry J. Jungman, Superintendent of Golf, Austin Parks and Recreation Department, 11706 Windermere Meadows, Austin, Texas 78759.

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ADDENDUM

The following elements constitute the statement of work as well as terms and conditions of this bid invitation.

1.0 CONTRACT PERIOD AND TERMINATION PROVISIONS

1.1 This contract shall be in effect for a six (6) month period beginning on or about March 15, 1976; provided, however, that such contract may thereafter be extended for a period not to exceed three (3) months subject to approval of the Contractor and the Director of Purchases and Stores.

1.2 Whenever one party to this contract in good faith has reason to question the other party's intent to perform, he may demand that the other party give written assurance of his intent to perform. In the event that a demand is made and no assurance is given within five (5) days the demanding party may treat this failure as an anticipatory repudiation of the contract.

2.0 CONTRACT QUANTITIES. The quantities shown on the Bid Sheet incorporated herein are merely estimates and do not obligate the City to order or accept more than City's actual requirements during the period of this agreement as determined by actual needs and availability of appropriated funds.

3.0 STATEMENT OF WORK. Contractor shall on an "on call" basis, furnish and apply non-liquid bulk fertilizer as required herein to golf course tees, fairways, and park areas. Said work shall be performed as instructed by City supervisory personnel including the number of pounds per acre requested for specific applications.

3.1 Working Days and Hours

Contractor working hours shall be between 6:00 A.M. and 3:00 P.M. Mondays through Fridays, excluding City of Austin legal holidays.

3.2 Advance Notice of Requirements

Contractor shall be required to furnish and begin application of fertilizer within five (5) working days of verbal notice from the City.

3.3 Temporary Waiver of Requirements

In the event the Contractor is unable on an isolated basis to apply the bulk fertilizer within the notice period of Section 3.2 above, the City, at its own option, may agree to spread such fertilizer at a lessor price as may be mutually agreed to by the Contractor and the City Manager or his designee; provided, however, Contractor shall still be required to load spreader in accordance with Section 3.1 herein.

MATERIAL, EQUIPMENT, AND APPLICATIONS REQUIREMENTS

1 The Contractor shall transport the subject non-liquid fertilizers in bulk to golf courses or park areas as designated by the Superintendent of Golf or his designee.

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ADDENDUM

There is to be no interim storage of fertilizers on the golf course or park areas, therefore, the Contractor must have a means by which to transfer bulk fertilizer directly into fertilizer spreader.

4.2 The fertilizer spreader must apply the fertilizer to a width of between 25'-35'. This fertilizer shall be applied to the required number of pounds per acre as instructed by the Superintendent of Golf or his designee.

4.3 That the nitrogen source of fertilizers be Ammonium Sulfate $(NH_2) SO_4$ in a water soluable form.

4.4 That the per ton cost include a separate price for the 19-6-3 and that 21-0-0 analysis fertilizers.

4.5 The Contractor shall be responsible to not overload the fertilizer spreader to the point where the tires on the spreader or any other equipment will rut the golf course or park area.

4.6 The Contractor shall have the capability of transporting and applying fertilizer at a minimum of two (2) tons per site per day to a maximum of twenty (20) tons per day whether to a single site or multiple sites; provided, however, that the City shall not require the Contractor to deliver and apply per day more than one of the items described herein. Also, the City shall not require the Contractor to deliver and apply less than 6 tons nor more than 20 tons on any given day.

5.0 ARREARS. No money shall be paid by the City upon any claim, debt, demand, or account whatsoever, to any person, firm, or corporation who is in arrears to the City of Asutin for taxes; and the City shall be entitled to counter-claim and offset against any such debt, claim, demand, or account in the amount of taxes so in arrears; and no assignment or transfer of such debt, claim, demand, or account after the said taxes are due shall affect the right of the City to so offset the said taxes against the same.

6.0 SAFETY REGULATIONS AND INDEMNIFICATION OF CITY

6.1 The Contractor shall be responsible for instructing his employees in appropriate safety measures to preclude accidents to City personnel or visitors during Contractor's work.

6.2 Contractor shall indemnify and hold harmless the City from all claims, demands, causes of action, or suits of whatever nature arising out of the services, labor, and equipment furnished by the Contractor or his sub-contractors under this contract; and, from all theft losses resulting from acts of employees of the Contractor or sub-contractor.

6.3 The City will not be liable for any sickness, accident, or injuries to the Contractor's personnel engaged in work under this contract.

7.0 INSURANCE REQUIREMENTS. During the term of this Agreement, Contractor agrees to secure

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and thereafter keep in full-force and effect the following insurance in the minimum limits indicated below:

7.1 Comprehensive general liability policy with bodily injury of $300,000.00 per occurrence and $300,000.00 aggregate.

7.2 Property damage of $100,000.00 per occurrence and $100,000.00 aggregate.

7.3 Workman's Compensation Insurance in accordance with statutory requirements.

7.4 Certificate(s) indicating the above coverage shall be deposited with the Director of Parks and Recreation. Each such certificate shall provide that coverage cannot be cancelled or decreased except after the expiration of fifteen (15) days after delivery of notice of intention to cancel or decrease insurance coverage to the Director of Parks and Recreation.

8.0 GENERAL OPERATING CONDITIONS. The Contractor shall endeavor to employ only experienced equipment operators capable of accomplishing quality work in a safe manner within a reasonable period of time. The City's Superintendent of Golf or his designee shall have the right to require Contractor to dismiss from the premises covered by this contract any employee or sub-contractor of the Contractor who due to insufficient experience or any other reason fails to safely or efficiently operate equipment and perform applications covered by this Agreement. Any such dismissed person shall not be again employed in the work of this contract without the prior written consent of the Director of Parks and Recreation or his designee.

9.0 OTHER PROVISIONS. In the event of any inconsistency between the pre-printed terms and conditions on the reverse side of Form PS 125 and the Addenda, the terms and conditions of the Addenda shall prevail.

SOIL FERTILITY AND ACIDITY

by

L. R. Hossner*
Texas A&M University

There are three different soil systems to consider as fertility units on a golf course. These are fairways, teeing areas and putting greens. Fairways are generally not modified greatly but are a function of the existing terrain and natural soil bodies. Its chemical and physical properties are also similar to the naturally occurring soils. Teeing areas and putting greens are modified and do not generally retain the natural soil properties. Putting greens are highly modified and probably represent the most intensely managed real estate in Texas.

The present trend in putting greens and teeing area construction is to sacrifice nutrient and water retention properties to achieve minimum compaction tendency and adequate soil aeration, percolation and infiltration of water. Recently constructed putting greens conform somewhat to the composition shown in Table 1.

Table 1. General composition of putting green.

Depth	Composition
0-12"	85-90% sand 5-10% peat 5-10% clay
12-14"	Coarse sand
14-18"	Gravel (tile drainage system)

The tendency in recent years has been to increase the amount of sand in the system. A percolation rate of 4-6" an hour with a 0.25" head is the desired flow rate. The final green composition should give a total pore space of 40 to 50% with large pores not less than 15%.

*L. R. Hossner, Associate Professor, Soil and Crop Sciences Department, Texas A&M University, College Station, Texas 77843.

Nutritional Requirements

Sixteen elements are now considered essential for the growth and reproduction of higher plants (Table 2). Notice that thirteen of these elements are supplied almost entirely from the soil. Nitrogen can be fixed from the atmosphere by special purpose bacteria but the importance of this process on golf courses would be expected to be minimal. When nutrient ions are present in insufficient amounts to satisfy plant requirements, they must be added as fertilizers.

Cation Exchange Properties of Soils

Soil clays and organic matter (peat) are negatively charged. This chemical property results in absorption of positively charged cations to the surface of the components. From Table 2 it is apparent that NH_4^+-N, K^+, Ca^{++}, Mg^{++}, Zn^{++}, Fe^{++}, Mn^{++} and Cu^{++} (positively charged cations) would tend to be absorbed by clays and organic matter if sufficient capacity occurs in the system. The tendency to use more sand and less clay and peat tends to lower the cation exchange capacity. This would mean that the positively charged nutrient elements could move more rapidly through the profile if there was no exchange capacity. The exchange capacity of several putting green mixtures as reported by Johns (1976) is presented in Table 3. Although the treatment containing 85% sand had the lowest CEC it was not significantly different from the others. Practically speaking, the clay and peat moss add considerable cation exchange capacity to the mix. A mixture with a cation exchange capacity of 20 meq/100 g could retain a maximum of 131 pounds of potassium (K) per ton. This is a substantial quantity. Decreasing the quantity of clay and peat moss will result in a corresponding decrease in the cation exchange capacity. A pure sand has no cation exchange capacity.

Negatively charged anions, such as NO_3^-, $HPO_4^=$, SO_4^+, Cl^-, MoO_4^- and $H_2BO_4^-$, are not held by the cation exchange sites in soils. If the anion is completely soluble in solution it will tend to move with the water. Nitrate nitrogen (NO_3^-) is an example of an anion that is soluble and will move with the soil water.

Some anions are not completely soluble in soil solution and tend to form compounds of varying solubility in the soil. Phosphorus ions ($HPO_4^=$, $H_2PO_4^-$) react in this manner.

The net result in regard to turfgrass management is as follows: (1) cations will tend to be retained in the soil by the negative charge associated with clay and peat moss (or other organic sources), (2) very soluble anions will move in the soil in relation to their solubility.

Table 2. Elements essential for plant growth.

Element	Symbol	Form Taken up by Plants	Source
		Macronutrients†	
Carbon	C	CO_2	air
Hydrogen	H	H_2O	water
Oxygen	O	CO_2,H_2O	air & water
Nitrogen	N	NH_4^+,NO_3^-	air & soil
Phosphorus	P	$H_2PO_4^-$,$HPO_4^=$	soil
Potassium	K	K^+	soil
Magnesium	Mg	Mg^{++}	soil
Calcium	Ca	Ca^{++}	soil
Sulfur	S	$SO_4^=$	soil
		Micronutrients‡	
Zinc	Zn	Zn^{++}	soil
Iron	Fe	Fe^{++},Fe^{+++}	soil
Manganese	Mn	Mn^{++},Mn^{++++}	soil
Copper	Cu	Cu^{++}	soil
Molybdenum	Mo	MoO_4^-	soil
Boron	B	$HBO_3^=$,$H_2BO_3^-$	soil
Chlorine	Cl	Cl^-	soil

† required in large (macro) amounts by plants.

‡ required in small (micro) amounts by plants.

Table 3. Cation exchange capacity of four green mixtures (adapted from Johns, 1976).

Putting Green Composition	Cation Exchange Capacity
	meq/100g
85% brick sand, 5% Lake Charles clay soil, 10% peat moss	20.5a*
80% brick sand, 10% Lake Charles clay soil, 10% peat moss	26.2a
80% brick sand, 10% calcined clay fines, 10% peat moss	25.6a
80% concrete sand, 10% calcined clay fines, 10% peat moss	23.1a

*values within a column followed by the same letters are not significantly different at the 5% level.

Example of Nutrient Loss from Irrigated Golf Green

Data collected by Brown, Thomas and Duble (1976) show the influence of nitrogen source and putting green mixture on the loss of applied fertilizer nitrogen. A portion of their data is summarized in Table 4.

Table 4. Sources and amounts of N applied and the amounts of No_3^--N lost by leaching from putting greens of varying composition expressed as a percentage of the applied N (Brown, Thomas and Duble, 1976).

Nitrogen Source	Date Applied	Rate	Data Collection Period	Applied Nitrogen Lost sand*	mixture	soil
		lbs. N / 1000 sq. ft.	days		-%-	
NH_4NO_3	2-16-73	3.34	49	34.7	21.7	8.6
12-12-12	7-26-73	3.0	27	12.5	8.7	0.6
Ureaformaldehyde	6- 6-73	5.0	50	0.1	0.3	0.1
Isobutylenediurea	6-20-74	3.0	42	0.8	0.7	0.1
Milorganite	10-17-73	3.0	47	2.9	1.5	0.1

*Composition of greens were as follows: 90% sand-10% peat moss (sand), 80% sand-10% clay soil-10% peat moss (mixture), fine sandy loam soil (soil).

nitrogen present as $(NH_4)_2SO_4$ and urea

The rate of loss of nitrogen from various sources by water leaching through a 90% sand-10% peat moss putting green is shown in Figure 1.

The data presented in Table 4 and Figure 1 illustrate several points:

1. Soluble forms of nitrogen, such as the NO_3^--N contained in NH_4NO_3, will leach readily through the green mixture and be lost in the drainage water.

2. Cations and slowly available forms of nitrogen, such as NH_4^+, urea, ureaformaldehyde, isobutylenediurea (IBDU) and milorganite, tend to remain in the soil and are lost at a slower rate.

3. The composition of the putting green as it influences water movement and the cation exchange properties of the mixture will affect the amount of nitrogen which is lost by leaching. Generally, the greater the clay composition of the green mixture the slower will be the movement of water through the profile.

4. Optimum nitrogen utilization and putting green quality may require a combination of nitrogen sources to incorporate both nitrogen availability to the grass as well as the long term effect of slowly available forms.

Soil Ph

Although soil Ph is widely used as a criteria for plant growth, it is also one of the least understood of the soil properties. Simply stated, soil pH is a measure of the relative acidity or alkalinity of a soil. There are four soil Ph ranges that are particularly informative: a pH less than 4 indicates the presence of free acids, generally from the oxidation of sulfides or due, perhaps, to intense application of ammonium fertilizers. A pH below 5.5 suggests the likely occurrence of exchangeable aluminum (Al^{+3}). A pH of 7.8-8.2 indicates the presence of free $CaCO_3$, and a pH greater than 8.5 indicates the presence of excess exchangeable sodium (alkali or sodic soil).

The pH scale ranges from 0 to 14 but under most situations the practical scale is from 3 to 9. A neutral soil has a pH of 7. Above pH 7 the soil is termed alkaline and below 7 the soil is acid. Only at pH 7 are the number of hydrogen and hydroxyl ions equal. Below pH 7 hydrogen ions predominate while above pH 7 hydroxyl ions predominate. A pH scale is shown in Figure 2 which illustrates these concepts.

In general, soils containing large amounts of calcium or lime have pH values of 7 and over. Soils containing little calcium are acid.

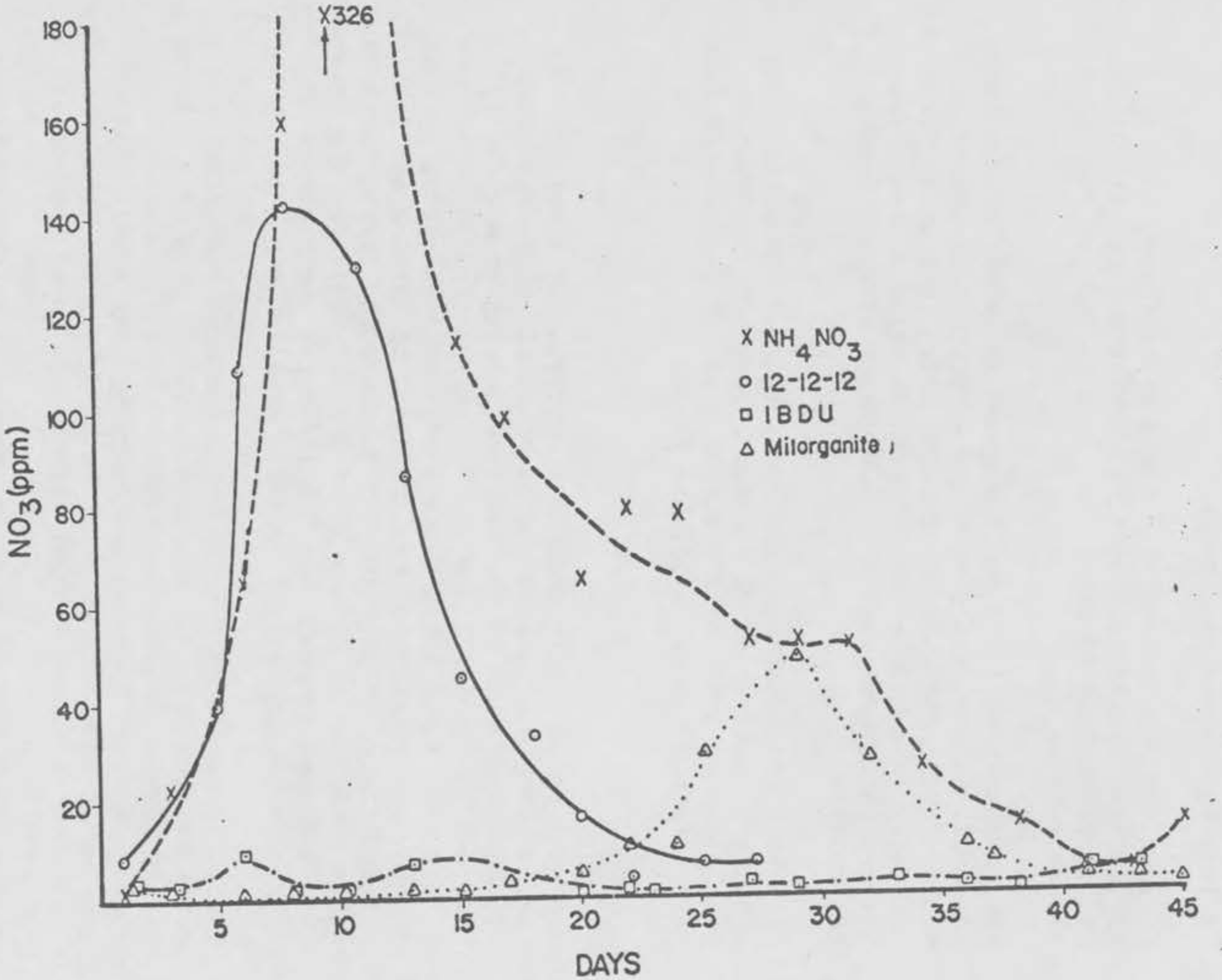

Figure 1. Concentrations of NO_3 in the leachate from sand plots treated with different sources of N fertilizer (Brown, Thomas, and Duble, 1976).

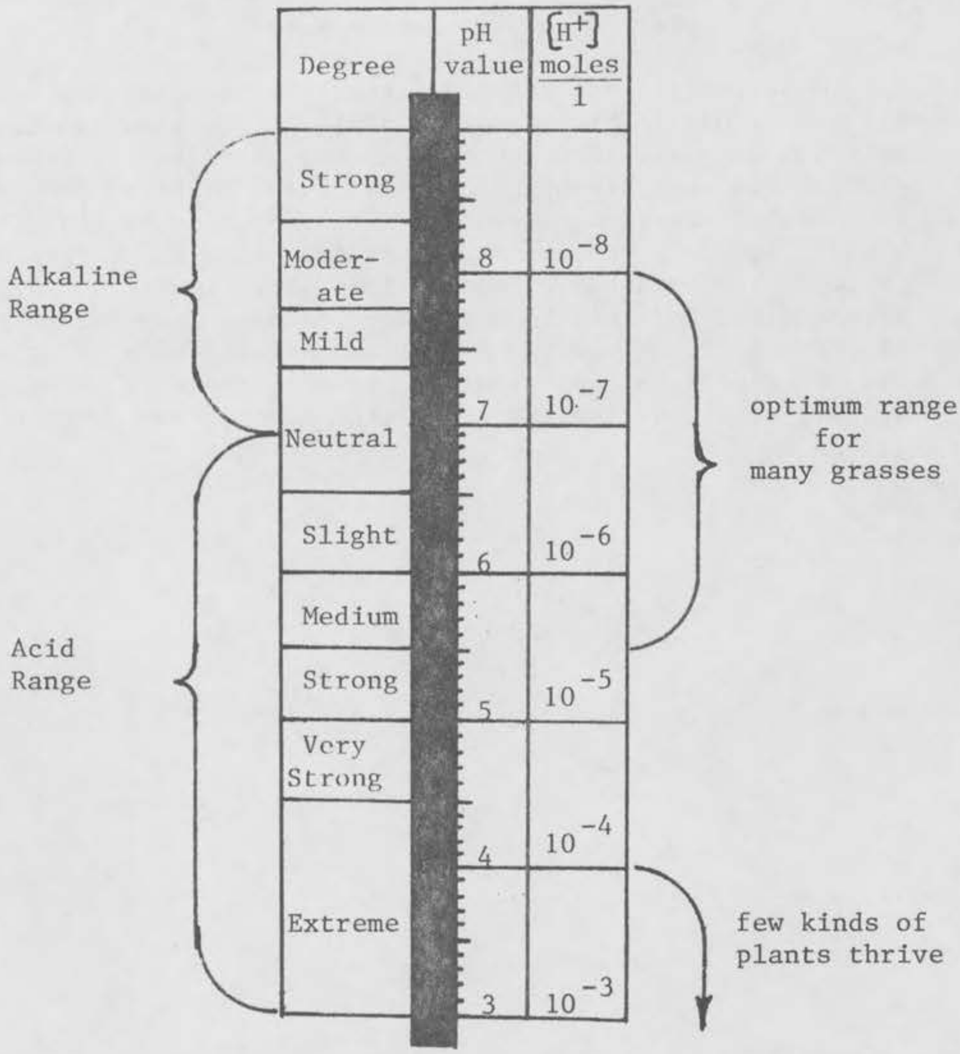

Figure 2. The pH scale.

Applying lime to acid soils will neutralize the acidity and increase the pH. One of the more common ways in which soil pH is decreased is by applying ammonium (NH_4^+) forms of nitrogen fertilizer. In the soil the NH_4^+ is converted to NO_3^- with a resultant release of H^+ ions. This reaction can be illustrated as:

$$NH_4^+ + 2O_2 \xrightarrow{\text{Biological}} NO_3^- + H_2O + \underline{\underline{\underline{2H^+}}}$$

The reaction can proceed rapidly in soils, and over a period of time and heavy nitrogen applications the soil pH will tend to decrease. Monitoring soil pH can be easily accomplished and the proper corrective action applied before the pH drops too low for good vegetative production.

