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P R E F A C E

These *Proceedings* of the 33rd Annual Texas Turfgrass Conference are provided to those who registered at the Conference as a reference to the wealth of information presented during the program. Since it was not possible for you to attend all of the sessions, the *Proceedings* will give you an opportunity to gain additional information. Also, you may want to review the papers of the sessions you attended to pick up points you might have missed.

These *Proceedings* could not be produced without the dedicated effort of those making the presentations. We are indebted to each of the authors for their contribution to the Texas Turfgrass Conference.

Special appreciation is extended to Jake Loden, my secretary, for her assistance with the preparation of these Proceedings.

Richard L. Duble

Richard L. Duble
Extension Turfgrass Specialist

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RENOVATING ATHLETIC FIELDS

by

Richard L. Duble*

Renovation of extensively used athletic fields is an annual requirement involving aeration, topdressing, weed control, fertilization and, in extreme cases, replanting. The first step in renovation involves correcting the conditions that caused the field to deteriorate. Poor drainage, soil compaction, weeds, excessive use or lack of a maintenance program could all lead to the deterioration of turf on a playing field. Renovation followed with a good maintenance program can change a poor field into a well-turfed field in a single season.

A good playing field should provide firm, resilient and uniform footing from a player's standpoint and color and grooming from a spectator's standpoint. The physical condition of the soil is just as important as the turf to firm, resilient and uniform footing. A hard, compacted soil or a wet, poorly drained soil cannot provide a good playing surface regardless of the amount of grass on the field. With or without good turf, a firm, uniform and resilient playing surface should be mandatory on all football fields.

Some situations cannot be satisfactorily improved without modifying the soil on the field. These fields are characterized by thin turf, very hard surfaces when dry, waterlogged and slick surfaces when wet or an excessive number of player injuries.

Short of replacing the existing soil with a good topsoil, insuring adequate surface drainage, aeration and topdressing provide the only methods of improving the physical condition of the field. A field constructed with a clay or clay loam soil should have an adequate crown to ensure drainage of the playing surface. Drainage outlets along the sidelines must be adequate to remove excess water from the field. If these conditions are not met, drainage would be the first step in renovation.

A soil similar in texture to that on the field should be used to build-up the crown. Prior to adding the topsoil, the field should be aerated with a coring-type aerifier by running over the field in 3 or 4 directions. The soil should be moist, but not wet, when the aerifier is used to get the penetration desired. The aerifier should extract cores from the top

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2 inches of the surface. The required topsoil should be distributed uniformly over the field and dragged to eliminate any ridges or depressions. If the crown needs to be raised more than 1 inch, the field should be disked 4 to 5 inches deep, topsoil added and the field graded. Bermuda grass will generally grow through 1 inch of a loam or sandy loam topsoil in a short time. But, if more than 1 inch of topsoil is required, the field should be replanted.

Where perennial weeds (dallisgrass, knotweed, nutgrass) are a problem, they should be eliminated with selective herbicides such as MSMA and 2,4-D. Assistance with identification of weeds and recommendations for their control can be obtained from County Agricultural Extension personnel.

If the use of your field is so intensive that an improved hybrid bermudagrass is required in place of common bermuda grass or if weeds are so numerous that little desirable grass can be found, complete vegetation control can be obtained with a herbicide such as Roundup. For Roundup to be effective the weeds and grasses must be actively growing. Thus, it would be early May in some areas of Texas before Roundup could be effectively used. Where Roundup is used for weed and grass control, the field can be replanted about 2 weeks after treatment (the time required for the herbicide to kill the existing vegetation). Prior to replanting, the field should be cultivated with a disk or tiller to alleviate soil compaction and to produce a finely pulverized seedbed for grass establishment.

Weed control with selective herbicides such as MSMA and 2,4-D should be practiced throughout the spring and summer to prevent the development of clumpy, unsightly weeds. Not only do weeds detract from the appearance of the field, but they contribute to poor footing and non-uniform playing conditions.

Where fields must be replanted, hybrid bermudagrasses such as Tifway or Texturf-10 should be used because of their greater wear tolerance. Although these grasses cost considerably more to plant than common bermudagrass, the improved playing surface produced and their greater wear tolerance make them the most reasonable choice. If a school goes to the expense to completely renovate a field (or to construct a new field), it would be poor economics to cut corners on the type of grass planted on the field.