Irrigation Water

Golf courses are heavily irrigated. In many instances the water may have a heavy load of salt. Salinity problems can develop if the salts do not move into and through the profile. If the salt composition of the water is high in sodium (Na^+) physical problems resulting from soil dispersion can occur. This may also decrease water infiltration. The pH of the soil may increase since the cation exchange capacity is dominated by sodium ions (see Figure 2). It is useful to have a water analysis to determine the salt load and salt composition of the irrigation water. A soil ammendment, such as gypsum ($CaSO_4$), can be helpful in supplying Ca^{++} ions to the soil exchange complex if soil problems resulting from excessive sodium develop.

SOIL PHYSICAL PROPERTIES

by

K. W. Brown*
Texas Agricultural Experiment Station

The most easily recognized and often mentioned physical property of a soil is its texture. The soil be it sand, silt, clay or some intermediate texture cannot be changed significantly without huge investments, even to alter small areas. These investments to change the texture are necessary on greens, but little can be done on the fairways and other areas. What we must do then is to manage the soils we have to work with. Through proper management, the soil structure can be maintained or improved so that infiltration, water retention and root growth can be maximized.

SOIL STRUCTURE

Soil structure is the arrangement or aggregation of particles. The most desirable structure is one that is water stable and forms small size aggregates. Maintenance of organic matter, and minimizing traffic when the soil is wet will assist in maintaining an open, porous structure. Care must also be taken to prevent the accumulation of salt, particularly sodium which is prevalent in much of the water used for irrigation.

INFILTRATION

The infiltration of water into a soil is usually limited by the structure of the immediate surface. The presence of grass and some residual organic matter on the surface breaks the impact of the rain drops and prevents them from shattering the surface structure. Water moves quickly at first into dry soil but the infiltration slows down as the soil becomes saturated to greater depths. Infiltration may be slowed down abruptly if the wetting front reaches a layer which is less permeable. A similar slowdown will also occur if the wetting front reaches a more porous zone, since water will build up in the surface layer before it breaks into a sand or gravel layer.

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WATER RETENTION

The water retention of a soil is influenced almost entirely by the texture as shown in Figure 1. The structure has a small influence in the amount of water retained when the soil is wet. The upper limit of water retention is known as the field capacity. It is the amount of water retained after drainage due to gravity becomes negligible. The lower limit or wilting point is the water content at which plants are no longer able to extract water, and thus, wilt. The water held between the wilting point and field capacity is known as the available water. As shown in the Figure 1, sands retain little water at either end of the range and the amount of available water is thus very small. They will require frequent irrigations, and they should be small so that excess amounts of water are not lost to deep leaching. Loam soils, being a mixture of about equal portions of sand and silt and a small amount of clay have the greatest ability to retain available water. Clay soils retain lesser amounts of available water since they retain large quantities which are bound too tightly for the plants to remove. Irrigation frequencies can be reduced in finer textured soils and the amount applied at any given irrigation can be increased.

EVAPOTRANSPIRATIONAL LOSSES

The loss of water to evaporation from the soil and plant surfaces will typically be of the order of 5-10% of the total water lost by the combination of evaporation and transpiration - known collectively as evapotranspiration. On a typical clear summer day, as much as 3/8 inch of water may be needed daily to supply the evapotranspiration requirements. Thus sandy soils with a two foot deep profile may be able to store water for 2.5 days after they have been thoroughly watered, while a two foot profile of loam or clay could supply water for 5 to 5.5 clear summer days. Cloudy days and light rains and high humidity will reduce the water requirements thus allowing longer intervals between irrigations.

IRRIGATION

Precautions must be taken to apply irrigation water at rates slower than the infiltration rate so that the water will not be lost to runoff. Irrigation equipment must be selected to apply water uniformly over the surface. Typical equipment presently in use may have a variability of as great as 50% from one location to another, thus requiring over irrigation of some areas to supply adequate water to other areas. Much of the water used to irrigate contains significant amounts of salt. It must be understood that while the water is lost to evapotranspiration, the salts will remain unless they are washed out of the soil by rainfall or scheduled heavy applications of water.

SOIL SALINITY

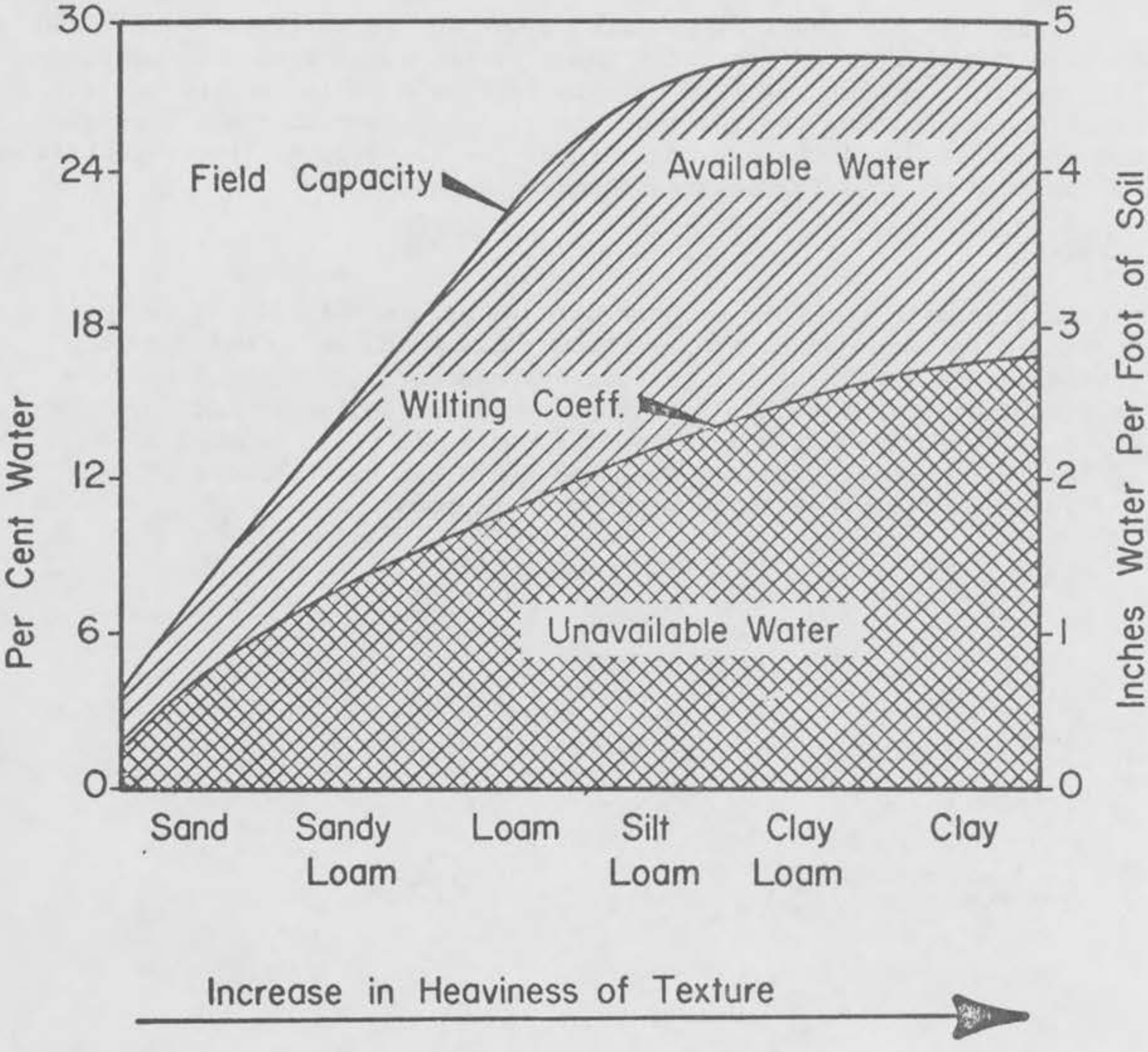
The accumulation of sodium in the soil will cause the soil particles to separate from each other and as a result the clay and silt will fill the pores resulting in a very tight impermeable condition. Calcium ions, on the other hand, will cause the particles to hold together as aggregates and will improve the structure. If the irrigation water has enough calcium to offset the adverse effect of the sodium, no problems will develop. If the water contains too little calcium, additions can be made directly to the soil in the form of lime, if the pH is low or gypsum if the pH is already in a desirable range.

SOIL AMENDMENTS

There are many soil amendments on the market which are advertised to have the ability of improving the physical properties with application rates of a pint per 1,000 square feet or a gallon or two per acre. Of all those we have tested, there is no evidence that these products are able to improve the physical properties of soils at the concentrations recommended or at affordable application rates.

DRAINAGE

Drainage in the form of open ditches or drain tiles may be necessary to remove excess water from areas that remain wet for long periods. The design of irrigations systems for agricultural land is well understood and is easily adapted to a particular situation. Drainage is particularly important if sodium is to be leached from soils. With proper drainage the root zones can be kept free of salt and water and growth will be much more vigorous.


30
24
18
12
6
0
5
4
3
2
1
0
Field Capacity
Available Water
Wilting Coeff.
Unavailable Water
Per Cent Water
Inches Water Per Foot of Soil
Sand
Sandy Loam
Loam
Silt Loam
Clay Loam
Clay
Increase in Heaviness of Texture

SOIL MICROORGANISMS AND THATCH ACCUMULATION IN TURF

by

R. W. Weaver*
Texas Agricultural Experiment Station

The most essential process accomplished by soil microorganisms is the decomposition of plant residues and recycling of nutrient elements. One major problem in turf grass production and golf green maintenance is thatch accumulation. Some people propose that organic material accumulates on the soil surface when turf is grown because microorganisms are not present or need to be activated. The purpose of the following presentation is to develop concepts on the role and limitations of soil organisms in plant residue decomposition.

In nature a balance is reached between litter decomposition and new growth of plants. This balance occurs because the soil has a limited supply of plant nutrients. When the nutrient supply of the soil is gone plants must have a new source of nutrients or they die. Man has learned how to intervene by applying plant nutrients as fertilizer. This results in continued plant growth and a build-up of thatch.

Everyone realizes that in prairies the growth of grasses resulted in a build-up of organic residues on the soil surface. These residues were constantly being decomposed by soil bacteria and fungi. Yet, as long as the thatch was on the soil surface the rate of decay was not very fast. Every farmer realizes that if crop residues are to be quickly decomposed they must be plowed into the soil. Nature has its own tillage implements. They are the soil microfauna; beetles, mites, spiders, crickets, earwigs, centipedes and earthworms. These organisms bury the plant material in the soil where the billions of fungi and bacteria can bring about decay.

Most turf areas do not have the organisms needed for burying the plant material in the soil. Various insecticides are used to keep turf free of troublesome pests. However, the insecticides also kill the organisms responsible for burying the thatch in the soil. Anyway, the microfauna would not bury the plant material fast enough to

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keep the soil surface free of plant residues. This is because they require plant litter for protection from the environment and as a place to reproduce. If they buried all the plant material their population would greatly decrease and thatch would again build-up.

Why does material have to be buried in the soil to decay rapidly? The main reason is that the soil surface is too dry when soil temperatures are warm enough for rapid decay. One of the best ways to preserve plants is to dry them. Microorganisms will still be present on dried plant material but they will not actively decay the plants until there is adequate moisture. Frequent watering of turf on golf greens doesn't keep the thatch wet long enough to fully decompose. Golf greens are clipped so close and drain so well that their surface dries out quickly.

Application of materials to turf that purport to increase the activity or population of soil microorganisms cannot reasonably be expected to increase the decomposition of thatch. The main factor limiting the decomposition of thatch is that the thatch is too dry. With adequate moisture each square inch of a golf green contains billions of bacteria and fungi capable of decomposing thatch. On an acre basis this amounts to approximately a ton of microorganisms.

In summation, soil microorganisms are important in decomposition of plant residues and nutrient cycling. But they are not capable of decomposing plant residues that dry out on the soil surface. Because of this the only practical way of controlling thatch build-up on the surface of golf greens is by verticutting, using plant varieties known not to accumulate large amounts of thatch, and controlling the rate of plant growth by using frequent light applications of nitrogen fertilizer.

U.S.G.A. SPECIFICATIONS FOR PUTTING GREENS

by

Alexander M. Radko*
U.S.G.A. Green Section

The most important project that will ever confront you as a golf course superintendent will be to build a putting green. It is a major task, one beset with pitfalls. Plan every step meticulously and be sure that you have detailed specifications--whether you do it yourself, or contract the work out.

To do the job right requires time. Too often the decision to go ahead with reconstruction is committee-delayed to the very last minute and then they want you to "do it yesterday, if not sooner"! This is the supreme test of your salesmanship ability. Building a green correctly is the supreme test of your profession. It must be done right the first time! For best results, we all know that timing is all-important to good grass growth; therefore, all plans must revolve about completion of all other work toward whatever "that magic planting date" is in your area.

There are several ways to successfully construct a green. If you choose the U.S.G.A. specs, you cannot deviate from them! U.S.G.A. specs require that your soils by laboratory-tested. This is to insure that the physical as well as all other qualities of the soil mixture meets specifications. Once you receive the formula, treat it like a cookbook recipe...it must be followed exactly, otherwise it will not work! To allow adequate time for necessary tests, for recommendations to be made, for mixing the soils and preparing the green site for acceptance of the soil mixture--all this requires time. We suggest that you begin working toward that end two months in advance of the target date for planting. We especially caution that you send samples of the sand, soil and organic material that you have selected for the top mix as early as possible. Two gallons of sand, one gallon of soil and one gallon of organic matter are required. Be sure to study the sand size requirements most carefully since sand will be the major component of the top mix. Use strong containers that will not break open in transit. Clean paint cans are ideally suited for this purpose. Be sure to clamp the cover on tight!

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It is best to allow two weeks for the material to arrive at the soils lab, eight days for the tests to be run and another week to have the written report of recommendations in your hands. This should allow adequate time for you to mix the soil, prepare the new green site and plant the green at its best time to insure good grass growth before adverse weather sets in.

The Green Section specification offers a fundamental approach to the problem of greens construction. It provides measurable characteristics of a synthetic mixture that will withstand compaction, have a good infiltration rate, hold a ball (when properly struck) to the green, require little down time after heavy rains and stand up better for winter play. Remember the prospect for the future is more rounds of golf per course and a longer playing season.

The most important consideration is not cost but doing it right the first time. If it fails, it is there for all to see and "your stock" in that membership's eyes takes a sharp plunge.

GENERAL SUMMARY OF THE GREEN SECTION SPECS REFINED

Main Changes over Old Specs

(1) Greens could be constructed with any sand of reasonable quality. However, a finer textured sand is now being recommended. Generally brick or mason's type sand. See size ranges below.

(2) Increased infiltration rate. See below.

(3) We now recommend pea gravel (1/4" to 3/8" in diameter) be used in the gravel blanket.

(4) Increased total pore space to 40-55%. See below for breakdown.

(5) We are recommending that a collar area of an additional 3-5 feet be constructed around the green exactly as the green is constructed.

THEREFORE

(A) Infiltration rate

minimum	2" per hour for bermuda (compacted)	*Infiltration rates reduced after turf is established.
minimum	2" per hour for bentgrass (compacted)	
maximum	10" per hour for both (compacted)	
ideal range	4-6" per hour for both (compacted)	

(B) Bulk density - measure of soil resiliency

maximum 1.60 g/cm^3 (grams per cubic centimeter)

minimum 1.20 g/cm^3

ideal is 1.40 g/cm^3

above 1.45 g/cm^3 - turf will be more compact

below 1.25 g/cm^3 - turf will be softer

(C) Porosity - amount of air spaces - micropores and macropores

minimum 40% capillary and non-caipllary

maximum 55% capillary and non-capillary

ideal is 25% capillary pore spaces and

25% non-capillary pore spaces

(D) Water retention - amount of available water held for plant usage

minimum 12% or 0.10" water held per inch of soil

maximum 25% or 0.20" water held per inch of soil

ideal approx. 18% held or 0.15" water held per inch of soil

*Grass roots can reduce infiltration rate by up to 80%; also for each 10% increase in silt and/or clay, the infiltration rate is cut in half.

(E) pH - ideal pH range of 6.0 to 6.5

(F) Organic matter - for water-holding capacity and cation exchange sites

maximum ash content chould not exceed 15% (silt and clay)

ideal ash content should be 10% (silt and clay)

So, organic matter should be 90% organic!

(G) Particle size - the following chart shows size range and limits for sand amendments

Gravel	Very Coarse Sand	Coarse Sand	Medium Sand	Fine Sand	Very Fine Sand	Silt and Clay
2 mm or larger	1-2 mm	1-0.5 mm	0.5-0.25 mm	0.25-0.1 mm	0.1-0.05 mm	
3%	7%					Maximum 3% clay 5% silt
Maximum (Not more than 10%)		DESIRED RANGE 65% minimum - optimum 75% plus		Maximum (Not more than 25% of total) (Preferably 10% of total)		

Other Areas of Concern (Cautions)

(1) Send soil samples to Texas A&M University for analysis -- 2 gallons sand, 1 soil, 1 peat (organic matter). Cost $130. Refer to paint store for empty gallon cans.

(2) Mix soil thoroughly off-site.

(3) Don't sod the green unless the sod has been grown on the same soil mixture.

(4) Topdress the green using the same soil mix used in the initial construction.

(5) Mulch cover prepared green until seed or stolons are established to prevent water from separating the soil particles.

(6) Sand layer (of coarse texture) between gravel and topsoil retained as in original specifications.

(7) Be sure to carefully follow the outlined building specifications for best results. Remember, an improper substitution in the specs will result in failure.

(8) Two main 4" tile lines - one for each side of the herringbone is preferred over one 4" tile if the green measures over 4,000 square feet. Two inch tile for laterals is satisfactory if spaced 10 to 12 feet apart

(9) A circumferal tile around base and leading into main also would be helpful.

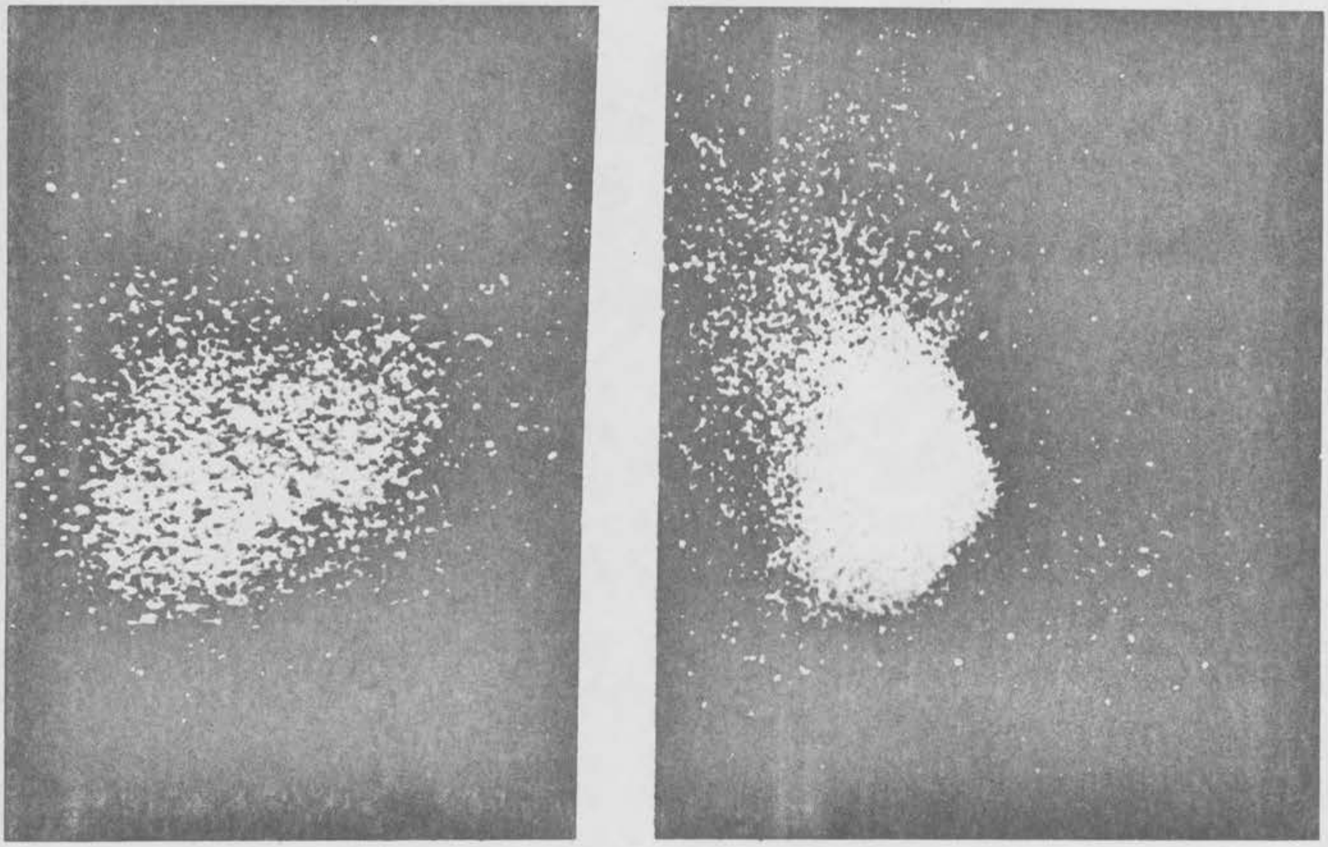
Sand for Golf Courses

by THE USGA GREEN SECTION STAFF

If all the materials necessary for the construction and maintenance of golf courses, sand—common sand—is among the most important. Great quantities are needed for bunkers and in topsoil mixtures both for the construction of greens and for later topdressing.

Sand is among the most abundant materials on earth, and it can be found in differing textures and colors, from the coarse white sand of coral atolls of the Pacific to the fine pink sand of Bermuda's beaches. Not every sand can be used for every purpose on golf courses, however. They must be defined and graded. Sands for topsoil mixtures have been precisely defined, while, surprisingly, sands for bunkers have not. More surprisingly, both are so close in particle size designation that they could be used inter-

Sand of the recommended particle size is at the left; common granulated sugar, the kind you find on any table, is on the right.



changeably. Research at Texas A&M University and at Mississippi State University resulted in the USGA Green Section recommendation for sand particles sizes ranging ideally between 0.25 millimeter and 1.0 millimeter in topsoil mixture for greens.

Sand in this particle size range also is suitable for bunkers. Sands in the range will not remain on top of the grass, but will seep into the soil. Everyone has seen a spray of sand lying on the green after an explosion shot from a bunker. Particles larger than one millimeter tend to remain on the putting surface, while sand particles in the recommended range permeate the turf and, therefore, cause no problems in mowing operations. Secondly, players will not have to remove pebbles from their line, and therefore, putting should take less time.

Sand for bunkers preferably should be light in color, or perhaps even white, but color is not so important in soil mixtures. The specifications table below is universally accepted by commercial sand firms throughout the nation. At present, anyone can go to a sand dealer and order as much brick, mason or concrete sand as he wants. Isn't it reasonable to expect, therefore, that sand companies should also add a golf sand to their stockpile, one that meets the specifications described herein?

The recommended range of sand particle size for bunkers best suits both requirements: that is, all sand should go through a 16-mesh screen and be retained on a 60 mesh screen. Ideally, the major portion of the sand, 75% at minimum, should be in the 0.25 to 0.50 millimeter range (medium sand). Silica sands are preferred, round rather than angular, if available.

The information presented here is the best judgement of the entire USGA Green Section Staff after study of research available and practical findings as a result of the Turfgrass Service Program. It is edited and reported by Alexander M. Radko, National Research Director. Staff members are William H. Bengeyfield, William G. Buchanan, Holman M. Griffin, James B. Moncrief, F. Lee Record, Carl Schwartzkopf, and Stanley J. Zontek.

SAND PARTICLE SIZE CLASSIFICATION TABLE

	*ASTM Mesh		Sieve Opening Millimeter	Sieve Opening Inches		
	4		4.76	0.187		
	5		4.00	0.157		
	6		3.36	0.132		
	7		2.83	0.111		
	8		2.38	0.0937		
	9		2.00	0.0787		
	10		1.68	0.0661		
	12		1.41	0.0555		
	14		1.19	0.0469		
	16		1.00	0.0394		
	20		.84	0.0331		
RANGE	24		.71	0.0278	COARSE	
FOR	28		.59	0.0234		
BUNKER	32		.50	0.0197		
USE	35	RANGE	.42	0.0165		IDEALLY –
	42	FOR	.35	0.0139	MEDIUM	MINIMUM
	48	SOIL	.30	0.0117		OF 75%
	60	MIXES	.25	0.0098		MEDIUM
	65		.21	0.0083		SAND
	80		.18	0.0070		
	100		.15	0.0059	FINE	
	115		.13	0.0049		
	150		.11	0.0041		
	170		.09	0.0035		
	200		.07	0.0029		
	250		.06	0.0025		
	270		0.5	0.0021		
	325		.04	0.0017		

Particle Size Designations

Textural Name	Tyler Scale[1] *(A.S.T.M.)	U.S. No. **(N.B.S.)	Sieve Opening millimeters	inches
Gravel	4 mesh	No. 4	4.76	0.1870
Fine gravel	9 mesh	No. 10	2.00	0.0787
Very coarse sand	16 mesh	No. 18	1.00	0.0394
Coarse sand	32 mesh	No. 35	0.50	0.0197
Medium sand	60 mesh	No. 60	0.25	0.0098
Fine sand	150 mesh	No. 140	0.105	0.0041
Very fine sand	270 mesh	No. 270	0.053	0.0021
Silt			0.002	0.00008
Clay			0.002	

[1]The USGA Soil Texting Laboratory uses the Tyler Scale

*American Standard for Testing Materials

**National Bureau of Standards

DISEASE IDENTIFICATION AND CONTROL ON BENTGRASS GOLF GREENS

by

Phillip F. Colbaugh*
Research and Extension Center at Dallas

The control of diseases of bentgrass golf greens is based on early and accurate detection and identification of potential pathogens. Although there are many diseases which attack bentgrass, only a selected few are capable of causing extensive damage and can be separated on the basis of their seasonal activity and symptoms on affected plants. The following is a list of characteristics of important diseases found on bentgrass golf greens in Texas:

1. PYTHIUM BLIGHT - caused by species of *Pythium* - especially *P. aphanidermatum* with high temperatures. Hot weather pathogen which spreads very rapidly.

   A. Symptoms - Turf killed in small, roughly circular spots (2-6 inches) that tend to run together. Blackened leaf blades, rapidly wither, often stick together and appear greasy. Depends on available moisture.

   B. Conditions favoring disease - Disease usually appears in low areas that remain wet. Disease depends on excessive moisture. *P. aphanidermatum* is very destructive at high temperatures 80-95°F. Other species of *Pythium* can cause disease at lower temperatures.

   C. Cultural control - Reduce shading. Improve soil aeration and water drainage. Irrigate only when necessary to a depth of 4-6 inches. Avoid excess nitrogen and thatch.

   D. Fungicidal control - OZ/1000 SQ. FT./10 GAL. WATER

Koban	3-6 oz	5-10 day intervals
Chloroneb (Tersan SP)	4 oz	
Dexon	4-5 oz	

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2. HELMINTHOSPORIUM LEAFSPOT - caused by *H. sorokinianum* during midsummer. Spores produced on infected plants and thatch.

   A. Symptoms - Leaf spotting or foliar blighting with brown borders. General decline of turf. Large areas can be affected.

   B. Conditions favoring disease - Drought followed by long moist period during midsummer. Excess nitrogen, soft growth favors infection.

   C. Cultural control - Avoid excess nitrogen and thatch accumulation in the summer. Avoid drought conditions.

   D. Fungicidal control - OZ/1000 SQ. FT./10 GAL. WATER

Daconil	4 oz	7-14 day intervals
Dyrene	4-8 oz	
Captan	4-6 oz	
Fore	4-6 oz	
Tersan L.S.R.	4-6 oz	

3. FUSARIUM PATCH - caused by *F. nivale* during cool and wet conditions of Fall, Winter and early Spring.

   A. Symptoms - Roughly circular areas pale yellow-whitish grey 2 inches to 1 foot diameter. During prolonged cool wet weather mycelium is visible at first white then turning to a faint pink color with exposure to the sun. Usually the leaves are attacked but crowns can be killed, too.

   B. Conditions favoring disease - Serious where air movement and soil drainage is poor. Where grass stays wet for long periods, especially where snow cover becomes packed.

   C. Cultural control - Avoid heavy applications of nitrogen in Fall. Avoid heavy thatch accumulation in winter

   D. Fungicidal control - OZ/1000 SQ. FT./10 GAL. WATER

Tersan 1991	6-8 oz	14 day intervals
Tersan L.S.R. (Maneb)	8 oz	
Fore	8 oz	

4. BROWN PATCH - caused by *Rhizoctonia* spp. during moist periods and high night temperatures. Spreads very rapidly.

   A. Symptoms - Foliar blighting. Circular areas of dead foliage 1-50 ft. Center areas can recover and give a "frog eye" appearance. Fungus threads can be observed during early stage of disease "smoke ring" effect.

B. Conditions favoring disease - Temperatures between 75-85° F and the presence of free moisture is ideal. High night (70 F) temperatures also encourage disease. Higher temperatures in summer reduce disease activity.

C. Cultural control - Morning irrigation to reduce free water on foliage. Balanced fertility program.

D. Fungicidal control - OZ./1000 SQ. FT./10 GAL. WATER

Thiram	3-4 oz	5-10 day intervals
Daconil	4-8 oz	
Fore	4-6 oz	
Dyrene	4-8 oz	
Tersan 1991	2-4-oz	

5. DOLLAR SPOT - caused by *Sclerotinia homeocarpa* mostly with an imbalance of nitrogen and rapid temperature changes.

A. Symptoms - Spring and Fall disease 1-3 inches in diameter. When dew is present the fungus can be seen on the foliage as a cob-webby growth. Individual blades of grass are constricted when diseased and turn bleached in color.

B. Conditions favoring disease - Quick temperature changes (warm days and cool nights). Unbalanced nitrogen fertility (high or low). Moisture stress favors the disease.

C. Cultural control - Avoid high or low nitrogen nutrition. Keep a balanced nutritional program. Avoid drought stressed turf.

D. Fungicidal control - OZ./1000 SQ. FT./10 GAL. WATER

Dyrene	4-6 oz	7-14 day intervals
Daconil	2-4 oz	
Tersan 1991	1 oz	
Tobaz (TBZ)	2 oz	

6. FUSARIUM BLIGHT - caused by species of *Fusarium*. Especially *F. roseum* and *F. tricinetum*.

A. Symptoms - Diseased areas in turf 1-2 ft. diameter. Diseased areas run together as the disease progresses. Leaves and crowns are attacked. Leaves brown-bleached appearance.

B. Conditions favoring disease - Favored by drought stress with moist period following. High rates of nitrogen and damage due to nematodes favor disease. Temperatures of 70-100°F and high humidity are necessary for disease.

C. Cultural control - Avoid high nitrogen in summer. Avoid drought stress and nematode damage to turf.

D. Fungicidal control - OZ./1000 SQ. FT./10 GAL. WATER

Tersan 1991	5-8 oz	2 applications at 10-14 day intervals
Fungo	4 oz	

7. FAIRY RING - caused by several species of mushroom fungi. Very common in the spring following heavy rainfall.

A. Symptoms - Dark green circular areas of grass with yellowish or brown bands of grass on each side. Mushroom or toadstool fruiting bodies may or may not occur.

B. Conditions favoring disease - Warmer temperatures in spring following heavy rainfall. Thick thatch or mat favors disease.

C. Cultural control - none

D. Fungicidal control - Common turf fungicides can be used to suppress disease activity by using two times the recommended rates for foliar spray. Erradication of these fungi is possible using formaldehyde drenches or fumigation with a volatile.

8. NEMATODE DECLINE - primarily active in the summer. Stylet and Spiral are probably most important.

A. Symptoms - General decline. Large areas usually affected.

B. Conditions favoring disease - Active on sandy soil in summer with moderate soil moisture and soil temperature (65-75°F).

C. Cultural control - Not available.

D. Chemical control - PINTS/1000 SQ. FT./15-25 GAL. WATER

1 Pt. Nemagon EC-2	1 treatment/year Spring or Fall
1 Pt. Fumazone 70 E	

Only on established turf which is moist. Apply only when temperatures exceed 60°F. Water immediately to insure good penetration and to avoid phytotoxicity.

BERMUDAGRASS PROBLEMS ACROSS THE SOUTH

by

James B. Moncrief*
USGA Green Section

1976 did not pass without problems for the turfgrass manager. In fact, more problems seemed to confront him than in the previous 2 or 3 years. One of the worst problems was the weather. It is almost a must to get daily as well as weekly and monthly reports in anticipation of completing projects that have been so well thought out and planned and from laborious hours of putting priorities on projects that enhance the game of golf.

1976 started with continuous cool weather in the spring that extended into the summer and delayed transition in many areas to the extent that there were many bare areas in problem bermuda greens especially those that are partially covered by shade from nearby trees. If you must keep trees near enough to the greens to create problems from roots and shade then special attention will have to be given to the bermudagrass in order to maintain it.

Controlling weeds that exist in the greens or throughout the golf course has to have a well timed operation of applying pre-emergent chemicals. If they are applied too soon, the residual will not last long enough for control and if too late, the bermudagrass will be root pruned severely. It is usually advisable to be assured of a strong turf before applying pre-emergence. Most research results are obtained on healthy turf. The combination of pre and post emergent chemicals should control the majority of weeds in turf when applied at the proper time. You must know your problem and results of chemicals if you expect to get the best control of weeds.

The weeds that are a problem across the south are <u>Poa annua</u>, goosegrass, crabgrass, spotted spurge, spurweed and sedge. Goosegrass was probably as abundant in 1976 as it ever has been and as hard to control. Research is showing the synergistic effect of chemicals for better control of goosegrass. However, the chemicals being researched are not cleared for turf even though they are being applied to plants used for food production. Good turf is the first line of defense for control of weeds.

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The bent greens as a whole were excelling this year especially those that were constructed correctly with proper irrigation management. Greens that have good wind movement across them perform better.

Bermudagrass is still a constant invader of bent across the south especially where bermudagrass is adapted. Siduron is still satisfactory for keeping bermuda out of bent greens.

Insects and animals are persistent and the population of mole crickets increases each year especially along the gulf coast and other coastal areas where golf courses are built. Mole crickets reproduce in the rough and wooded areas adjacent to the golf course and invade the course after rainy spells or where there is excess moisture.

The insects that were the most prevalent this year were sod webworms, cut worms, army worms, bermuda mites, corn seed beetle, rhodesgrass scale, fire ants and ground pearl. Pine trees were attacked by the southern pine beetle, ips, and turpentine beetle. Be sure that any pesticide you use is cleared for the problem that you have. The oak decline and dutch elm disease is still destructive.

The golf courses are the best place for diseases to develop as conditions they require are present. Misuse of irrigation will favor disease problems. However, there are excellent fungicides to keep diseases to a minimum.

The mixtures of grasses in greens seems to be increasing. There should be a pure stand of grass treated as a nursery for a source of sod for use on greens especially. Any undesirable grass mixed in the greens should be removed as soon as it is identified but at the same time, when you remove it, you should minimize any disturbance to play.

Development of rough was quite slow in some areas because of the cool spring especially with hybrid bermudagrass where the open was held in Atlanta in June 1976. A growth stimulant, gibberellic acid, was applied beginning May 21 at 5 grams per acre and repeated at about 10 to 14 day intervals with 3 applications before the tournament beginning June 17. A 3 inch uniform rough was grown for the tournament from June 17 to 21 which would not have been possible without the stimulant to the Tifgreen. Coordination of spraying the gibberellic acid and application of fertilizer stretched and relaxed the grass so a golf ball would sink down into it giving a player more incentive to keep the ball in the fairway.

Probably the most frustrating problem this fall has been slow or lack of germination of seed for overseeding greens. It has sometimes been 2 to 3 weeks before the ryegrass would sprout and indicate overseeding would be established for winter play. There seems to be a tendency for fescue to germinate with a lower temperature than perennial ryegrass where they are used together. Greens that were overseeded at least a week to 10 days earlier than the normal overseeding dates had better germination than those seeded at regular seeding time or later. There is no doubt that the -52^{o} total collective below normal temperature for October 1976 influenced the slow germination and establishment of a good putting surface especially in the mid and upper south.

Seaside bentgrass germinated readily and is much more evident than it usually is at this time of year.

Vandalism is a problem that does not take any particular pattern. You can never anticipate when or how it will hit.

In spite of the trials and tribulations of the turfgrass manager, he still seems to have a good golf course and strives to do better at all times. In the future, the turf manager may have fewer employees while paying them more with more fringe benefits.

TURFGRASS FERTILIZATION - NITROGEN

by

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Grasses have a greater capacity to utilize nutrients, particularly nitrogen, than any other cultivated plants. Although many grasses can survive low fertility levels, their productivity, density and color is largely a function of fertilization. Nitrogen is utilized by the grass to produce new vegetative growth; thus, the nitrogen requirement for a particular turf depends partly on the need for rapic vegetative growth. For example, a golf tee or a football field would require a rapid rate of growth in order to recover from injury; whereas, such growth is not desirable in a lawn. Thus, a much higher nitrogen fertility level would be required on the golf tee or football field than on the lawn. Also, turfgrass species and varieties differ in their ability to utilize nitrogen. Bermudagrasses may respond to applications of 20-24 pounds of nitrogen per 1,000 square feet per year, but St. Augustinegrass may not respond to more than 6-8 pounds of nitrogen per 1,000 square feet per year. Certainly, with the current supply and cost of fertilizer materials, particularly nitrogen, our concern should not be how much fertilizer we can apply, but how little can we apply without reducing turf quality. Even though bermudagrass utilize 24 pounds or more of nitrogen, acceptable quality turf can be produced by 4-6 pounds under some conditions. We should also place less emphasis on color and pay more attention to producing healthy turf that is less susceptible to environmental stresses and pests.

Grass Species and Varieties

Fertilization programs must be established on the basis of the growth pattern of a particular grass. In general, we might consider three broad classifications: warm season grasses, cool season annuals and cool season perennials. Warm season turfgrasses include bermudagrass, St. Augustine, centipede, zoysia and several less common species. These grasses generally begin rapid growth in April (except in the extreme South) and continue growth into October. Fertilization of these grasses may begin in early March and continue into

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November. Heavy application rates of soluble fertilizers during the rapid growth period should be avoided since it only promotes excessive vegetative growth. Early spring (March) and late fall (October) applications of nitrogen are desirable to promote early recovery in the spring and to maintain color in the fall. Soluble nitrogen sources at a 1 to 2 pound per 1,000 square feet rate are preferred at these times because the nitrogen is readily available to the grass. Within the warm season grass classification there is a wide variation in nitrogen requirements (Table 1). Bermudagrass on a heavily used area may require two pound of nitrogen per 1,000 square feet per month; whereas, a St. Augustinegrass lawn may require only spring and fall applications of nitrogen at two pounds per 1,000 square feet.

Table 1. RELATIVE N REQUIREMENTS OF TURFGRASSES

Bermudagrass, hybrids	HIGH
Bermudagrass, common	
Bentgrass	
Bluegrass	
Ryegrass	
Tall fescue	
Zoysiagrass	
St. Augustinegrass	
Red fescue	
Centipedegrass	
Carpetgrass	
Buffalograss	LOW

Cool season annuals or cool season grasses used as temporary cover include ryegrass, *Poa trivialis*, redtop bent, red fescue and others. These grasses are used to provide color and protection to the dormant species or for temporary erosion control at construction sites. A fertilization program on temporary grasses has different objectives than that for a permanent turf. Rapid establishment and quick cover are the major objectives of the fertilization program. Thus, fall fertilization and light winter and spring fertilization would meet the requirements of a temporary cool season grass since its survival beyond early spring is generally not important.

Cool season perennial grasses including bluegrass, fescue and bentgrass have growth patterns that differ from the other grasses. The major growth periods for these grasses are fall and spring with dormant or semidormant periods in summer and winter. In the culture of these grasses it is important not to force growth with nitrogen during the dormant or semidormant periods. Most of the nitrogen

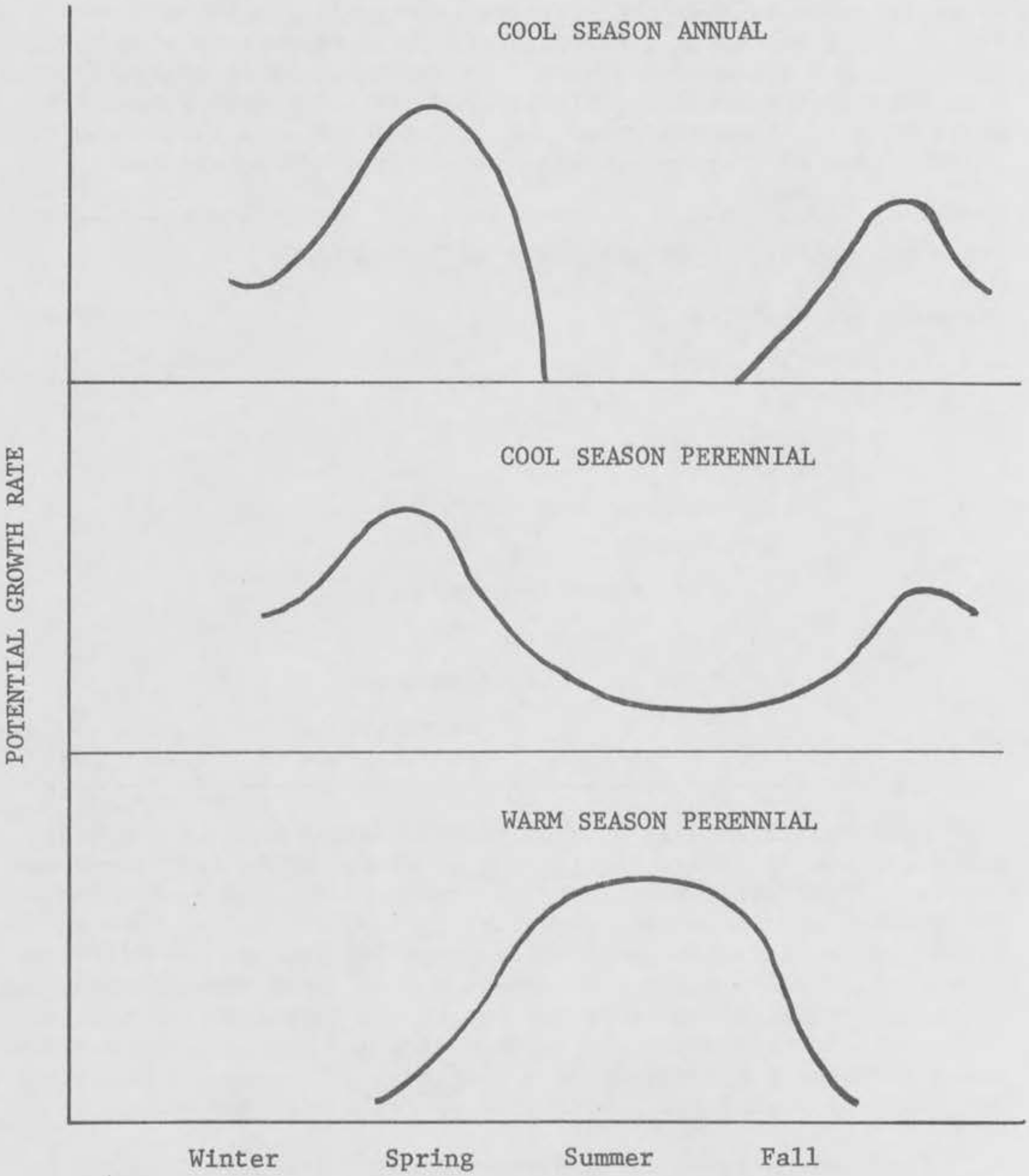


Figure 1. Growth patterns of three classifications of turfgrasses.

should be applied in the spring and fall except in the case of bentgrass golf greens which require small amounts of nitrogen throughout the year to maintain acceptable color.