Replanting should be completed by June 1 (June 15 at the latest) to have a complete turf cover by the season opener. A good maintenance program can produce a dense turf cover in 8 to 10 weeks. Perhaps Bear Bryant said it best when Kyle Field was renovated in 1956..."On June 1 the ground was bare, but by September the turf was the best I have ever played on." Sprigging at a minimum rate of 10 bushels per 1,000 square feet, watering as needed to keep the grass growing and fertilizing at a rate equivalent to 1 pound of nitrogen per 1,000 square feet every two weeks provided the only magic needed to develop the turf on Kyle Field in 1956. The same can be done on any athletic field in Texas.

Several aspects of the fertilization program are critical to the development of a healthy turf on a playing field. Nitrogen is required to produce a turf, but it should be available to the grass at low and uniform rates. A single application of fertilizer should not provide more than 1 pound of soluble (available) nitrogen per 1,000 square feet. On a newly planted field this amount of nitrogen should be applied at 2 to 3 week intervals. For maintenance fertilization, 4 to 5 week intervals are satisfactory.

On an athletic field where traffic is very concentrated, potassium is equally as important as nitrogen to the survival of the turf. Potassium has shown to greatly increase the wear tolerance of grass. Potassium should be applied at nearly the same rate as nitrogen.

Phosphorus is important in the establishment of turf on a new field and in the recovery of turf worn by game use. On a new field a ratio of about 1 to 2 for phosphorus to nitrogen would be adequate. Under maintenance conditions a 1 to 3 or 1 to 4 ratio of phosphorus to nitrogen should be used. Thus, a 3-1-2 ratio of N-P-K would be ideal for most football fields.

Timing of fertilizer applications is just as important to the vigor of the turf as the rate and analysis of fertilizer applied. Applications should be made in the early spring and continued until a satisfactory turf cover develops. A complete fertilizer such as 12-4-8 should be applied in late summer and again in the fall. These applications are important to the recuperative potential of the grass during the playing season.

Mid-summer applications of fertilizer should be avoided unless the grass has not completely covered the field. Excess growth during the summer does not contribute to the durability or quality of the turf during the playing season, but only increases maintenance requirements.

Mowing height and frequency are also critical to the development of a dense, wear-resistant turf. Common bermudagrass should be mowed at least once a week at a height of 1 to 1½ inches. More frequent mowing from mid-summer through the playing season will improve the density and wearability of the turf.

Improved grasses such as Tifway and Texturf-10 bermudagrasses should be mowed twice weekly at a height of 3/4- to 1-inch. Reel-type mowers are required to maintain bermudagrasses at these mowing heights.

Summary

1. Aerate the field in 3 or 4 directions with a coring-type aerator in early spring.

2. Topdress the field with 50 to 100 yards of sandy loam or loam topsoil.

3. Smooth the topsoil with a grader, and drag the field to work the topsoil into the existing turf.

4. Install drainage outlets along the sidelines to remove excess water if necessary.

5. Eliminate undersirable weeds and grasses with Roundup or with selective herbicides.

6. Replant the field, if necessary, with Tifway or Texturf-10 bermudagrass.

7. Fertilize with a complete fertilizer in the spring, late summer and fall.

8. Water the field thoroughly (to a depth of 4-6 inches) but as infrequently as possible.

9. Mow the grass short and frequently. Common bermuda grass should be mowed at a height of 1 to 1 1/2 inches once each week. Tifway or Texturf-10 bermudagrass should be mowed at 3/4- to 1-inch twice weekly.

10. Control weeds with selective herbicides in early summer.

CARE AND MAINTENANCE OF ARTIFICIAL AND NATURAL GRASS ATHLETIC FIELDS

by

George Toma*

Good afternoon, fellow turf men. I sincerely appreciate the opportunity to be here. Whenever I have the opportunity to speak to a group of athletic field turf managers, I look across the room and think to myself--Gee! I sure wish there could be two or three times the amount of people here--and for this reason--it would be nice if two or more members from your organizations came along. The members that I would like to see at all of these turf meetings are our stadium managers, the heads of Parks and Recreations Departments, and yes, even the owners of amateur and professional teams. If we could get these people to come along for a day, it would be so worth while for all of us concerned with the care and management of athletic fields, many times our turf programs have to start with these people.