Turf Use

In addition to grass species, the use of a particular turf has a major influence on the fertilization program required. A golf green that is mowed daily with the clippings removed and that receives heavy traffic has a much higher nitrogen requirement than the same grass used for fairway or lawn turf (Table 2). Golf tees and athletic fields that are damaged by traffic require nitrogen for recovery as well as for color and density. In general, the nitrogen requirement increases as the mowing frequency increases, as the mowing height decreases and as traffic increases. Also, where clippings are removed, nitrogen as well as phosphorus and potassium requirements are increased. All of these management practices are determined by the use of the turf facility.

Table 2. Turf use largely determines the nitrogen requirement for a particular grass variety.

Grass Variety	Turf Use	Nitrogen Requirement (lbs N/1000/year)
Common bermudagrass	golf course	8
	lawn	6
	roadside	2
Tifgreen bermudagrass	golf green	18
	fairway	6
	lawn	6
Emerald zoysiagrass	golf tee	8
	lawn	4
St. Augustinegrass	lawn	4
	roadside	2

Nitrogen Sources

Fortunately for the turf manager, alternative sources and formulations of nitrogen are available to meet most of his requirements. This certainly was not the case several years ago when the only material available to turf managers was the same as that available for crop production. Turfgrasses have fertilizer requirements that differ from most crops, since turf is maintained in a vegetative growth stage and is a perennial crop. Consequently, turf has a higher nitrogen requirement and a lower phosphorus and potassium requirement than most crops. Also, since a uniform growth rate is desired in turf, slow release formulations of nutrients, particularly nitrogen, are sometimes preferred over the soluble nitrogen sources utilized for crop production. Speciality fertilizers for turf include activated sewage sludge (Milorganite), ureaformaldehyde, IBDU, sulfur-coated materials and special formulations of soluble and slow release fertilizer materials such as a 16-6-12 fertilizer with half of the nitrogen from an organic source.

These organic and slow release fertilizers have several advantages over the soluble fertilizers. First, the organic and slow release materials do not result in the burst of vegetative growth that follows the application of soluble nitrogen materials. Second, the hazard of burning the turf is not as great as with the soluble sources. Third, the frequency of application is not as high as with the soluble materials. And, finally, leaching losses (movement of the nitrogen below the rootzone of the turf) are much less with the organic and slow release nitrogen sources than with the soluble sources.

Nitrogen Efficiency

Nitrogen is readily lost from the grass-soil environment without proper planning and management. Many factors influence the recovery or efficiency of utilization of nitrogen by a turf. Soil texture is one factor that determines the most efficient rate and source of nitrogen fertilization. Coarse-textured soils such as sands and loamy sands require small, frequent applications of nitrogen if soluble sources are used. Heavier, less frequent applications of slow release nitrogen sources may be used on sandy soils without excessive loss of nitrogen. Irrigation rates should be controlled to prevent excess leaching of nitrogen through the rootzone (Figure 2). Light, frequent irrigation is necessary on coarse-textured soils and heavier and less frequent irrigation may be practiced.

Clipping removal has a significant effect on the efficiency of nitrogen utilization (Table 3). Where clippings are removed from golf greens or lawns, the nitrogen contained in the clippings (3 to 4% of dry weight) is lost from the system. Whereas, nitrogen may be recycled through the grass several times where clippings are not removed. Thus, turf areas where clippings are not removed require less nitrogen than those areas from which clippings are removed.

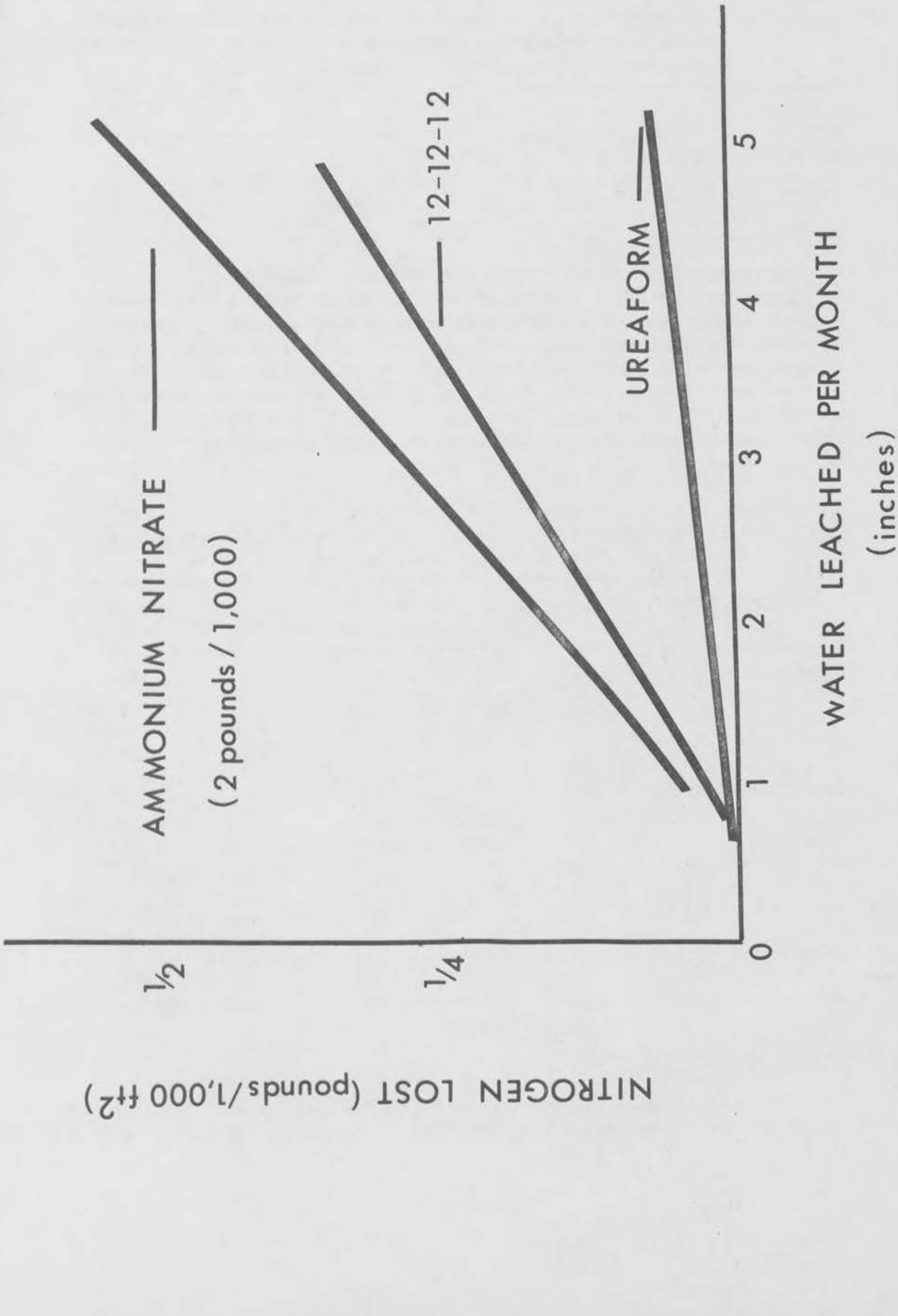

AMMONIUM NITRATE
(2 pounds / 1,000)
12-12-12
UREAFORM
WATER LEACHED PER MONTH
(inches)
NITROGEN LOST (pounds/1,000 ft2)
1/2
1/4
0
1
2
3
4
5

Table 3. Pounds of N, P_2O_5 and K_2O applied and removed per 1,000 square feet during one year from a Tifgreen bermudagrass golf green, Corpus Christi, Texas.

	N	P_2O_5	K_2O
Applied (estimated)	18	3	6
Removed in clippings (measured)	6.5	1.6	3.4

Although failure to remove clippings has been thought to lead to thatch accumulation, research has indicated little relationship between thatch and clipping residues except where heavy rates of nitrogen are applied. Nitrogen efficiency and utilization is also reduced by heavy thatch accumulation. Fertilization practices that do not promote thatch development also increase the efficiency of nitrogen utilization in turf (Table 4 . In addition, significant amounts of nitrogen are tied up in the thatch layer of a heavily thatched turf.

Table 4. Thatch accumulation in a Tifgreen bermudagrass putting green as affected by nitrogen sources and rates.

Nitrogen Source	Rate (lbs/1,000/12 wk. period)	Thatch (mm)
Milorganite	4	6.0
	6	6.1
	12	7.1
Ureaformaldehyde	4	5.6
	6	6.6
	12	7.1
Ammonium sulfate	4	6.7
	6	6.9
	12	7.7

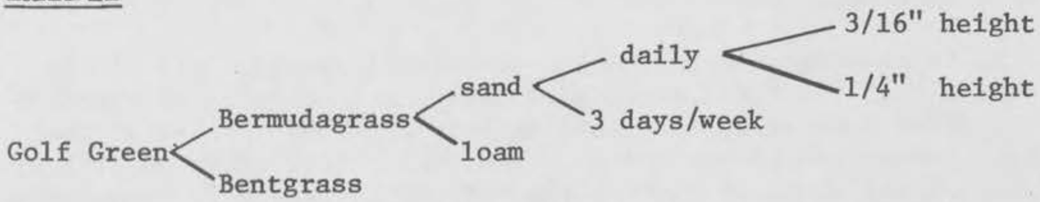
Fertilization Programs

Fertilization programs cannot be defined without specific knowledge of the grass varieties, turf use, soil type, irrigation schedule and mowing practices (height, frequency and clipping removal). Table 5 illustrates 16 potential situations on golf greens that require different fertilization programs. Other factors such as level of thatch, the length of the growing season, the desired results and the cost may place additional limitations on the fertilization program. Thus, individual programs must be established on the basis of research recommendations, previous experience and demonstrated results.

Table 5. Factors that influence the frequency, rate and source of nitrogen fertilization.

Turf Use	Grass Variety	Soil	Irrigation	Mowing Practices

EXAMPLE



WEED CONTROL IN BERMUDAGRASS TURF

by

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Weed control, whether in row crops or in turf, is primarily a management decision. The methods employed will vary with the available resources and with the expertise of the manager. Certainly, a vigorous healthy turf should be the cornerstone on which any weed control program is based.

While no single approach to weed control provides all of the answers all of the time, herbicides have been incorporated into the weed control program of most turf managers. When applied at the correct dosage and at the correct time, herbicides offer an effective and economical means of controlling many of the weeds in bermudagrass turf.

There are certain principles which are applicable to most situations in which herbicides are involved. First, herbicides should never be considered as fertilizers. Invariably the turf will also be affected by the herbicide but if a recommended herbicide is applied at the proper rate and time, the turf will recover with no permanent injury. Secondly, when the weed to be controlled is closely related to the turf, it is difficult to control the weed with chemicals without injuring the turf. For example, it would be extremely difficult to remove common bermudagrass from a Tifgreen bermudagrass turf without injuring the Tifgreen bermudagrass.

Herbicides Suggested for Established Bermudagrass Turf

Basically, the herbicides suggested for use in bermudagrass turf are divided into categories - those to be applied before the weeds germinate and those to be applied after the weeds have emerged. The preemergence herbicides include Balan, Dacthal, Betasan, Kerb and Princep. The postemergence herbicides include 2,4-D, Silvex, Mecoprop, MSMA and Endothal.

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Balan is a member of the dinitroaniline family of herbicides which includes chemicals such as Treflan, Cobex, Amex 820, Basalin and Tolban. Although liquid formulations of Balan are available, granules are usually applied in turf. Two applications per year are usually required - one in early March to control summer annual weeds and the other in September to control winter annual weeds. Rainfall or sprinkle irrigation after application usually increases effectiveness. Weedy grass such as crabgrass, goosegrass and annual bluegrass are more readily controlled than are broadleaved weeds such as sheppard's purse. Although some root pruning may occur, Balan can generally be safely used near desirable trees and shrubs. However, overseeding with annual grasses must be delayed and perennial weeds are usually not controlled.

Although Dacthal does not belong to the dinitroaniline family, its weed control spectrum is somewhat similar to Balan in that both herbicides are more effective against annual grasses than against broadleaved weeds. Also, Dacthal can be safely used near desirable trees and shrubs and will not readily control perennial weeds. Dacthal may be applied as a wettable powder and is generally applied in the fall or before the bermudagrass breaks dormancy in the spring. Its persistence is somewhat dependent on rainfall or irrigation in that it leaches readily in sandy soils but may be quite persistent under dry conditions.

Diphenamid is another preemergence herbicide suggested primarily for control of annual grasses in bermudagrass turf. It is available as a wettable powder and is generally applied in the fall or before the bermudagrass breaks dormancy in the spring. Its persistence is somewhat dependent on rainfall or irrigation in that it leaches readily in sandy soils but may be quite persistent under dry conditions.

Betasan is a broad spectrum herbicide which effectively controls both broadleaved and grassy weeds. It is applied in both liquid and granular form. It is generally safe to use near desirable trees and shrubs and is generally considered to be more persistent in the soil than is Balan or Dacthal.

Princep is perhaps the most persistent of the preemergence herbicides suggested for use in bermudagrass turf. It is generally applied to dormant turf from November to early May before weeds emerge. Its use should be restricted to native bermudagrass and to situations where overseeding is not necessary. Princep is somewhat more effective against small seeded broadleaved weeds than it is against grasses but it usually provides satisfactory control of both. Some injury to the turf may be observed especially on alkaline soils. Also Princep should not be used under the drip line of small trees or shrubs.

Kerb differs from the above chemicals in that it may be applied either preemergence or postemergence. However, it has a rather limited control spectrum and is used primarily for the control of annual bluegrass. If applied postemergence, Kerb should be used while the bluegrass is in the 1 to 2 leaf stage or poor control may result. Kerb is available as a wettable powder and overseeding should be delayed for at least 90 days after application.

Banvel, 2,4-D, Mecoprop and Silvex are all "hormone-like" herbicides applied to control broadleaved weeds. For best results, these herbicides should be applied when the weeds are young and actively growing. Also the hazzard to desirable flowers and shrubs from the drift of these herbicides should be recognized. By spraying at lower pressure when there is little wind, one can reduce physical drift. By using salt formulations, vapor drift can essentially be eliminated. Salt formulations may leach into the root zone of desirable trees, but, at suggested rates of usage, the injury to trees from root uptake is usually limited to a slight leaf curl.

Although MSMA is applied postemergence, it is not a "hormone-like" herbicide but is considered to kill weeds on contact. It is especially useful for the control of grassy weeds with broadleaves such as Dallisgrass, grassbur, goosegrass and crabgrass. MSMA has little soil activity so repeated applications may be required. An advantage to the low soil activity of MSMA is that overseeding can be accomplished soon after application.

Experimental Chemicals for Turf

Although governmental regulations and increasing costs have tended to reduce the availability of new herbicides, some recently introduced herbicides appear to have a place in a turf program. Ronstar, a new herbicide from Rhodia, looks promising for control of a number of weeds including annual bluegrass, corn speedwell and hop clover. Ronstar is applied preemergence at a rate of 3 to 4 pounds per acre. Research from Georgia indicated that 2 or 3 annual applications of Ronstar did not reduce the turfgrass quality of 5 varieties of bermudagrass but 4 annual applications did effect the early green-up of some varieties.

Amex 820 is a new preemergence herbicide from Amchem. It belongs to the dinitroaniline family of herbicides and should have many of the characteristics of Balan. Probe, a new product of Velsicol, has shown promise for postemergence control of goosegrass and crabgrass with a minimum of discoloration in the turf.

Because of low crop tolerance, Roundup, a herbicide from Monsanto, will probably have limited use directly in turf. However, for turf renovation and for weed control in areas where a non-selective herbicide is needed, Roundup has tremendous potential. Its ability to control perennial plants without any significant soil residue makes Roundup an almost unique herbicide.

Summary

Although no single approach to weed control is completely satisfactory, herbicides often fit into the weed control program. A variety of herbicides are available for pre- or postemergence use. Apparently, fewer new herbicides are being released than in previous years because of increased costs and governmental regulations. Always use herbicides and other chemicals in accordance with label instructions.

SALINITY INTERACTIONS WITH FERTILITY AND MANAGEMENT

by

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Good soil conditions, both physical and chemical, are necessary for the maintenance of quality turfgrass.

Soils in arid to semi-arid parts of the country are often characterized by salt accumulation and/or high soil pH. However, this condition is not necessarily limited to these sections of the country. Saline conditions also occur along coastal regions and in humid climates where saline ground water exists. In regions where these conditions do exist, special cultural practices are required to maintain an acceptable level of turfgrass quality.

Soil salinity refers to excess salts in the soil. Normally, we think of sodium as the main salt problem. However, excess of any salt can lead to salinity. Calcium and magnesium are salts as well as plant nutrients and excess of these chemicals can be toxic to some plants. Other examples of salts are: epsom salt ($MgSO_4$), gypsum ($CaSO_4$), and street salt ($CaCl_2$).

Salt problems in soils usually develop in one of three ways: salts already present in the soil; high ground water tables; and from salts added in the irrigation water. Salt accumulation in the soil through irrigation is by far the most frequent cause of salt accumulation. Amounts of salt added to a soil by irrigation water over a six year period when 36 inches of water is applied each year is shown in Table 1.

Water containing one ton of salt per acre-foot is generally considered to be good quality water, yet in two years enough salt could accumulate to harm salt-sensitive plants and in four years most plants could be seriously affected. Therefore, salts added to the soil must be removed before accumulation becomes serious. This can only be accomplished by leaching; that is, by washing the salts down through the soil below the bottom of the rootzone. Thus, leaching and drainage become essential in the control of salinity.

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TABLE 1

Quantities of Salt Added to the Soil by Annual Applications of 3 Acre-Feet of Water of Various Salt Concentrations

tons of salt per acre-foot water applied	Tons of Salt Added to the Soil[1]					
	1 Year	2 Years	3 Years	4 Years	5 Years	6 Years
0.5	1.5	3	4.5	6	7.5	9
1	3	6	9	12	15	18
2	6	12	18	24	30	36
4	12	24	36	48	60	72
6	18	36	54	72	90	108

[1]These amounts will accumulate in the soil if not leached downward with extra water.

There are three types of salt affected soils; saline, saline-alkali, and nonsaline-alkali. Saline soils contain sufficient soluble salts to injure plant growth. Sodium salts are present in saline soils, but not excessively high in proportion to calcium and magnesium salts. Soil pH is usually 8.4 or less.

Saline-alkali soils usually exist when sodium compromises more than one half of the total soluble cations and the pH remains below 8.5. Removal of excess salts will cause the soils to change to nonsaline-alkali conditions instead of normal.

Nonsaline-alkali soils do not contain large amounts of soluble salts, but do contain enough exchangeable soidum to interfere with growth of most crop plants. The dominance of sodium impairs flocculation and causes deterioration of soil structure.

Turfgrass plants absorb water and dissolved nutrients from the soil through the root hairs partly by a physical process called osmosis. Water can only move from the soil into the root as long as the osmotic pressure of the root hair is greater than that of the soil water. Salt accumulation creates a soil solution with a greater osmotic pressure than that of the root, slowing the flow of water and dissolved nutrients into the root haris. This is the major effect of excess soluble salts on plant growth. The turfgrass plants are more prone to wilting and desiccation when water absorption by turfgrass roots is restricted by the high osmotic pressure of the soil solution. The first visual symptoms of salinity effects on turfgrass are wilting and a blue-green appearance followed by an irregular stunting of growth.

Turfgrass tolerance to salinity problems varies considerably among turfgrass species and in some cases within species. Researchers are continually seeking new varieties of bermudagrass with improved salt tolerance. It should be noted that germinating seedlings are the most sensitive to salinity. This makes proper watering essential during establishment and especially during overseeding of bermudagrass greens.

Turfgrass growing on saline soils often does not respond to fertilizer applications. Most inorganic nitrogen and potassium fertilizers are soluble salts, and when salinity is the principal factor retarding growth, fertilizers often add to the problem and sometimes do more harm than good. In saline areas fertilizer is wasted each year because the chief factor limiting growth is salinity even though nutrients such as N-P-K may be deficient. Salinity must first be corrected before the turfgrass will show a response to fertilization. These soluble salts should be leached from the soil prior to application of fertilizers.

Slightly alkaline soils usually have a pH of 7.5 - 8.4. Nutrients such as phosphorus, boron, maganese, copper, zinc, and particularly iron may become limited due to a lower solubility under alkaline conditions. Measures should be taken to adjust the pH to around 7.0. Correction of slightly alkaline soil can be accomplished by the addition of soil-acidifying materials such as sulfur, sulfuric acid, and acidifying fertilizers like ammonium sulfate and ammonium nitrate.

Higher pH's (8.5 - 10.0) associated with alkali soils also affect nutrient availability. While phosphorus and iron are more available at these pH's, plant growth is usually restricted because of the toxicity of other elements such as aluminum, sodium and sometimes boron. Also, under alkali conditions the sodium may induce deficiencies of other cations, particularly calcium and magnesium.