I believe many times there is a communications gap between all of us in our organizations when we propose to try to better our playing fields. Here is where natural grass suffers. Those higher up in command attending would get a better idea of the problems for the betterment of our playing conditions. In doing this, we can show them ways of saving money or at times a few more dollars could give them a playing field that is superior to artificial turf. The only time many of our supervisors become concerned about our playing fields is when it rains or the grass doesn't look good. They become really concerned when it is raining--perhaps a double header is on tap--plus a near sell out. The field is saturated and they become very jumpy. They wish to do everything possible now--even bring in helicopters at $100 or more per hour. Tomorrow the sun comes out and everything is forgotten until it rains again for a big game.

Still, we could never get them down to brass tacks to remedy the situation. They may bring in helicopters at a vast expense and this is not the answer. The answer is to get them thinking. If we could get them to understand our soil-turf and equipment problems, then we could start on our maintenance programs.

Money was available for a helicopter but it is not available for some type of drainage or perhaps the purchase of an aerifier to eliminate the

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problems of a wet, compacted playing field. I know what some of you men go through, because groundskeepers are dedicated men and without the proper equipment, it makes our job really tough. Never give up--you can still have a respectable field on a very low budget.

In Kansas City, our past playing field of natural grass was the envy of every baseball, football, and soccer team. The most important part of this was that we operated on a limited budget with poor soil conditions; no tile drainage except for the natural sloping surface drainage, and without the necessary turf maintenance equipment, and no automatic irrigation system. Working under these conditions, we maintained a field that was used by baseball, soccer, and football, plus other events, and the thrill of all this was, we did not have any complaints from the players. Most of all, we only had one knee injury in nine years, and it was a non-operational one at that. Foreign soccer players stated we had the second best soccer field in the world--only the one in England beating us out. So, as we look back, under these all around poor conditions, having three sports played on one field and natural grass surviving--giving the players a playing field they enjoyed playing on and one of beauty from a fan's standpoint.

All of this now is in the past, and as days go by, we often hear conversations that someday in the near future, our natural grass is on vacation and someday it will return.

In August of 1972 we opened our new Arrowhead Stadium, Home of the Kansas City Chiefs with an artificial surface of 3M Tartan Turf. In April of 1973 we opened our new Royals Stadium, Home of the Kansas City Royals, with the same artificial surface, Tartan Turf. I have worked with artificial turf since 1967 on a limited basis--so working our two new stadiums with artificial turf did not hit me all at once. I have worked on all three artificial turfs--namely poly turf, by U.S. Biltrite--Astro turf by Monsanto, and Tartan Turf by 3M. Presently, the only one in the business today is Astro Turf, plus a new one called Super Turf.

The transition from natural to artificial for my men was very minor, for as I have stated before many times, that natural grass has taught many of us in the turf business "Pride" and natural grass has taught my men how to maintain artificial turf. I have found in my travels that if you have a good natural grass field and switch to artificial turf you will have a good artificial turf field, if the installment is good. If you have a poor natural grass field, you can bet your boots you will find that the artificial turf will also be poor. It seems to boil down to the first three letters in management--"M-A-N". I did not see a vast difference is maintaining both types of fields. They are about even in pluses and minuses with natural grass that is well maintained giving one a much better playing surface for the players with less complaints and injuries.

In Kansas City, when we are talking about our old natural grass field, which we could say cost between $15 to $20 thousand dollars--that figure is way - way underboard compared to our new Tartan Fields. We are speaking of a figure of one million, two hundred thousand dollars. Our Arrowhead Field is now 7 years old, still looking good on top, but problems with the padding coming loose from the asphalt base are arising.

Our baseball field had been replaced two years ago after three years due to poor installation and inferior turf. 3M has now dropped this product in 1974. Our warranty was for five years, so they replaced the entire field at their cost. This time, their turf and workmanship was much better - still - the padding was not replaced - like putting shingles over rotted decking - about 2 years left.

It takes the same number of people to maintain artificial turf as it does natural grass. In maintaining our natural grass field, we had equipment worth three thousand dollars compared to nearly forty thousand dollars for artificial turf. For example, we had one Toro professional mower, one Jacobsen Estate, one Three Gang Roller, and Pin Spiker. In maintaining artificial turf, we have two four thousand dollar vacuums that we must use. If we don't, we lose our warranty. It costs us two thousand dollars a year for vacuum brushes and bags, a three thousand dollar tractor to pull the vacuum sweeper, a 10 thousand dollar 35 HP tractor to pull a $12,500 water removal machine which we have three. The self-propelled water removal machine runs thirty-seven thousand dollars. We have a three thousand dollar air compressor to blow the dirt out of the turf around the bases, plus hand and wet vacuum machines. So, one can see that it takes some equipment to maintain artificial turf at professional standards.

Let's look at our daily baseball schedule--one plus for artificial turf is it gives the men a little more sleep. The men start at 10:30 a.m. with natural grass, we had to start at 7:00 a.m. to remove the tarp so that the tarp wouldn't burn the grass when the sun came out. At 10:30 a.m. we remove the field cover. The field cover is 160' X 160', made of vinyl coated nylon. The cover is placed on the infield each and every night after the game. This is a little more difficult since we cannot drive large bridge spikes into the turf to prevent the winds from blowing the tarp away. Here, we use a vast number of sand bags. The field cover is used to keep the sliding pits--dirt around the bases--from becoming mud and to keep the artificial turf dry so the balls will not skip. Ground balls on wet artificial turf have the tendency to skip rather than bounce. Instead of mowing the turf, the field is now vacuumed and the time to do this could be doubled or even triped over the mowing time. For one must creep along to get the dirt out of the turf. The men daily walk the entire field with a special ammonia solution to wash out tobacco juice stains, and with a special paint brush comb they comb out burns--marks on the turf caused by players shoes on sudden stops and starts which fuse the turf blades together. They also carry a special aerosol can of gum freeze and freeze the gum melted into the turf and comb the gum out with the special combs. Many times, when the men are working on the turf, the turf temperature can range between 120^{o} to 140^{o}. Daily, or as needed, a special pipe hose connection on an air compressor is used to blow out the dirt out of the turf around a twelve inch area around the sliding pits, and then hand-vacuumed up.

If it rains, there is no drainage system on artificial turf, except for the drains along the playing field walls. After a rain, we must take the water removal machine and remove the excess water. If we use the Roller Squeegee type machine, it takes around one hour, but this type machine is very harmful to the padded base. The water vacuum machine takes four to eight hours. After the excess water is removed, it takes plenty of sun and wind to dry the artificial fibers. Before a game, it takes a few more men to help get the field ready after practice in the fifteen minutes alloted time. Here it is vacuuming the infield sideline area, plus using street type push brooms to sweep the dirt off the turf around the sliding pit areas and yes, gum freeze.

To maintain a good artificial turf field, one must have a good maintenance program. Still, a very very important factor is that one must be very careful not to over do it and wear the turf out--not through play, but through too much maintenance. Our men's daily bonus for working on artificial turf is working both bull pen areas (which are 24 feet by 80 feet) of Zoysia grass on a Purr Wick System sand base, laid over 65,000 artificial turf. Here, they could breathe again on a hot day.

A plus for artificial turf is that it can withstand more extra events that could play havoc on natural grass. But as playing conditions go, a well maintained natural grass field has it all over artificial turf, 99% of the players dislike artificial turf, especially on hot days when the surface temperature could hover around 130^{0}-140^{0}. Players playing on it all year complain of their legs getting tired in late August. During hot days games in Kansas City, we have boxes filled with ice and when players come into the dugout between innings, they place their feet in the ice filled boxes.