High pH and salt accumulation in soils will impair good turfgrass growth. When selecting a location for a golf course, it is essential that water quality (salinity and sodium hazard), salinity of soil, and drainage potential of the soil all be determined. If salts exist in the water supply and good internal drainage is not provided, it is assured that salt accumulation will occur.

WORKSHOPS

Mowing

Calibration of Sprayers

CALIBRATION OF SPRAYERS

by

Dave Weaver*
Texas Agricultural Extension Service

Sprayer calibration involves speed, pressure and nozzle size. If spray equipment does not have an accurate speedometer, the desired speed in miles per hour (MPH) can easily be determined. Pressure for herbicide spraying should be between 20 and 40 psi. Higher pressure is desirable for insecticide and fungicide spraying. Nozzle size selection depends upon the quantity of solution suggested on the pesticide label in gallons per acre (GPA).

The accompanying table will aid in selecting the correct nozzle tip for the pressure and speed that is desired or practical. This table was taken from a Spraying Systems Company catalogue. Similar charts are available from other spray equipment manufacturers and are equally useful.

Numerous calibration methods are available and can be used successfully. This procedure is relatively simple and fast. The only equipment required is a steel tape, two stakes, a watch with a second hand and a container marked in ounces.

If you know the speed (MPH) you wish to travel, the gallons per acre (GPA) of spray solution desired and the nozzle spacing (W) on the boom, these values can be substituted into the formula below:

$$\text{GPM per nozzle} = \frac{\text{GPA} \times \text{MPH} \times \text{W*}}{5940}$$

*W = distance between nozzles in inches

This one formula and some simple arithmetic will allow a sprayer to be calibrated in a few minutes if the desired speed is known in miles per hour (MPH).

To determine correct MPH, set the throttle to give the desired speed and mark this setting. Set two stakes 88 feet apart. (88 feet is 1/60 of a mile or 88 feet per minute = 1 MPH.)

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With the throttle set, check the time in seconds from a running start that it takes to drive the course. Repeat and get an average number of seconds to travel 88 feet. Divide 60 by the number of seconds to drive the course and this will give speed in MPH.

Example: It takes 12 seconds to drive 88 feet.

$$\frac{60}{12} = 5 \text{ MPH}$$

Now that the correct speed is known, the formula can be used.

Example problem: Using a sprayer with nozzles 20 inches apart on the boom, calibrate to apply 15 GPA operating at a speed of 5 MPH.

Solution: Using the formula: $\text{GPM per nozzle} = \frac{\text{GPA x MPH x W}}{5940}$

Substitute: $\text{GPM per nozzle} = \frac{15 \text{ x } 5 \text{ x } 20}{5940} = \frac{1500}{5940} = 0.25$

0.25 GPM is emitted from each nozzle

(The accompanying table indicates that at 5 MPH, 20 inch spacing and 15 GPA, a 8003 nozzle tip will emit 0.25 GPM at between 25 and 30 pse.)

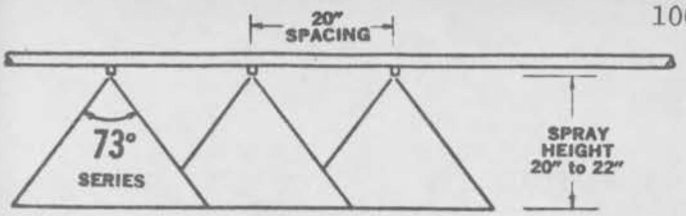
To convert to ounces, multiply by 128 (the number of ounces in a gallon).

0.25 x 128 = 32 ounces is emitted from each nozzle every minute

With the equipment sitting still, set the throttle to the 5 MPH mark as determined earlier. Turn on the sprayer and catch the output of one nozzle for one minute in a container marked in ounces. If 32 ounces are collected, the sprayer is applying 15 GPA. It may be more desirable to catch the output for 1/2 minute, or 30 seconds. In this case, 16 ounces should be collected.

If the number of ounces is very close to 16, an adjustment in pressure may be made. If the quantity is far from correct, the nozzle tips will have to be changed.

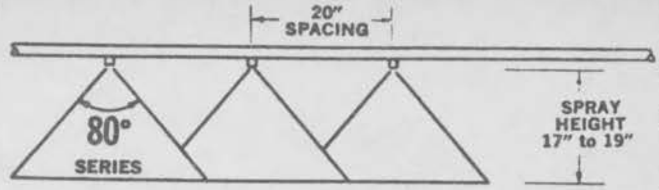
Collect the output from all nozzles to see that all are about the same (within 10%). A replacement tip may be necessary. It may be desirable to use nozzle tips one-half the size of all others on each end of the boom. This will allow for overlap of the swath as each round is made.



FLAT SPRAY TeeJet TIP NO.	LIQUID PRESSURE in p.s.i.	CAPACITY 1 Nozzle in G.P.M.	GALLONS PER ACRE 2 M.P.H.	3 M.P.H.	4 M.P.H.	5 M.P.H.	7.5 M.P.H.	10 M.P.H.
730039 • 2.5 GPA (100 MESH)	20	.028	4.1	2.7	2.1	1.6	1.1	.8
	25	.031	4.6	3.1	2.3	1.8	1.2	.9
	30	.034	5.0	3.3	• 2.5	2.0	1.3	1.0
	40	.039	5.8	3.9	2.9	2.3	1.6	1.2
	50	.044	6.5	4.3	3.3	2.6	1.7	1.3
	60	.048	7.1	4.7	3.6	2.8	1.9	1.4
730077 • 5 GPA (100 MESH)	20	.055	8.1	5.4	4.0	3.2	2.2	1.6
	25	.061	9.0	6.0	4.5	3.6	2.4	1.8
	30	.067	10.0	6.6	• 5.0	4.0	2.6	2.0
	40	.077	11.4	7.6	5.7	4.6	3.0	2.3
	50	.08	12.7	8.5	6.4	5.1	3.4	2.6
	60	.09	14.0	9.3	7.0	5.6	3.7	2.8
730116 • 7.5 GPA (100 MESH)	20	.08	12.1	8.0	6.0	4.8	3.2	2.4
	25	.09	13.6	9.1	6.8	5.4	3.6	2.7
	30	.10	15.0	10.0	• 7.5	6.0	4.0	3.0
	40	.116	17.2	11.5	8.6	6.9	4.6	3.5
	50	.13	19.2	12.8	9.6	7.7	5.1	3.8
	60	.14	21	14.0	10.6	8.4	5.6	4.2
730154 • 10 GPA (100 MESH)	20	.11	16.1	10.7	8.1	6.4	4.3	3.2
	25	.12	18.0	12.0	9.0	7.2	4.8	3.6
	30	.13	20	13.3	• 10.0	8.0	5.3	4.0
	40	.154	23	15.2	11.4	9.1	6.1	4.6
	50	.17	26	17.0	12.8	10.2	6.8	5.1
	60	.19	28	18.6	14.0	11.2	7.5	5.6
730231 • 15 GPA (50 MESH)	20	.16	24	16.1	12.1	9.7	6.5	4.9
	25	.18	27	18.0	13.5	10.8	7.2	5.4
	30	.20	30	20	• 15.0	12.0	8.0	6.0
	40	.231	34	23	17.1	13.7	9.1	6.9
	50	.26	38	26	19.2	15.3	10.2	7.7
	60	.28	42	28	21	16.7	11.2	8.4
730308 • 20 GPA (50 MESH)	20	.22	32	21	16.1	12.9	8.6	6.5
	25	.24	36	24	18.1	14.5	9.7	7.3
	30	.27	40	27	• 20	16.0	10.7	8.0
	40	.308	46	30	23	18.3	12.2	9.2
	50	.34	51	34	26	20	13.6	10.2
	60	.38	56	37	28	22	14.9	11.2
730385 • 25 GPA (50 MESH)	20	.27	40	27	20	16.1	10.8	8.1
	25	.30	45	30	23	18.0	12.0	9.0
	30	.33	50	33	• 25	20	13.3	10.0
	40	.385	57	38	29	23	15.2	11.4
	50	.43	64	42	32	26	17.0	12.8
	60	.47	70	47	35	28	18.6	14.0
730462 • 30 GPA (50 MESH)	20	.33	49	32	24	19.4	12.9	9.7
	25	.37	54	36	27	22	14.5	10.9
	30	.40	60	40	• 30	24	16.0	12.0
	40	.462	69	46	34	27	18.3	13.7
	50	.52	77	51	38	31	20	15.3
	60	.57	84	56	42	34	22	16.8
730616 • 40 GPA (50 MESH)	20	.44	65	43	32	26	17	13
	25	.48	72	48	36	29	19	14
	30	.53	80	53	• 40	32	21	16
	40	.616	92	61	46	37	24	18
	50	.69	102	68	51	41	28	21
	60	.75	112	75	56	45	30	22
730770 • 50 GPA (50 MESH)	20	.54	81	54	40	32	21	16
	25	.61	90	60	45	36	24	18
	30	.67	100	67	• 50	40	27	20
	40	.770	114	76	57	46	30	23
	50	.86	127	85	64	51	35	26
	60	.94	139	93	70	56	37	28
730924 • 60 GPA (50 MESH)	20	.65	97	66	50	40	26	20
	25	.73	108	72	54	43	29	22
	30	.80	120	80	• 60	48	32	24
	40	.924	137	92	69	55	37	28
	50	1.03	155	103	77	62	41	31
	60	1.13	170	113	85	68	45	34

• Indicates "standard" Gallons per Acre coverage at 30 PSI and 4 MPH tractor speed.

NOTE: Above listed spray nozzles represent the most widely used flat spray sizes. Many other sizes also available . . . including nozzles producing 95°, 110° and 150° spray angles. Write for information.



FLAT SPRAY TeeJet TIP NO.	LIQUID PRESSURE in p.s.i.	CAPACITY 1 Nozzle in G.P.M.	GALLONS PER ACRE 2 M.P.H.	3 M.P.H.	4 M.P.H.	5 M.P.H.	7.5 M.P.H.	10 M.P.H.
800067 • 4.3 GPA (100 MESH)	20	.05	7.0	4.7	3.5	2.8	1.8	1.4
	25	.055	7.8	5.2	3.9	3.1	2.1	1.6
	30	.06	8.6	5.7	• 4.3	3.4	2.3	1.7
	40	.067	9.8	6.6	4.9	4.0	2.6	2.0
	50	.07	11.0	7.4	5.5	4.4	3.0	2.2
	60	.08	12.0	8.1	6.0	4.9	3.3	2.5
8001 • 6.4 GPA (100 MESH)	20	.07	10.5	7.1	5.3	4.3	2.8	2.2
	25	.08	11.8	7.8	5.9	4.7	3.1	2.4
	30	.09	12.9	8.6	• 6.4	5.1	3.4	2.6
	40	.10	14.9	10.0	7.4	6.0	4.0	3.0
	50	.11	16.7	11.2	8.3	6.7	4.5	3.4
	60	.12	18.2	12.2	9.1	7.4	4.9	3.7
80015 • 9.7 GPA (100 MESH)	20	.11	15.7	10.5	7.8	6.3	4.3	3.2
	25	.12	17.5	11.7	8.8	7.1	4.7	3.6
	30	.13	19.2	12.9	• 9.7	7.7	5.2	3.9
	40	.15	22	14.9	11.1	8.9	6.0	4.5
	50	.17	25	16.7	12.4	10.0	6.7	5.0
	60	.18	27	18.2	13.6	10.9	7.4	5.5
8002 • 12.9 GPA (50 MESH)	20	.14	21	14.0	10.5	8.4	5.6	4.2
	25	.16	23	15.7	11.8	9.4	6.3	4.7
	30	.17	26	17.2	• 12.9	10.3	6.9	5.2
	40	.20	30	20	14.8	11.8	7.9	5.9
	50	.23	33	22	16.5	13.2	8.8	6.6
	60	.25	36	24	18.1	14.4	9.7	7.2
8003 • 19 GPA (50 MESH)	20	.21	32	21	15.7	12.6	8.4	6.3
	25	.24	35	23	17.6	14.1	9.4	7.1
	30	.26	38	26	• 19	15.4	10.3	7.7
	40	.30	45	30	22	17.8	11.8	8.9
	50	.34	50	33	25	20	13.2	10.0
	60	.37	55	36	27	22	14.4	10.9
8004 • 26 GPA (50 MESH)	20	.28	43	28	21	16.8	11.2	8.4
	25	.32	47	31	24	18.7	12.5	9.4
	30	.35	51	34	• 26	21	13.7	10.3
	40	.40	59	40	30	24	15.8	11.9
	50	.45	66	44	33	27	17.7	13.3
	60	.49	73	49	36	29	19.4	14.6
8005 • 32 GPA (50 MESH)	20	.35	53	35	26	21	14.0	10.5
	25	.40	59	39	29	23	15.7	11.7
	30	.43	64	43	• 32	26	17.2	12.9
	40	.50	74	49	37	30	19.8	14.9
	50	.56	83	55	42	33	22	16.6
	60	.61	91	61	45	36	24	18.2
8006 • 39 GPA (50 MESH)	20	.42	63	42	31	25	16.9	12.6
	25	.47	70	47	35	28	18.7	14.1
	30	.52	77	52	• 39	31	21	15.5
	40	.60	89	59	45	36	24	17.8
	50	.67	100	66	50	40	27	20
	60	.73	109	73	55	44	29	22
8008 • 52 GPA (50 MESH)	20	.56	84	56	42	34	22	17
	25	.63	94	63	47	37	25	19
	30	.69	103	69	• 52	41	27	21
	40	.80	119	79	59	48	32	24
	50	.89	132	89	66	53	35	27
	60	.98	145	97	73	58	39	29
8010 • 64 GPA	20	.70	105	70	53	42	28	21
	25	.78	117	78	59	47	31	24
	30	.86	128	86	• 64	51	34	26
	40	1.00	148	99	74	59	40	30
	50	1.11	165	111	83	66	44	33
	60	1.22	181	121	91	73	49	36
8015 • 97 GPA	20	1.06	157	105	79	63	42	32
	25	1.23	176	117	88	71	47	35
	30	1.30	193	129	• 97	77	52	39
	40	1.50	222	148	111	89	59	45
	50	1.67	248	165	124	100	67	50
	60	1.83	272	181	136	109	73	55
8020 • 128 GPA	20	1.41	209	140	105	84	56	42
	25	1.58	235	156	117	94	63	47
	30	1.73	257	171	• 128	103	69	51
	40	2.00	297	198	149	119	79	59
	50	2.23	331	221	166	132	88	66
	60	2.45	364	242	182	146	97	73

OPERATION OF MOWING EQUIPMENT

by

Jim Joplin*
Jacobsen Manufacturing Company
Tyler, Texas

I would like to thank Dick Duble and Dr. Beard for asking me back to your conference this year.

My topic, like Tony's, could take a full day to cover if we took every type of mowing equipment individually. So we will try to hit the high spots.

Let's Face Facts! Ninety percent of all installations buying mowing equipment today have one primary goal. How fast can I get the job done?

Let's talk about speed. First of all, speed is a relevant thing. If it takes 2 hours to do a job now, and you buy a piece of equipment to do it in 1 hour, you must be doing 1 of 2 things.

1. Getting a piece of equipment of the same size to cover the area at twice the speed--

2. Getting a larger piece of equipment with twice the width of cut at the same speed.

But do we only need speed? We have other considerations.

Secondary considerations, to most buyers, after they have found a piece of equipment that will cut the time of their job in half, leaving their turf in quality shape are safety, efficiency of the equipment, and maintenance on the equipment.

In general, this brings other points to question.

1. Why are you mowing?
   Just to get it cut? For safety, health, fire prevention, vision on roads, o.k. I'll accept rough rotories, flails, or sickle bar mowers.

   But most of us are here to better turf areas and their use. So we are mowing turf, not just cutting grass. We have to consider the turf, its playability, its wear, and of course, its aesthetic value. So high quality rotories and reels are the answer.

---

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2. Types of turf or grass areas to be mowed. Terrain. Soil and weather conditions. Area use. Limiting factors such as personnel, operating budget, safety of people and property in and around the area have to be weighed.

Take some time--get the right equipment! Let's discuss the types of equipment we all know, their pluses and their minuses in this regard.

1. Rotories
   A. Speed? Sure--the fastest mowing equipment made. Some manufacturers claim their rotories will mow up to 10-11 mph.

   B. Quality of cut? If kept sharp okay for most areas of general mowing. Quality of cut decreases with higher speed and dullness of blades.

   C. Safe? Yes? No? Maybe?
   Depending on the terrain, operator, and design and condition of the equipment, all the aforementioned apply. Surely they have safety problems.

   D. Efficiency of use. Very efficient for areas it's designed for. For all practical purposes you can say it's the most maneuverable piece of mowing equipment made, when all things are right. Condition of the blades, power source, adjustments to the area to be mowed, and the skill of the operator all have an effect on efficiency.

   E. Maintenance of equipment. High? Low? Depends on use of the rotory. Certainly the quality of the finished work depends on blade sharpness, blade tip speed, efficiency of power source, and general working of the unit which takes lubrication, adjusting to conditions, and inspection for wear.

   High maintenance = Good Quality of Cut
   Low maintenance = Poor Quality of Cut

2. Reel Mowing Equipment

   A. Speed? Not as fast as rotories when comparing ground speed. But where reel mowing has its greatest advantage is in the ability to cover wider swaths of cut with the same or lower power source engine horse power.

   A 20 hp. power source that can operate a 6 ft. rotory at 8 mph, can use an 11 ft. reel mower at 4-6 mph in the same terrain.

   B. Quality of cut? The highest quality of cut available, whether it be with ground driven units or even higher if the reels are powered.

C. Safe? I think there is little question that reels are the safest way to mow large areas.

D. Efficiency of use? High efficiency of reels is predicated on 4 things.

1. Terrain where it's used.
2. Volume or percent of grass to be removed.
3. Condition and adjustment of mowing units.
4. Frequency of use.

Anyone of the aforementioned terrain, condition and adjustment of units, the frequency of use, which will sometimes determine the amount of leaf volume cut and height of cut, can, if not right, reduce the efficiency of a reel mowing unit.

E. Maintenance of equipment. Let's face it. You get what you pay for; whether it be in money or time and effort in maintaining your equipment.

Properly maintained and adjusted reel equipment will give you the quality and efficiency you desire. Less time spent in this area will give you less quality. If you are satisfied with the quality of the job your reel mowing equipment does, with the amount of maintenance you perform, that's o.k.

But lets consider this question. If we were using rotories, flails, etc. in high quality turf areas, would you have to have higher maintenance, adjusting, and preparation costs? Of course you would. You get what you pay for.

3. Flails and Sickle Bars

A. Speed?

Proper operation is about the same speed as with reels. As with rotories the terrain and other limiting factors on reels are overcome with flails and sickles.

B. Quality of Cut? Much less than reels and high quality rotories. Here again ground speed, as it goes up, will generally lower your quality of cut.

C. Safe? Sure - very safe to especially surrounding people and property.

D. Efficiency of use? For the job they are designed to do, they do it well. But in quality turf, they leave a lot to be desired in cutting efficiency.

For the most part you, as turf area managers, have at your disposal an arsenal of tools in power equipment not known to any other part of the world.

Equipment Built for Safe Operation

Since the O.S.H.A. statutes have come about, all manufacturers of power mowing equipment have spent thousands of dollars to make their equipment operator proof. Switches, sensors, and mechanical interlocks have come into every day use and I dare say everyday misuse.

Toro, Jacobsen, and most other major equipment manufacturers now use certain safety mechanisms to try and prevent operator and maintenance personnel injuries. Certainly most riding equipment now have key switches that have to be turned on before they can be started - both recoil and electric start.

Most either have to be out of gear, clutch in, or hydro in neutral before starting. Powered reel mowers and rotary mowers should have a safety switch to keep their units off until machine is started. These safety switches are to protect the operator or maintenance man.

Some dual range transmission hydrostatic units even have switches to automatically shut down the engine if it is tried to be operated in high or transport range. Hydrolic mowing tractors have sensor interlocks to protect the machine from careless operators when lowering or raising units. These safety features are to protect the machine.

Each machine comes with an operator's manual. All these switches and interlocks are thoroughly explained in it. Do you know the operating instructions for that Toro, that Jake, that's in the owner's manual? Better still do you even know where your manual is? Did you even get one? If you don't know the operating procedures, please take the time to get with your turf salesman and the book and find out. If you can't find your book or you didn't get one, please ask your salesman to get one for you and then use it. Then for God's sake don't keep it to yourself!

How many here are or have come up through the ranks as equipment operators? How much actual instruction did you receive when you got to operate the first Triplex Greensmower? "Get on it. Start it up. Mow across the green until you can make a clean up pass. And-uh- by the way, don't fall off."

That was your instructions if you were lucky. A new hydraulic mowing tractor? "You've pulled gangs, right? You've driven a tractor, right? You'll do all right." That's about the extent of it.

How about you managers? You have operators that you wouldn't turn loose in you 1969 Chevy pick up. But yet, without a whole lot of instruction, you let them operate a $15,000 turf tractor. Get yourself and your operators educated.

When you got that new hydrostatic mowing unit, did you understand that the engine rpm should be 75 to 100% at all times when it was in use? Did you make sure your operator understood this and did it? If you didn't, when it started marcelling, or worse, yet when you dropped a transmission, did you raise hell? Boy, did you!

But whose fault was it? Yours for not reading the owner's manual? Maybe! Your salesman for not spending enough time with you on the equipment? Could be! Whoever was at fault is of no consequence. The mower failed, you have down time, other costs, and your boss is as mad as a wet hen.

Could all this be prevented? Sure it can! I am going to give you an idea that I'm sure is not going to go over with some turf equipment salesmen.

When you purchase a new piece of equipment, especially if it's one you have not been using before, ask your salesman to come out when it's delivered or the next day and go over the operation, adjustments, and maintenance of it.

He can only say three things:
1) "O.K., sure, I can do it."
2) "I'm sorry, I've got to be somewhere else."
3) "I just sell 'em, I don't know nothing about 'em."