Multi-purpose stadiums have a conversion system to cover up the dirt area for football. This is time consuming, and a tough job to get everything to line up. Many times, there are humps which cause players to slip and fall. In the past, we would have to convert the dirt areas on our natural grass field to grass for football. We had good results with two methods. One, the seeding method, and two, the sodding method. Groundskeeper Dick Erickson of the Minnesota Vikings and Twins used these methods to great success with the help of Dr. James Watson of Toro. With the seeding method, we would pre-germinate Ryegrass by placing the seed in 55 gallon barrels with nail holes on the bottom sides with wooden pegs to let the water out twice daily. The seed would soak for seventy-two hours replacing the water twice a day. On Friday, the seed would be dumped on a concrete floor to dry. On Saturday, the seed would be mixed with Milorganite or Perlite to help facilitate the handling and be ready to seed on Sunday, which was our last baseball game. In soil preparations of the dirt infield, baselines, mound, and home plate, we would scarify lightly using a home-made nail drag for we wished to retain the firmness and even footing from the baseball infield. Now hold on to your hats--one must seed this between 40 to 60 pounds per 1,000 square feet. The seed would be down after the game on Sunday using a nail drag or a rake to rake it in lightly, followed by a light rolling, and a good soaking, then keeping it moist, not saturated. On Tuesday, I would topdress the area lightly if needed. To hasten the germination and growth, one can cover the area with Polyethylene. This proved worthwhile in the Super Bow game in the L.A.

coliseum in 1973 when the field was moved 20 yards to an area of no grass. On Friday or Saturday, we would use a greens mower full roller type and mow at one inch. Results were always great. We had the green color that we needed and the footing came from the firmness left over from baseball dirt playing surface.

If one sods an area like this, or any part of a football field during the season, gentlemen, it can be done now and you can play on it as soon as you remove your equipment. Usually sod men cut their sod for delivery 18" X 72" with a half inch of soil. This is great when you have a month to go or so and the grass has a chance to knit, but when you have an hour or a day, it will not work. It will work if you do this --have the sod grower cut the sod 18" X 36" with 1-1/2 to 2" of soil. I have sodded like this and never had a piece come up. A number of years back, in the orange bowl, we sodded areas of the center of the field on Thursday, and Friday, and played the super bowl game on Sunday with no problems.

Now we will go across the street to Arrowhead Stadium, Home of the Kansas City Chiefs. Here we have been on our Tartan Turf field for 7 years. The team has practiced daily on it, and ran their tackling sleds over it for three years. There seemed to be many leg injuries and they became slow to heal. Three years ago we built a natural grass practice field and they now do all their practicing on the natural grass field. At times, I wish they would do some practicing on the artificial turf and give the natural grass a rest. But no, they love the natural grass. Let me throw in a little true story here.

On Saturday, June 13, 1973, I was standing at the entrance to the playing field at the L. A. Coliseum and the Miami Dolphins came running down the tunnel on to the playing field for a brief, pre Super Bowl day game work out. As the players hit the turf, you could hear them say--"Great--Superb--Thank goodness for real grass". It seemed that they were happy to be playing on real grass after all their problems with their fake grass. It seemed to make them happy and I would venture to say, that their happiness from working out on natural grass led them to be world champions the next day.

On an artificial turf field, work goes on. After a game, one does not replace divots: instead, of men walking every five yard line with pre-germinated seed and soil mix, they carry a bucket with ammonia solution, a paint brush comb, an aerosol can of gum freeze. Here they remove shoe polish, turf burns, and gum. Some of the turf burns can be as much as six feet long. Depending on how hard the game was played, it usually takes four men eight hours to get the burns, stains, gum, shoe polish off the field after an average game, cigarette burns are a major problem. A year ago we had a visiting coach smoke along with the team doctor--between them they put 28 burns on the sidelines.

The cost of decorating a football field of artificial surface compared to natural grass runs 75% more in price--it costs an average of $500 for paint alone to paint the six foot white boarder for each game if needed. There should be no smoking on artificial turf since the hot ashes and butts will melt an area about the size of a dime. There is no re-sodding or artificial turf, but an artificial turf nursery is necessary. One square yard of natural turf re-sodding may take minutes--but one square yard of replacing artificial turf may take a day. Artificial turf may have to be fertilized using 45% Urea. This is done to help melt the ice and snow, but it makes the field real slick.