If the answer is # 2 or #3, then tell him that when the equipment is delivered by Colonial, Goldthwaite's, Watson, or whomever, you will have them take it back. He will then say o.k. and we all will learn about it - you, your operator, and your salesman or his replacement will teach you.

Another good idea is to teach a backup man. What happens when your greens mower operator gets the flu or quits or whatever? Do you have to mow greens? As a turf manager you have more to do than that. Or you should. So have a back up man or men who know and understand the operation of several pieces of equipment.

Just let me say this before I close and get down off my soap box. Our company, Toro, distributors, and tech shcools have educational courses in equipment maintenance. We will see the day, and it should start at your installation, when we will put the same effort into operators. You can have the best designed, skillfully built, finely tuned and adjusted piece of equipment, but what do we do with it? We turn it over to the least paid, least educated, and possibly least mature people in our organization. These are the people we have no time to have schools for. No time for giving extra incentive or responsibility to. And they have the most to do with, whether the piece of equipment operates as it should or lasts as it should.

Let's recap:

1. Assess the area to be mowed.
2. Pick the right equipment.
3. Maintain it right.
4. Train your operators to use it.

I invite your questions and discussion on mowing equipment after Tony's part of this program.

Thank you.

MOWER ADJUSTMENT AND MAINTENANCE

by

Tony Gilbert*
Goldthwaite's of Houston

A reel type mower is a precision tool and should be sharpened keeping this fact in mind. The process of sharpening a reel mower is one of reshaping the cutting edge of the bedknife and the reel blades with grinding and lapping. The object: restore the match between the reel blades and the cutting edge of the bedknife.

Sharpening is necessary when the grass is not cleanly cut and/or the cutting unit is noisy. When this occurs the reel blade edges and the bedknife edge have become rounded.

Rounded blade edges cause grass to be pinched off rather than cleanly sheared. This is undesirable to the health of the grass plant and will cause the grass ends to become discolored. That is why it is so important to keep the blades sharp to obtain a quality cut and appearance.

Sharpening is also necessary when streaking occurs or when the grass is not being cut across the entire width of the reel. Streaking could be caused by nicks on the reel blades and/or bedknife by uneven wear on the bedknife and reel blades. Nicks are caused by hitting foreign objects in the turf. Uneven wear is usually caused by over-adjustment of the bedknife to the reel.

Backlapping with a lapping compound may restore the edges and match, if the reel blade edges and bedknife edge are slightly rounded and do not have severe nicks. Oftentimes a mower is deemed by users to need grinding when reel bearing adjustment, bedknife adjustment and/or lapping is all that is necessary. Both grinding and lapping are necessary when the following condition or combination of conditions exist:

1. Severely rounded reel blade edges and bedknife edge.
2. Reel blade or blades that have become bent and are significantly higher than the others.

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3. When severe nicks exist on the bedknife and/or reel blades.
4. When uneven wear exists on the bedknife and reel blades.
5. When the reel becomes cone shaped.

Check for a cone shaped reel, prior to grinding, by measuring on one end from the reel shaft to the outer blade edge and then repeating the process on the other end. If there is a difference in measurements, the reel is cone shaped and will have to be ground to a cylinder during the grinding operation.

Refer to the grinder manufacturer's operating manual for the proper type or shape of wheel that can be properly installed on a given grinder. Utilize a medium grain silicone carbide wheel for grinding prior to and during each grinding job. The grinding wheel should be dressed with a diamond dresser. A properly dressed wheel insures smooth, even grinding and reduces the total time for each job. An improperly or undressed wheel can contribute to an uneven grind, because it will cause the operator to run too heavy contact between the wheel and bedknife or reel blade, trying to make it grind faster. This causes excessive heat build up, which results in a poor grind. An improperly or undressed wheel can cause the wheel to chatter during grinding.

Five steps to accurate reel grinding

Prior to sharpening the reel, it is important that a condition check be made on the mower. Sharpening is usually performed with the unit assembled, therefore, the quality of the finished job is greatly dependent on the proper function of the internal components. The following items require special attention:

1. The reel bearings should be free of all radial and axial movement or end play. If movement is detected the reel bearings should be either adjusted or replaced.
2. Check the reel for broken spiders or blades and repair accordingly.
3. Check all fasteners for proper tightness.
4. Clean the reel thoroughly of dirt, rust and scale. The grinding wheel guide finger will not follow the reel blade evenly if dirt or scale is on the blade surface. This will affect the quality of the grind.

Check the level of grinder prior to the grinding operation. Be sure to check the level in both directions. Consult the grinder manufacturer's manual for instructions on securing the mower in the grinder. The mower must be secured in the grinder so that no movement occurs while grinding is being performed. The most widely used principle of grinding reels is the straight line method. Some grinding equipment has the capacity to perform the hook method of reel grinding. Both methods are accurate if care is taken when mounting, aligning and grinding the reels.

The mower must be aligned in the grinder so that the reel shaft is perfectly aligned with the grinding wheel. If the reel shaft is not aligned with the grinding wheel, the reel blades may not be the same height. This could result in uneven contact with the bedknife resulting in the uneven wear pattern. To properly align, mount the aligning tool on the grinding wheel housing. This tool will align the reel shaft both level and parallel with the grinding wheel. The mower is in a vertical position on the Foley grinder, therefore, the following alignment process should be used:

1. Align the reel shaft so it is level with the grinding wheel. Starting at the non-adjustable end, position the aligning tool so the threaded rod will just contact the top surface of the reel shaft. Be sure the reel shaft is clean.
2. With the aligning tool locked in this position, pull the rod to the rear to clear the reel and move the carriage to the opposite end.
3. With the aligning tool positioned in the approximate same location of the reel shaft on the adjustable end, push the rod in toward the reel shaft and position the reel shaft so the rod will just pass over and contact the shaft, as it did on the opposite end with the grinder adjustment knob. After the adjustment has been made, pull the rod to the rear and move the carriage back to the opposite end. Recheck to be sure that both ends contact the rod in the same manner. This alignment will assure that the reel shaft is level with the grinding wheel.

Next, align the reel shaft so it is parrallel with the grinding wheel.

1. Starting at the non-adjustable end, position the aligning tool so that the threaded rod contacts the center of the side of the reel shaft. Lock the tool in position.
2. Put inward pressure on the threaded rod and turn the adjusting nut until the rod contacts the reel shaft and the nut contacts the tube.
3. Without moving the nut, pull the rod to the rear to clear the reel and slide the carriage down to the adjustable end.
4. Push the rod in toward the reel shaft. If the rod contacts the reel shaft and there is a gap between the nut and the tube, the reel will have to be adjested away from the rod until the rod just contacts the tube and the rod is against the reel shaft. If the nut contacts the tube and there is a gap between the rod and the reel shaft, adjust the grinder until the reel shaft contacts the rod and the nut is against the tube. Be sure to relax the lock securing the adjustment rod. This will avoid any binding or pre-loading. Tighten the adjustment after it has been completed. Re-check the adjustment on the non-adjustable end to be sure the alignment is the same on both ends. When you are sure the adjustment is correct, the reel is ready to grind.

Position the aligning tool in the approximate same location as on the opposite end of the reel and let the rod drop along side the reel shaft. Utilize the grinder adjustment knob to position the reel shaft so the rod contacts the shaft as it did on the opposite end. Re-check to be sure that both ends are contacting the reel shaft in the same manner. This will assure that the reel shaft is parallel with the grinding wheel.

The next procedure is to align the reel shaft so that it is level with the grinding wheel. The procedures are as follows: starting at the right end, position the aligning tool so that the threaded rod contacts the center of the reel shaft. Lock the tool in position. Be sure the shaft is clean. Put downward pressure on the threaded rod and turn the adjusting nut until it just contacts the tube. Then pull the rod up to clear the reel and move the carriage to the opposite end of the grinder.

Consecutively number each blade in the direction of normal mower rotation with felt tip marker or chalk. Next, stand in the grinder operator's position and position the grinding wheel and guide finger on the number one blade at the right end of the reel.

Reel mowers should be ground with the blade relief angle of approximately 15 degrees. This angle is determined by the grinding wheel relationship with the blade during the grinding process. As a starting point, position the guide finger in a manner that will put the blade in a parallel line between the center of the grinding wheel and the reel shaft.

Darken an area of the cutting surface of the number one blade with a felt tip pen, so the contact area between the grinding stone and the blade can be easily seen.

Adjust the grinding wheel so that it is positioned lightly against the number one reel blade where it has been darkened by the felt tip pen.

Rotate the wheel in the direction that it will turn during the grinding operation, so that the blade will be forced against the guide finger. As the wheel is rotated, a scrub pattern will appear on the blade surface.

The correct wheel to blade position will be obtained when the scrub pattern appears at the backside of the reel blade. Under no circumstances can the grinding wheel be positioned so the contact is beyond the center line of the blade toward the cutting edge. This will result in a negative grind and a poor quality of cut due to the bedknife not contacting the cutting edge of the reel blade.

Adjust either the head assembly or the guide finger until the proper scrub pattern is obtained. Before changing the position of the head assembly or guide finger, back off the infeed of the grinding wheel slightly. This will avoid damage to the wheel during the scrub pattern checks. Lock the head assembly or guide finger in place after the proper scrub pattern has been obtained and do not change the setting during the rest of the reel grinding procedures.

Dress the grinding wheel with a diamond dresser and proceed to grind. Re-check for the correct grind angle by observing the grind on the blade after the first pass has been made. Normally the grind will always be started from the right side. This should cause the grinding stone rotation to force the reel blade against the guide finger, as the carriage is moved from the right to the left end of the reel. This condition is influenced by the reel helix or twist and the grinding wheel rotation. Some mowers will have to be ground starting from the left side. This is because of the direction of the reel helix. Start with the number one blade and adjust the feed so that light to moderate contact is obtained. Then make a pass across the blade.

After the stone moves off the opposite end of the blade, rotate the reel blade downward and allow the guide finger to ride against the back of the reel blade as the carriage is moved back to the right end for the next pass.

Allowing the blade to rest against the guide finger will keep the wheel from contacting the reel blades when the carriage is moved from the left to the right to start the grind on the next blade. Continue to grind in the numerical sequence until the last blade is ground. When further adjustment of the grinding wheel is needed, be sure to adjust for light to moderate contact with the reel blade. Heavy contact can cause excessive heat build up resulting in an uneven blade surface.

The sparks coming off the grinding wheel should have a sparkler or bright appearance and travel one to two feet. The spark appearance is an indication of how well the grinding wheel is performing. Sparks that travel a short distance and are dull in color indicate the wheel needs to be dressed. Be sure to move the carriage back and forth in smooth, steady passes. The grinding wheel must move off the end of the reel on each pass. Feed adjustment should be made with the wheel off the reel blade. Do not stop the carriage or change the wheel feed while the reel blade is passing under the wheel. Serious damage to the blade will result.

Continue the grinding procedures until a sharp edge is obtained on the full length of all the reel blades. Then, without changing the grinding wheel feed adjustment make a final pass in reverse order (7, 6, 5, 4, 3, 2, 1) to compensate for grinding wheel wear. The reel should be a true cylinder when this has been completed and there should be a sharp cutting edge at the leading edge of the reel blade.

Be sure to periodically clean the carriage ways with a brush or air, so that the grinding operation will be as precise as possible. As soon as the grinding operation is complete, remove the cutting unit from the grinder and install the bedbar. Adjust the bedknife to reel relationship so that the machine can be backlapped to establish a land area and assure a perfect match between bedknife and reel.

The lapping process is a very important step in maintaining reel type mowers. Lapping must be performed when the reel blade and bedknife edges are slightly rounded and do not cut the grass cleanly with a light bedknife to reel adjustment. Lapping must be performed after a reel and bedknife have been reground to establish a land area and assure a perfect match between the bedknife and reel cutting edges. Lapping is not intended to be a reconditioning process to correct for nicked or severely rounded blades or uneven bedknife wear. Utilize a good grade of lapping compound with a soluble carrier. If the lapping solution is the type that must be mixed, add liquid detergent until the compound is of a free flowing consistency. The solution should not be thick like a paste, because it will not flow evenly onto the bedknife surface. Use of a liquid detergent as a carrier or a water soluble carrier for the compound insures that the mower can be easily washed off after the lapping has been completed and the new edge will not be destroyed by residue compounds. The proper lapping procedure is as follows: take care to be sure that the bedknife is level with the reel and light contact is evident. Operate the lapping machine so the reel turns in the reverse direction. Apply the lapping solution evenly with a 2-inch brush over the full length of the reel assuring that all blades have been covered. Apply the solution whenever the noise of the reel running against the bedknife begins to disappear or the appearance of the reel indicates there are areas where the lapping solution has dissipated. A light bedknife to reel adjustment should be maintained throughout this process. If the reel and bedknife have been resharpened, continue to lap until a 1/32-inch land area is visible on the reel blades and the cutting edges appear sharp, even and are consistent on each blade. If you are lapping dull and rounded reel blades, continue to lap until the cutting edges are sharp, even and consistent. This can only be checked by periodically shutting off the machine and examining and feeling the cutting edges. It is beneficial to lightly drag a fine file along the front of the bedknife cutting edge, after lapping, to remove any burr that may have appeared.

Thoroughly clean the machine of lapping solution after the lapping operation is completed. If the machine is not cleaned thoroughly, the compound will remove the sharp edge as soon as the reel is put into operation. Use paper to check for sharpness across the entire length of the reel and the bedknife. If the paper is not cut cleanly along the entire length of the bedknife, additional lapping or regrinding will be necessary.

Rotary mowers cut grass by the blades cutting surface impacting against the grass stems at a high velocity. The cutting edge of the blade must be kept in a sharp condition to assure a quality of cut. A dull blade will produce a ragged cut and will require an excessive amount of engine horsepower to rotate the blade.

The most common causes for rotary mowers not giving a good quality cut are due to dull cutting edges and/or bent blades. Keep the blade cutting edges as sharp as possible. It is important that the sharpening process be done correctly. Three items must be checked if a blade is removed for sharpening. The blade must be checked to insure that it is not bent and has the correct attitude in relation to the housing and ground surface.

The blade must be sharpened in the correct manner and the blade balance must be checked each time the blade is reground. It is also very important that the blade retaining nut be sufficiently tightened to assure that it will not loosen during operation.

Check the blade for straightness prior to sharpening. This can be checked by laying the blade on a flat surface. Slight bending and twisting of the blade can be corrected. If the bending is extreme the blade should be replaced. Under no circumstances should heat be used to straighten the blade.

Grind the top surface of the blade only. Try to maintain the original cutting edge angle. Do not grind the bottom surface or a chisel shape will be the result. The lowest portion of the blade that contacts the grass must be the cutting edge or the grass will not be cleanly cut and excessive horsepower will be needed.

After the blade has been sharpened, the balance must be checked. This can best be accomplished using a commercial balancer. If a commercial balancer is not available, the blade can be checked by placing it on a pin clamped in a vice. If one end of the blade swings down, material must be ground off the heavy end until the blade will stay in the fixed position. Remove the material in very small amounts to avoid removing too much. Remove the material from the tip and not the sail area.

TURFGRASS RESEARCH

Soils

Grasses

Diseases

Insects

DEVELOPMENT OF A TURFGRASS RHIZOTRON AT TEXAS A&M

by

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In June of 1976, construction of a rhizotron or root observation laboratory was initiated at the Turfgrass Field Laboratory, Texas A&M University. Basically, a rhizotron is a tunnel with part or all of the side walls adjacent to the tunnel being constructed with glass. An observer walking through the tunnel walkway can turn to either side, remove the cover from the glass, and directly observe the roots growing down the glass face. The glass face must be covered and light tight except during observation periods. Otherwise, root growth along the glass plates will be limited because roots are negatively phototropic, that is, they will grow away from the light.

Such a facility has numerous advantages for research purposes. Most importantly, a rhizotron allows direct and continued observation of the grass root system while the plant itself is growing in the field under more typical conditions. The influence of environmental and cultural conditions on root initiation, growth rate, distribution, and maturation can readily be studied. Another advantage of the rhizotron is that insects and the effects of disease causing organisms which attack the root system can be directly observed without disturbance while they are actively damaging the plant roots.

The turfgrass rhizotron utilizes root observation boxes as frames for the glass portions of the side walls. In essence, these boxes are pots with one side being made of glass. Forty eight root observation boxes (robs) were required for use in the rhizotron. Dimensions of the robs (Figure 1) were 30 inches deep, 10 inches wide, and 12 inches long. The glass observation face consisted of quarter inch, double strength glass plate. In order to enhance root growth along the glass plates, they were positioned at a 15^{o} angle off the vertical. With a turfgrass growing surface area of 120 square inches on top, the boxes hold 1.38 cubic feet of soil and provide a root observation area of 308 square inches.

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After the construction of the robs had been completed, a trench 30 feet long, 6 feet wide and 6 feet deep was excavated in the southeast corner of the turfgrass research plot area. Each side wall of the trench was lined with 24 robs, side-by-side as shown in Figure 2. Soil below the robs was retained by sheets of 3/4" exterior plywood. Both the robs and the plywood siding were held in place with a welded frame of 2" angle iron. Both Dr. K. Brown and Dr. R. Tanenbaum of Texas A&M were consulted on the rhizotron design in terms of safety and general construction.

Once the frame holding the robs and plywood siding was in place, a ceiling of 24 gauge sheet metal was placed between the two rows of robs over the top of the trench. The sheet metal was depressed downward in the center about 4 inches creating an area which could be filled with soil. This enabled the entire top surface of the rhizotron to be covered with sod. A uniform sod across the rhizotron top surface is essential if a uniform microclimate around the treatment turfs is to be attained. Bare soil, metal, or other non-transpiring surfaces would result in a differential heating and cooling. Such a differential would result in greater water use rates for that portion of the turf closest to the non-transpiring surface. Below this ceiling and between the two rows of robs is the walkway space for observers. This space is 30 feet long, 6 feet high and 3 feet wide.

Drainage from the rhizotron was provided by 3 tile drains; one beneath each row of robs and one beneath the center of the walkway floor. The walkway floor consisted of a seven-inch deep layer of pea gravel. The rhizotron was completed in August, 1976 with the installation of electric lighting and 120 v power outlets.

Currently the rhizotron is being used to study the rooting behavior of St. Augustinegrass and bermudagrass under water stress as influenced by potassium fertilization and temperature. Some of the environmental parameters being measured include temperature at various soil depths and other points in the turf and around the rhizotron. In this study the temperature is being monitored at 31 separate locations by means of copper-constantan thermocouples. Psychrometers are being used to monitor both soil water content at various depths and the turfgrass leaf water potential. Root data collected includes daily root growth rates, branching, initiation and senescence. This study is the first in a series of such research projects made possible by the construction of the Texas A&M turfgrass rhizotron. Individuals attending the 1977 Texas Turfgrass Field Day will have the opportunity to see this facility in operation.

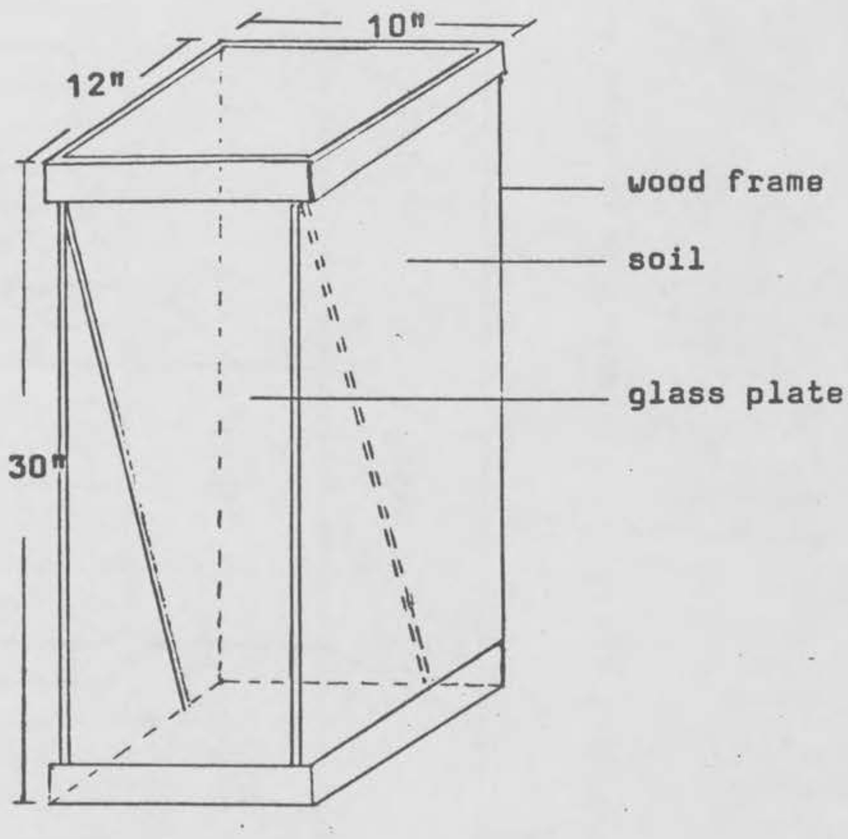

Figure 1. Root observation box with door and glass insulation removed.

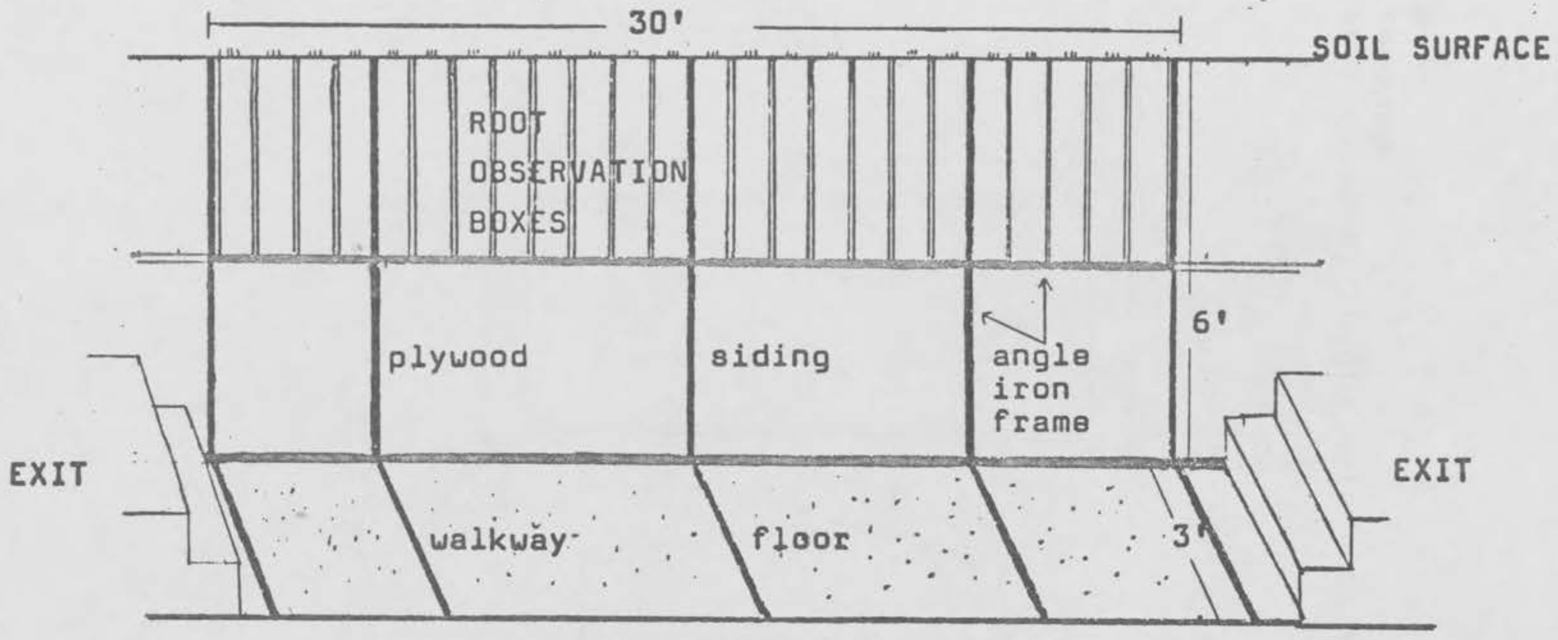

Fig. 2. Cross section of Texas A&M Turfgrass Rhizotron

SOIL MIXTURES USED FOR GOLF GREEN CONSTRUCTION

by

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A golf green is constructed by first leveling and contouring the subgrade to conform to the proposed finished grade. Ditches 6 inches wide and 6 inches deep are cut into the subgrade, usually in a herringbone or gridiron pattern. Pea gravel (1/4" diameter) is placed on the bottom of the ditches, then 4" diameter drainage tile is placed in the ditches. The ditch is then filled with pea gravel. A four-inch layer of pea gravel is then spread uniformly over the subgrade.

The soil mixture, which is usually 80-85% sand, 5-10% soil or inorganic amendment, and 10% organic amendment, should be mixed uniformly off site. The soil mixture is then placed on top of the pea gravel to a height of 12-14" without disturbing the contour of the pea gravel. The soil mixture is then rolled and the surface is ready for sprigging or seeding. The finished product is a putting green built according to United States Golf Association Green Section specifications. The green, if built properly, should have satisfactory drainage, it should resist compaction, and it should have infiltration rates of 4-6 inches per hour (10-15 cm/hr).

Since the availability of the materials used in the soil mixtures varies widely from region to region, a greenhouse experiment was devised to compare a number of the more commonly used materials. Simulated golf green profiles were constructed in metal containers which were 30 cm in diameter and 50 cm deep. The bottom 15 cm of the containers were filled with pea gravel and the upper 35 cm were filled with the various soil mixtures. The variables included sands and inorganic amendments used in golf-green soil mixtures.

Each profile was compacted by dropping a weight equivalent to 19 g/cm^2 from a height of 38 cm a total of 50 times. Infiltration rates were then measured by saturating the profile, establishing and maintaining 1.25 cm head of water above the profile, and collecting the water that flowed out of a drainage port at the bottom of the container.

Following the initial infiltration measurements, each profile was sprigged to Tifdwarf bermudagrass. The turf was watered and fertilized regularly and was mowed at a height of 3 cm. After dense, uniform stands

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of turf were established, a second set of infiltration rates were obtained. Then, the profiles were re-compacted, the turf was allowed two weeks to recover, and a third set of infiltration rates were obtained.

In the first study, all mixtures contained 80% brick sand, 10% peat moss, and 10% inorganic amendment. The various inorganic amendments included:

a) Lake Charles clay - a 70% clay soil,
b) Calcined clay fines,
c) Basic slag aggregates,
d) Polyloam - a polyethelene material which is a commercial soil amendment,
e) Ground rubber - rubber from auto tires ground into small particles, and
f) Calcined clay aggregates.

The infiltration rates of these various mixtures are shown in Table 1.

Table 1. Infiltration rates of soil mixtures containing 80% brick sand, 10% peat moss, and 10% inorganic amendment (by volume).

Inorganic Amendment	Infiltration I (after compaction)	Infiltration II (after grass establishment)	Infiltration III (after estab. and recompaction)
		cm/hr	
Lake Charles clay	84.1	27.7	0.3
Calcined clay fines	109.0	96.5	13.7
Basic slag aggregates	115.0	106.3	20.4
Polyloam	104.0	94.8	22.5
Ground rubber	113.9	93.2	22.8
Calcined clay agg.	137.7	135.9	25.2

USGA Green Section recommendations: minimum: 5.0-7.6 cm/hr
maximum: 25 cm/hr
ideal: 10-15 cm/hr

The data in Table 1 show that for each mixture, the infiltration rate decreased after grass establishment, and decreased again after establishment and recompaction. These data corroborate earlier findings of Brown and Duble (1).

The infiltration rates of the above mixtures were then measured in the USGA Physical Soil Test Laboratory and compared with the infiltration rates obtained in the greenhouse after establishment and re-compaction (Table 2). It was found that the infiltration rates obtained in the USGA laboratory were much higher than those obtained in the greenhouse. In fact, greenhouse mixtures which had infiltration rates that were acceptable according to USGA recommendations had infiltration rates that were above the maximum standard when measured in the USGA lab. It was felt that the greenhouse profiles more nearly resembled actual field conditions and that the USGA should raise the maximum standard for infiltration rates so that mixtures that were otherwise acceptable would not be excluded for having high infiltration rates.

Table 2. Infiltration rates after establishment and recompaction of soil mixtures containing 80% brick sand, 10% peat moss, and 10% inorganic amendments as measured in a greenhouse study and in the USGA Physical Soil Test Laboratory.

Inorganic Amendment	Greenhouse	USGA lab
	------------cm/hr------------	
Lake Charles clay	0.3 f	1.6 h
Calcined clay fines	13.7 cd	42.9 d
Basic slag aggregates	20.4 ab	64.3 b
Polyloam	22.5 ab	104.2 a
Ground rubber	22.8 ab	53.7 cd
Calcined clay aggregates	25.2 a	62.8 bc

Treatments within a column with different letters following them differ significantly at the .05 level using Duncan's Multiple Range procedure.

USGA Green Section recommendations: minimum: 5-7.6 cm/hr
maximum: 25 cm/hr
ideal: 10-15 cm/hr

Measurements of available water were obtained in the greenhouse by saturating the profiles and allowing them to drain to field capacity. Cores which were 11 cm in diameter by 15 cm in depth were taken from each profile and weighed. The cores were wrapped on the sides with aluminum foil and allowed to dry until the turf on the top of the cores wilted. The cores were then re-weighed. The difference between the two weights was the amount of available water for that core. No significant differences appeared between any of the above mentioned soil mixtures. There were also no significant differences in root growth measured from uniform soil cores between any of the above mentioned soil mixtures.

Since a dense, uniform stand of turfgrass was never established on the soil mixtures containing ground rubber, it was concluded that ground rubber was inadequate for use as an inorganic amendment. Mixtures containing 10% by volume Lake Charles clay were also inadequate for use in golf greens due to their extremely low infiltration rates (see Table 2). The other mixtures mentioned above were all acceptable for use in golf green construction.

In another experiment, which was a 3 x 2 factorial study of sands and inorganic amendments, all mixtures contained 80% sand, 10% inorganic amendment, and 10% peat moss. The three sands used included:

a) Brick sand - a medium textured sand which meets the USGA specifications for particle size distribution,
b) Concrete sand - a coarse textured sand which does not meet USGA specifications, and
c) Brady sand - a fine textured sand with a very narrow particle-size distribution that does not meet USGA specifications.

The two inorganic amendments used were Lake Charles clay and calcined clay fines. All treatments were replicated three times.

Measurements of infiltration rates showed that mixtures containing calcined clay fines had significantly greater infiltration rates (15.1 cm/hr) than mixtures containing Lake Charles clay (1.7 cm/hr).

Studies also showed that mixtures containing Brady sand held significantly greater amounts of available water than the mixtures containing brick or concrete sand. Brady sand mixtures also had significantly greater capillary porosities than the other sands. Bulk density measurements showed that mixtures containing Brady sand were significantly lower in bulk density than the other mixtures. Finally it was found that root growth in the Brady sand mixtures was greater than in the other mixtures. In particular, root growth in Brady sand mixtures was significantly greater than in mixtures containing brick sand which is perhaps the most commonly used sand for golf green construction. It was thus concluded that Brady sand produced a soil mixture that was superior to brick or concrete sand.

1976 WINTER OVERSEEDING STUDIES

by

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The extension of patent rights to include turfgrass cultivars has stimulated the development of extensive breeding and cultivar improvement programs in more than a half dozen private seed firms located in the cool humid regions of the United States. The result has been an unparalleled increase in the number of turfgrass cultivars now commercially available or in advanced stages of development for release to the general public. The Kentucky bluegrasses (Poa protensis L.), chewing fescue's (Festuca rubra L.), and perennial ryegrasses (Loluim perenne L.) in particular have been emphasized. Half the perennial ryegrass cultivars included in this study were not available just two years ago.

Although most of these cultivars were developed for use on higher cut lawn turfs in the cool climatic regions of the United States, attention needs to be given as to their potential for use in winter overseeding of dormant bermudagrass turfs. Accordingly, this is the first in a series of studies to be conducted over a period of four years.

MATERIALS AND METHODS

This winter overseeding study was conducted on a mature bermudagrass green located on the Texas A&M University Turfgrass Field Lab plots at College Station, Texas. Cultural practices utilized on the experimental area during the previous summer included: daily mowing at 0.25 inch; an application of 1 pound nitrogen per 1,000 square feet per growing month; applications of phosphorus and potassium as needed based on soil tests; irrigation as needed to prevent wilt; and an occasional application of diazinon as needed to control insect pests which were causing serious injury to the turf. No preemergence herbicide had been applied. The plot size was 5 x 7 feet in a randomized block design of 3 replications. Two of the replications were on Tifgreen bermudagrass and one replication was on Tifdwarf bermudagrass.

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The overseeding procedure can be summarized as follows: on October 21, 1975, the bermudagrass turf was vertically mowed intensively in five directions with the cuttings being removed by means of a mower and catcher. This severe vertical mowing was necessitated by a buildup of vegetation during the growing season. One pound of actual nitrogen per 1,000 square feet was applied on October 22 in the form of ammonium sulfate. Mowing was ceased on October 24 and the fungicide Captan was applied at the recommended label rate on October 27. The actual seeding of the plots was accomplished on October 27 and 28. It involved hand distribution of the seed uniformly over the entire plot area with the boundaries defined by a 24 inch high seeding box. The seed was then pushed into the turf by means of a bristle broom which was bounced up and down across the plot. Subsequently the plot area was topdressed at a rate of 0.4 cubic yard per 1,000 square feet. The plot area was then kept constantly moist for 14 days by irrigating lightly at 60 minute intervals between 10 a.m. and 4 p.m. No seedling diseases, either Pythium or Rhizoctonia, were observed that required a fungicide application. Mowing was reinitiated on November 3 at a higher cutting height of 5/16 inch.

The perennial ryegrass cultivars were seeded at 40 pounds per 1,000 square feet, the chewing fescues at 30 pounds per 1,000 square feet, the Kentucky and rough bluegrasses at 12 pounds per 1,000 square feet, and the bentgrasses at 3 pounds per 1,000 square feet. Among the seed mixtures, Medalists 2 and 4, Dixiegreen and the CBS Blend were seeded at 40 pounds; Medalist 400 at 38, Medalist 200 at 32; Medalist 300 at 29; Scotts 101 and 102 at 25 pounds; and Scotts 2 at 18 pounds per 1,000 square feet. These were the rates suggested by the firm providing the seed mixture.

Cultural practices utilized on the overseeded turfs during the winter period included the following: mowing 3 times per week at 5/16 inch with clippings removed. Fertilized at bi-weekly intervals at rates on a slit plot basis of 3 and 4 foot widths, respectively. The individual plots were also split in the opposite direction with one half receiving an application of iron sulfate every two weeks at a rate of 2 ounces per 1,000 square feet. Irrigation was applied as needed to prevent wilt. No fungicides were applied during the entire period of the study since no visual disease injury symptoms were evident. An application of carbaryl insecticide at the recommended label rate was made on November 4. Seedling height measurements and percent cover ratings were taken 3 times per week. Subsequently, the plots were rated visually for shoot density and/or turfgrass quality at 15 day intervals. Spring transition comparisons were made more frequently as needed along with a shoot density count.

RESULTS AND DISCUSSION

The overall performance summaries are given in Table 1 for 20 perennial ryegrass cultivars; in Table 2 for 10 chewings fescue, creeping bentgrass, rough bluegrass and Kentucky bluegrass cultivars;

and in Table 3 for 11 polystands. Breakdowns into the 11 biweekly ratings over the winter period are summarized by the same three subgroupings in Tables 4, 5 and 6. It should be indicated that the winter of 1976 was quite mild with the bermudagrass never going completely dormant in terms of complete loss of chlorophyl in the more protected leaves lower in the canopy.

Only 4 of the 10 top ranked perennial ryegrass cultivars were commercially available. They included Manhattan, Pennfine, Yorktown, and NK-200. As a group, these same cultivars also ranked superior in spring transition. There was an extended period with essentially no significant rainfall throughout November, December and the first two thirds of January. Maintenance of a green vegetative cover was provided solely through irrigation. As a result there was a gradual increase in the soil pH and salt levels. This caused the development of an irregular, mottled pattern of chlorotic growth that was most severe during the January 7th and 20th ratings (see Tables 4, 5 and 6). This was just prior to the first significant rainfall. A similar condition was reported in many locations throughout the state. No disease causal organism or nematode problem was found. Thus, the turf grass deterioration was attributed to the high pH and salt levels. It was overcome by increasing the nitrogen fertilization level and eventually by the late January rains. The five top ranked perennial ryegrass cultivars, Citation, Manhattan, S-321, Pennfine and Yorktown also ranked superior in performance during this period of general decline. Manhattan was particularly outstanding in its ability to grow and produce a quality surface under these high pH-high salt conditions.

Among the 10 non-ryegrass cultivars compared in Table 2, Dawson chewing fescue and Sabre rough bluegrass ranked superior. They also ranked higher than all 20 perennial ryegrass cultivars. The warm dry conditions of the 1976 winter were particularly favorable for the fine leaved fescues. Sabre rough bluegrass was particularly tolerant of the high pH-high salt conditions of mid-January. All 10 cultivars were substantially inferior to the perennial ryegrasses in establishment rate. The rough bluegrasses were inferior in terms of spring transition. The poor spring transition of rough bluegrass was associated with a distinct yellowish-green coloration. Brown patch disease activity was noted on the two rough bluegrasses in mid-February with Sabre being more severely affected. No fungicide was applied to control the brown patch. Also, Delta Kentucky bluegrass was severely attacked by Helminthosporium leaf spot disease during the period from mid-March through early April.

The performances of 11 polystands during the winter overseeding are compared in Tables 3 and 6. No major differences in winter performance were evident among the group of polystands included in this study. Medalist, Dixiegreen and Medalist 4 ranked slightly higher in establishment rate while no large differences were evident during the spring transition period.

The lack of disease activity probably contributed to the relative uniformity in rankings within species. These studies are to be continued during the next several winters in multiple locations around the state. Under these conditions (especially a moist winter), disease development might be a more significant factor that would increase the differentials among species, cultivars and polystands. It should be emphasized that this is the first year of a four year study. No final recommendations can be given at this time. This data is presented as a progress report only.

Table 1. An evaluation of twenty perennial ryegrass cultivars for winter overseeding of bermudagrass greens (winter of 1975-76; Texas A&M University, College Station, Texas).

Ryegrass Cultivar	Winter Performance[1] (11 ratings)	Establishment Rate[2] (6 ratings)	Spring Transition: Visual Quality (3 ratings)[3]	Spring Transition: Leaf Density Count[4]
Citation	6.1 [5]	4.6 bc[8]	5.3 a[8]	128 abcd[8]
S-321	6.0	4.8 bc	4.7 bc	151 abcd
Manhattan	6.0 [6]	5.2 ab	4.5 bc	210 a
Pennfine	5.9	3.6 cde	5.0 ab	135 abcd
Yorktown	5.8	4.9 b	4.8 abc	171 abc
Derby	5.4	4.7 bc	4.8 abc	104 bcd
Birdie	5.4	4.7 bc	5.0 ab	103 abcd
Omega	5.4	4.0 bcde	5.0 ab	163 abcd
NK-200	5.2	4.8 bc	4.7 bc	154 abcd
Diplomat	5.2	4.6 bc	4.7 bc	178 ab
NK-100	4.9	4.9 b	4.7 bc	104 bcd
Linn	4.9 [7]	4.7 bc	4.7 bc	106 cd
Pelo	4.9	1.9 f	4.7 bc	71 bcd
Eaton	4.5	4.8 bc	4.5 bc	172 abc
Game	4.4	2.9 ef	4.3 c	105 bcd
Lamora	4.3	6.0 a	4.5 bc	102 bcd
Epic	4.1	3.2 de	4.5 bc	123 abcd
Oregon (common)	3.8	4.3 bcd	4.3 c	61 d
Norlea	3.6	4.9 b	4.5 bc	126 abcd
KO-13	3.1	4.2 bce	4.3 c	71 cd

[1]Visual rating of 9-best and 0-poorest; November 28, 1975 to April 16, 1976.

[2]Visual rating of 9-best and 0-poorest; November 4 to November 14, 1975.

[3]Visual rating of 9-best and 0-poorest; May 4 to June 11, 1976.

[4]Leaf count per square decimeter; May 24 and 25, 1976.

[5]Values joined by the same line are not significantly different at the 5% level for Duncan's Multiple Range Test.

[6]S-321=6.05; Manhattan=5.97.

[7]NK-100=4.94; Linn=4.89; Pelo=4.87.

[8]Values with the same letter are not significantly different at the 5% level for Duncan's Multiple Range Test.

Table 2. An evaluation of ten non-ryegrass cultivars for winter overseeding of bermudagrass greens (winter of 1975-76; Texas A&M University, College station, Texas).

Cultivar & Species	Winter Performance[1] (11 ratings)	Establishment Rate[2] (6 ratings)	Spring Transition: Visual Quality (3 ratings)[3]	Spring Transition: Leaf Density Count[4]
Sabre rough bluegrass	6.4 [5]	3.3 a[6]	3.2 d[6]	518 b[6]
Dawson chewings fescue	6.4	3.2 a	3.5 d	696 a
Denmark rough bluegrass (common)	5.7	2.3 a	2.7 e	687 a
Penncross creeping bentgrass	4.6	1.0 b	5.0 a	186 e
Seaside creeping bentgrass	4.5	1.0 b	4.5 abc	400 c
Emerald creeping bentgrass	4.3	1.0 b	4.8 ab	302 d
Encota chewings fescue	3.3	3.0 a	4.3 bc	141 e
Jamestown chewings fescue	3.2	3.0 a	4.7 abc	316 cd
Koket chewings fescue	3.1	2.3 a	4.3 bc	178 e
Park Kentucky bluegrass	2.9	1.0 b	4.2 c	32 f

[1]Visual rating of 9-best and 0-poorest; November 28, 1975 to April 16, 1976.

[2]Visual rating of 9-best and 0-poorest; November 4, 1975 to November 14, 1975.

[3]Visual rating of 9-best and 0-poorest; May 4 to June 11, 1976.

[4]Leaf count per square decimeter; May 24 and 25, 1976.

[5]Values joined by the same line are not significantly different at the 5% level for Duncan's Multiple Range Test.

[6]Values with the same letter are not significantly different at the 5% level for Duncan's Multiple Range Test.

Table 3. An evaluation of eleven polystands for winter overseeding of bermudagrass greens (winter of 1975-76; Texas A&M University, College Station, Texas).

Seed Mixture	Winter Performance[1] (11 ratings)	Establishment Rate[2] (6 ratings)	Spring Transition	
			Visual Quality (3 ratings)[3]	Leaf Density Count[4]
Medalist 200	5.7 [6]	3.0 c[7]	4.7 ab[7]	282 ab[7]
Scotts 2	5.6	2.8 c	4.2 b	265 bc
CBS blend[5]	5.5	4.2 bc	5.0 a	198 cd
Dixiegreen	5.5	4.4 a	5.0 a	110 d
Medalist 2	5.4	5.1 a	4.5 ab	106 d
Medalist 400	5.4	3.9 bc	5.0 a	358 a
Medalist 300	5.3	3.0 c	4.8 a	174 cd
Scotts 101	5.3	3.5 bc	4.5 ab	161 d
Scotts 1	5.2	3.6 bc	5.0 a	132 d
Medalist 4	5.2	4.3 ab	4.7 ab	178 cd
Scotts 102	4.7	3.0 c	4.5 ab	107 d

[1]Visual rating of 9-best and 0-poorest; November 28, 1975 to April 16, 1976.

[2]Visual rating of 9-best and 0-poorest; November 4 to November 14, 1975.

[3]Visual rating of 9-best and 0-poorest; May 4 to June 11, 1976.

[4]Leaf count per square decimeter; May 24 and 25, 1976.

[5]Blend of 3 perennial ryegrass cultivars.

[6]Values joines by the same line are not significantly different at the 5% level for Duncan's Multiple Range TDst.

[7]Values with the same letter are not significantly different at the 5% level for Duncan's Multiple Range Test.

Table 4. Biweekly winter performance ratings* of twenty perennial ryegrass cultivars for winter overseeding of bermudagrass greens (winter 1975-76, Texas A&M University).

Ryegrass Cultivar	28 Nov. 1975	12 Dec.	27 Dec.	7 Jan. 1976	20 Jan.	4 Feb.	18 Feb.	4 Mar.	17 Mar.	1 Apr.	16 Apr.	Average
Citation	6.0	6.5	6.7	4.8	3.8	4.3	6.7	6.5	6.7	7.2	8.2	6.1
S-321	5.3	5.7	5.8	5.3	4.7	4.3	7.0	7.0	7.3	7.0	7.0	6.0
Manhattan	5.7	4.2	4.7	5.7	5.7	5.5	7.3	8.0	6.0	6.0	7.0	6.0
Pennfine	5.3	4.8	5.5	4.2	4.0	5.3	6.7	7.2	7.0	7.2	7.7	5.9
Yorktown	5.7	4.8	5.2	5.0	4.5	5.7	6.3	6.7	5.7	6.5	7.3	5.8
Derby	6.5	4.7	4.8	3.5	2.8	4.7	5.7	6.5	6.0	7.0	7.0	5.4
Birdie	4.8	5.0	5.3	3.3	3.3	4.0	5.7	6.3	6.7	7.0	7.7	5.4
Omega	4.8	4.8	5.2	3.3	3.0	4.2	5.7	6.0	6.7	7.3	8.0	5.4
NK-200	5.2	5.0	5.2	3.5	3.3	4.3	6.7	6.8	5.7	5.3	6.3	5.2
Diplomat	5.5	4.7	4.8	4.0	3.3	4.0	5.3	6.2	6.0	6.2	7.0	5.2
NK-100	4.8	5.2	5.7	3.0	2.7	4.0	5.7	6.0	5.3	5.3	6.7	4.9
Linn	6.2	4.8	5.2	3.2	2.8	3.2	6.0	6.3	5.0	4.8	6.3	4.9
Pelo	3.8	4.5	4.8	4.2	3.5	5.0	5.3	6.0	4.7	5.3	6.3	4.9
Eaton	6.3	4.3	4.2	2.7	2.2	3.2	5.3	5.8	4.3	5.3	6.3	4.5
Game	4.0	4.5	5.2	3.2	2.7	3.0	5.0	5.3	5.7	4.7	6.7	4.4
Lamora	5.3	3.7	3.8	3.0	2.7	3.0	5.3	6.3	4.3	4.3	5.3	4.3
Epic	4.3	4.0	4.5	3.0	2.3	3.0	5.0	5.5	4.0	3.8	5.7	4.1
Oregon (common)	4.3	3.2	3.5	2.5	1.8	2.2	4.7	5.0	4.0	4.3	6.3	3.8
Norlea	5.0	2.8	3.0	1.7	1.2	1.8	5.3	6.2	4.0	3.3	5.3	3.6
KO-13	4.2	2.2	2.5	1.8	1.3	2.2	4.7	5.2	3.0	2.5	4.3	3.1

*Visual ratings of 9-best and 0-poorest; average of 3 replications.

Table 5. Biweekly winter performance ratings* of ten non-ryegrass cultivars for winter overseeding of bermudagrass greens (winter 1975-76; Texas A&M University, College Station, Texas).

Cultivar and Species	28 Nov. 1975	12 Dec.	27 Dec.	7 Jan. 1976	20 Jan.	4 Feb.	18 Feb.	4 Mar.	17 Mar.	1 Apr.	16 Apr.	Average
Sabre rough bluegrass	5.8	5.7	5.3	5.3	4.8	7.3	6.7	7.2	7.8	7.0	7.7	6.4
Dawson chewings fescue	6.7	7.0	6.8	3.5	2.8	5.3	7.3	7.3	7.7	7.3	8.3	6.4
Denmark rough bluegrass	3.5	4.8	5.3	3.8	3.3	6.0	7.3	7.7	7.7	6.5	7.0	5.7
Penncross creeping bentgrass	2.0	4.7	5.0	2.8	2.5	5.2	4.0	4.7	5.3	6.3	7.7	4.6
Seaside creeping bentgrass	1.8	4.0	4.2	3.2	3.2	4.8	4.3	5.0	6.0	5.7	7.0	4.5
Emerald creeping bentgrass	2.0	4.0	4.2	3.0	2.2	4.3	4.3	4.8	5.3	5.7	7.0	4.3
Encota chewings fescue	5.2	3.2	3.8	1.2	0.7	1.8	4.3	4.8	3.7	2.7	5.3	3.3
Jamestown chewings fescue	4.2	2.3	2.5	1.7	1.0	2.3	3.3	4.3	4.0	3.3	5.7	3.2
Koket chewings fescue	3.7	4.7	5.0	1.8	0.8	2.3	3.3	4.3	3.0	2.3	3.0	3.1
Park Kentucky bluegrass	1.8	3.2	3.3	2.5	2.0	3.0	3.3	4.2	2.7	1.5	4.3	2.9

*Visual ratings of 9-best and 0-poorest; average of 3 replications.

Table 6. Biweekly winter performance ratings* of eleven polystands for winter overseeding of bermudagrass greens (winter 1975-76; Texas A&M University, College Station, Texas).

Seed Mixtures	28 Nov. 1975	12 Dec.	27 Dec.	7 Jan. 1976	20 Jan.	4 Feb.	18 Feb.	4 Mar.	17 Mar.	1 Apr.	16 Apr.	Average
Medalist 200	4.0	6.0	6.2	5.2	4.3	6.0	5.0	5.7	6.3	6.8	7.7	5.7
Scotts 2	4.2	5.8	6.0	3.8	3.3	6.3	6.0	6.2	7.0	6.2	7.3	5.6
CBS blend**	4.5	4.7	5.2	3.8	3.2	5.0	6.7	6.7	6.3	7.2	7.7	5.5
Dixiegreen	5.7	5.0	5.3	4.5	4.2	5.0	5.7	6.0	5.3	6.5	7.0	5.5
Medalist 2	4.7	4.7	5.0	4.7	4.0	4.7	6.3	6.5	6.0	7.0	7.3	5.4
Medalist 400	4.7	5.7	5.8	3.5	3.5	5.3	5.3	6.5	5.3	7.2	7.0	5.4
Medalist 300	4.0	3.8	4.3	4.5	3.8	5.0	5.7	6.7	6.0	7.3	7.3	5.3
Scotts 101	4.7	3.8	4.5	5.3	4.7	5.3	5.0	6.0	5.7	6.3	7.0	5.3
Scotts 1	4.3	3.3	3.8	4.5	3.8	4.3	5.7	6.3	6.3	6.7	7.7	5.2
Medalist 4	5.3	3.8	4.3	3.5	3.3	4.0	6.0	6.8	6.0	6.5	7.0	5.2
Scotts 102	4.2	3.7	4.0	3.7	3.2	3.7	4.3	5.2	6.5	6.3	7.3	4.7

*Visual ratings of 9-best and 0-poorest; average of 3 replications.
**Blend of 3 perennial ryegrass cultivars.

WINTER DORMANCY OF TWO BERMUDAGRASS CULTIVARS AS INFLUENCED BY GIBBERELLIC ACID

by

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Warm season turfgrasses are the predominant species utilized in the warm climatic regions of the country. They have an optimum growth temperature range of 72 to 95°F (23 to 35°C). Although the warm season turfgrasses perform extremely well under these optimum temperatures, upon the advent of cool fall temperatures of 50 to 58°F (10 to 12°C) they undergo discoloration and enter into a state of dormancy.

Low temperature discoloration in warm season turfgrasses is the result of physiological disruptions referred to as chilling injury. Chilling injury can be defined as the lethal injury observed in plants of tropical-subtropical origins when exposed to temperatures above freezing but below 58°F (12°C).

In those regions of the country where warm season turfgrasses are the predominant species used, there are two cultural practices commonly employed to maintain a green cover through the winter:

1. Dying or painting the dormant turf.

2. Overseeding the dormant turf with a cool season species.

The expense involved in these procedures can be quite costly expecially on large turfgrass areas. Therefore, alternative approaches for maintaining a green cover through the winter are needed.

One practice which is of increasing interest is the application of gibberellic acid (GA_3) prior to or immediately following low, chilling temperature. It has been shown that GA will allow the turfgrass to maintain its green color well into the winter months.

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Another practice which has received little attention is the use of resistant cultivars. Although there is no known bermudagrass cultivars that will retain their green color throughout the entire winter at continual temperatures below 50 to 58°F (10 to 12°C) there are several which show a wide range of tolerance. Therefore a growth chamber study was conducted at Texas A&M to evaluate the response of two bermudagrass cultivars treated with GA while exposed to chilling temperatures.

Plant Material

Ormond bermudagrass (*Cynodon dactylon* (L) Pers.). Excellent low temperature color retention.

Pee Dee bermudagrass (*Cynodon dactylon* (L) Pers. x *Cynodon transvaalensis* [Burtt-Davy]). Poor low temperature color retention.

Growth Conditions

Turf plugs of each cultivar were established and maintained in plastic pots, 5½ inches deep and 3½ inches wide. The root zone soil was 100% mortar sand. The plant material was maintained outdoors and received a complete nutrient solution twice weekly. Both cultivars were clipped at ½ inch. After the turf plugs had become established in the pots (about 4 weeks) they were transferred to a high light environmental growth chamber where they were maintained under a 12 hour photoperiod and a day:night temperature of 90:80°F. The light levels at the surface of the turf were maintained at 900 E M^{-2} sec^{-1} in the growth chamber for two weeks.

At the beginning of the dark period, temperature was lowered 4°F per hour until the leaf temperature reached 50°F. The next morning, two hours after the commencement of the next light period, GA was sprayed on the foliage at a rate of 30 glacre. The same rate of GA was again applied following the first week at 50°F.

Visual observations and rankings of each of the turf plugs were made weekly with 10=best and 1=dead. The turfs were clipped back to the original acclimation height at the end of each week. The collected clippings were dried at 200°F for 30 hours.

Results and Discussion

Growth and Color

Pee Dee had a significantly lower visual rating than the other three treatments after one week exposure to 50°F (Table 1). After two weeks exposure, Pee Dee and Ormond with GA as well as non-treated Ormond showed a significantly higher visual rating than the Pee Dee control. Ormond treated with GA had the highest visual ratings of all treatments.

Table 1. Visual turfgrass quality ratings* of two bermudagrass cultivars following one and two weeks exposure to chilling temperatures.

Bermudagrass Cultivar	GA Treatment	Exposure Time (weeks) one	two
Pee Dee	No	6.7bc**	2.5a
Pee Dee	Yes	7.7d	5.8b
Ormond	No	7.9d	6.2b
Ormond	Yes	7.8d	7.6cd

*10=best, 1=dead.

**Means with like letters do not differ significantly at the 0.01 level (HSD=0.9).

Pee Dee showed a significantly lower clipping weight than the other three treatments (Table 2). After one week exposure to 50°F, both

Table 2. Clipping dry weights (mg/pot) from two bermudagrass cultivars following two weeks exposure to chilling temperatures.

Bermudagrass Cultivars	GA Treatment	Exposure Time (weeks) one	two
Pee Dee	No	26.2ab*	11.8a
Pee Dee	Yes	45.6bc	61.7c
Ormond	No	40.7bc	29.7ab
Ormond	Yes	47.1bc	69.4c

*Means with like letters do not differ significantly at the 0.05 level (HSD).

cultivars receiving the GA treatment as well as the untreated Ormond were not significantly different from each other. However, after two weeks exposure to 50°F both Pee Dee and Ormond not receiving the GA had significantly lower clipping weights than the GA treated turf.

This study shows that the application of GA immediately following chilling temperatures above freezing appears to have potential value. Also, the effectiveness can vary depending the relative chill susceptability of the cultivar.

This study is the first phase of a continuing study including:

1. The effects of GA on the long term photosynthetic responses of chill resistant and chill sensitive warm season turfgrass species and cultivars.

2. The effects of GA on the chloroplast ultrastructure of these chill resistant and chill sensitive species and cultivars following exposure to chilling temperatures.

CULTURAL PRACTICES AID SUMMER DISEASE CONTROL ON TURF

by

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Fungal diseases of turfgrasses initiated during the summer represent a serious problem to the maintenance of good quality turf in Texas. Field studies on the occurrence of summer turf diseases on home lawns in north-central Texas indicated a high incidence of fungal diseases on poorly adapted cool-season grasses and on warm-season grasses weakened by summer drought conditions. Helminthosporium leaf blotch of bermudagrass caused by *Helminthosporium cynodontis* and Fusarium blight of tall fescue turf caused by *Fusarium roseum* are two of the most common and destructive diseases of Dallas area home lawns during the summer. Both of the diseases are difficult to control by applications of fungicides because repeated applications are often necessary to prevent the initiation of disease activities. Field and laboratory studies suggest that cultural practices designed to reduce the activities of these fungal patholgens on turf crop debris or thatch can be important measures to aid in disease control during the summer.

Helminthosporium leaf blotch of bermudagrass turf is commonly observed on home lawns or recreational areas following hot, dry periods. The disease appears to be of increasing importance on stands of dwarf bermudagrass or closely clipped common bermudagrass which supports a thick layer of crop debris. Symptoms of the disease are caused by spores of the fungus which are produced on the crop debris or on infected plants during the summer. Field and laboratory studies have shown that spore production by the fungus was greatly favored by allowing the crop debris to become dry before application of moisture. Maximum spore production by the fungus was observed on fresh clippings which were dried and remoistened to saturation in the laboratory. The increased spore production was attributed to the higher nutrient content of bermudagrass clippings as compared to partially decomposed crop debris where no sporulation by the fungus was observed. Laboratory studies were conducted to determine the effect of drying of bermudagrass crop debris on the release of nutrients following remoistening. These studies demonstrated a striking release of carbohydrate and protein

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from dry crop following several cycles of drying and remoistening as compared to very low levels of nutrients released from continuously moist crop debris. The increased release of available nutrients from dried crop debris following remoistening is believed to play a major role in allowing the fungus to produce spores which initiate disease activity during the summer months.

The occurrence of Fusarium blight on tall fescue home lawns was verified during the summer of 1975 in Dallas and is the first report of the disease in Texas. This disease has been a serious problem on Kentucky bluegrass in the midwestern and eastern United States for approximately 12 years. The increased usage of tall fescue grass in home lawns planted in Texas has increased the occurrence of the disease in the northern areas of the state. The disease usually first appears in late June or early July as soon as the weather turns hot. Fusarium blight of tall fescue turf occurs primarily as a rot of the stem base of affected plants and secondarily as a foliage blight. Hot, dry, windy weather is especially favorable for the expression of the disease since affected crowns may be in advanced stages of rot, causing a reduction in the ability of the plant to take up adequate nutrients and water. Severe forms of the disease were commonly observed on sparcely seeded lawns or dense lawns which were closely clipped. Disease activity was also favored by application of high rates of nitrogen fertilizer during the summer.

Field and laboratory studies demonstrated that spore production by the fungus on tall fescue crop debris was favored by cyclical patterns of drying and remoistening. An increased release of nutrients following remoistening of dry crop debris or clippings was demonstrated and was shown to enhance spore production by the fungus. The increased spore production by the fungus on remoistened, dry crop debris agreed with the greater incidence and severity of disease observed on drought affected tall fescue lawns during the summer. Research workers in other states have shown that this disease can be greatly reduced by frequent irrigation of bluegrass lawns during the summer. This relationship was verified on tall fescue home lawns in the Dallas area.

Cultural and environmental factors which determine the supply of available moisture to turfgrasses during the summer are considered to be important for the suppression of disease activities by H. cynodontis and F. roseum. Drying of turf crop debris was shown to stimulate spore production by both pathogens following remoistening. An increased supply of available nutrients on remoistened, dry crop debris is thought to contribute to the increased growth activities and spore production which was observed. A continuous supply of moisture to the crop debris of turfgrass during the summer months can reduce spore production by these pathogens because of a limited supply of available nutrients and increased decomposition activities by saprophytic microorganisms.

Irrigation of turfgrasses during the summer should be based on the existing structure of the turf canopy. The crop debris layer should be kept moist and not overly wet because this would favor activity by other fungal pathogens. A thin canopy turf should be irrigated more frequently than a turf with a thick or dense canopy. Increasing the mowing height during the summer and reducing the thickness of the crop debris layer are suggested to maintain moisture of the crop debris for longer periods. Localized dry areas of turf should also be detected and corrected as soon as the weather turns hot.

DEVELOPMENT REPORT ON THE TEXAS A&M UNIVERSITY TURFGRASS RESEARCH PROGRAM

by

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Department of Soil and Crop Sciences

Much of the effort during my initial year at Texas A&M University has been devoted to (1) familiarization with turfgrass growing conditions and problems in the state of Texas, (2) design, procurement and installation of improved turfgrass research facilities, and (3) selection, hiring and training of research personnel. Progress made to date in each of these areas will be outlined as follows:

I. Major areas in which research emphasis will be placed.

A. Turfgrass Culture

1. Shade turf culture.
2. Thatch: its causes and prevention - grant support by the O. J. Noer Research Foundation.
3. St. Augustinegrass culture - cutting heights and nutritional levels.
4. Low temperature discoloration avoidance.
5. Cultural programs for low maintenance turfs
6. Winter overseeding practices.

B. Environmental Stress Investigations

1. Low temperature chilling injury: mechanisms and prevention.
2. Drought stress: root-potassium relationships - using a rhizotron.
3. Water use rates and their manipulation - grant support by the O. J. Noer Research Foundation.
4. Wear tolerance comparisons among species, cultivars and various cultural practices - grant support by the USGA Green Section Research Fund.
5. Shade adaptation mechanisms.
6. Physiology of heat stress injury and prevention.

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C. Cultivar Improvement and Evaluation

1. Dateing for improved St. Augustinegrass cultivars - cooperative project with J. Beard, R. Toller, M. Gaylor and E. Bashaw.
2. Cultivar evaluations for sports turfs and low maintenance areas.
3. Disc gel electrophoresis identification of turfgrass cultivars - grant support by the Manhatten Ryegrass Growers Association.

D. Pest Control

1. Bermudagrass suppression in St. Augustinegrass sod production - grant support by the Texas Sod Producers Association.
2. Nutsedge control in bermudagrass.

II. Development of Research Facilities

A. Field Lab Building

A new TAMU Turfgrass Field Lab Building is now under construction and will be completed sometime in January. It is located on the north side of the existing Turfgrass Field Research Laboratory. This 4400 square foot facility will house the equipment utilized in maintenance of the turfgrass field research plots along with a service shop and classroom for teaching the labs in three of the turfgrass courses taught at Texas A&M University. Space is also allocated for (1) a controlled climate growth room which has the capacity for seven growth chambers, (2) a small plant diagnostic wet lab, and (3) a control center for the irrigation master control panel and recording equipment for an extensive microclimate station. There will be an opportunity to view this new facility while attending the Turfgrass Field Day this coming June. This facility will greatly expand the turfgrass research and teaching capabilities at Texas A&M University.

B. Field Lab Plots

Plans are also now in the final stages for (1) conversion to a valve-in-head automatic pop-up irrigation system, (2) installation of a drain tile system, and (3) root zone modification of an extensive portion of the plot area. Once this is accomplished, a new set of field plots will be established during the 1977 growing season.

C. Greenhouse

A new 2900 square foot greenhouse has been designed and is now under construction for use by the Forage and Turf Project. It is scheduled for completion in May of 1977. This glass house will greatly improve the facilities (1) for the winter propagation of turfgrass and (2) for greenhouse research in terms of better temperature, humidity, and light control in comparison to the temporary polyethylene greenhouse that has been utilized in the past.

D. Stress Physiology Lab

A substantial addition to the research equipment for the environmental stress physiology laboratory will allow detailed research involving photosynthesis and respiration as well as qualitative and quantitative analysis of a wide range of carbohydrates, proteins and lipids.

III. Selection and Training of a Research Staff

The Texas A&M University Turfgrass Research Project has been quite fortunate in obtaining three well qualified, strongly motivated individuals to carry out the multitude of day-to-day activities involved in an extensive Turfgrass Research Program. They are:

A. Mr. James Eckhardt: a Research Associate on the TAMU staff. His main responsibilities will be in turfgrass weed control and cultivar evaluations including winter overseeding. Jim received his Masters Degree in the turfgrass area at the University of Arizona under Dr. Gordon Johnson.

B. Mr. Doug Schwepler: a Research Technical Assistant in charge of the Stress Physiology Laboratory. Doug received his Masters Degree from Purdue University and has had previous experience in laboratory work at the University of Indiana.

C. Mr. Dwight Chaffin: with three years of undergraduate course work and pursuing completion of his Bachelors Degree at this time, Dwight is in charge of the Turfgrass Field Research Laboratory. He comes to us with a good background in the mechanical skills that are so valuable to this position, and is teaching the mower maintenance course to our undergraduate turf majors this spring semester. There are 15 students in the course.

When the professional turfmen from throughout Texas are attending the TAMU Turfgrass Field Day this June, they will have the opportunity to meet these three key people and observe their work. They are a very critical dimension in furthering the research and teaching programs at Texas A&M University.