A plus for artificial turf is for rock concerts. Rock concerts bring in a nice big fat pay check to the stadiums. It is a money making event, plus a big headache for the groundskeepers. A lot of hard work goes into preparing a field for rock concerts. We use two different methods. In Royal's stadium, we cover the artificial turf first with Polyethylene, followed by laying 1300-- 4' X 8' X 1/2" sheets on Homasota Board, covered again by Polyethylene, followed by a heavy 18 ounce nylon cover. Around the stage area we use 800 sheets or 3/4" X 4' X 8' plywood for fork lift traffic. Here, one can see the work and the expense involved one must protect the turf from fires, soft drinks, alcoholic drinks, knife cuts, and many other things.

In Arrowhead stadium, we use a nylon tarp cover for a roadway and stage area, followed by using 1000 sheets of 3/4" X 4' X 8" plywood for a roadway and stage area, followed by covering the field with a special aluminum-fiber glass-vinyl-canvas cover. A cover for a football field for rock concert protection will run between 40 and 60 thousand dollars. After six uses, it is about shot. One should see the filth left on a field after a rock concert. It's unbelieveable!

Our crew averages between the ages of 16 and 22 years of age, and they are very diversified. They work on artificial grass, the bull pens are Zoysia. Our landscaped islands are a mix of Merion, Windsor and Flyking. Our practice field is a mix of A-34, Merion, Flyking, Windsor, Baron plus ryes of Pennfine, game, Yorktown, Manhattan, and Derby. Our summer practice field which is used by 100 players for four hours a day is Common Bermuda, so we have many grasses to work with.

In professional sports, such as baseball, football, soccer, plus a variety of other events, are held today in what we call multi purpose stadiums, those built to house all these events for the sports fans of America. The prime tennant in these stadiums usually are professional teams. The players are the best men available to supply the people who pay their freight with sporting thrills. These men are pros. Their employers have invested millions of dollars in them. These athletes have the best doctors, coaches, and equipment. Stadium playing field walls are padded for their protection. Usually, everything is looked into to prevent injury to these valuable players in order to protect the clubs investment and to have a first class performance.

Now, the playing field at times gives us a different picture. Home and visiting players become aware of a poor playing field, and they turn gun shy. When players make such remarks as "What a Rock Pile--Sand Pit--Pavement--" and "Obstacle Course", it is a safe bet that the playing of the game will be second rate. So, when it comes down to the playing field, when good natural or artificial turf is necessary to give these athletes the best possible conditions to perform on and help protect them from injury, will these conditions be on the field of play? Here is where we all come in--the Groundskeepers--is he a professional in his field as the athletes are in theirs? Is he trying to give the players the best playing field to perform on? The fans a field of beauty? The management a sound, reasonable operation?

There are the questions that should be answered by the condition of the playing field. It is our job to grow good turf or to maintain a good artificial turf, and here we must hustle and work hard and may I say again, thanks for inviting me here. To one and all, may all your good fortunes be as numerous as blades of grass. Now I would like to show you some slides - followed by a question period.

CONTRACT ARRANGEMENTS

by

Kent Potts*

I will make my presentation on a positive basis so my comments will be in the form of suggestions. By failing to follow the recommendations you may expect problems. Probably the same problems that I have experienced which prompted me to make a point of the matter.

To begin, I would like to organize the rebuilding process into three phases:

1. Preconstruction
2. During construction
3. After completion

Points important to the contractor prior to beginning work are:

1. Who controls the project? (Architect, Greens Committee, Pro, Club Manager, Golf Course Superintendent, or nobody)

It is important that the contractor may receive guidance and gain answers from one authoritative person. Sometimes, this is very difficult and nothing is more frustrating or slows progress more than trying to sort out various answers and opinions or not being able to gain a prompt authoritative answer.

2. Review and discuss contruction processes. This will allow both parties to have a knowledge of what to expect and will make the construction period smoother by eliminating surprises.

3. Discuss course requirements; such things as temporary play, ingress and egress, and routes through the course, etc.

I am sure you can think of other preliminary points to consider; but, I hope these examples will stimulate your thinking to cover everything possible in advance of actual construction. This will make your activity much more bearable.

During the construction period you should:

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1. Follow the preconstruction arrangements or you have wasted your initial time.

2. Keep ongoing operations efficient and effective. You may expect your contractor to operate in the same manner. Otherwise, you might find two crews using each other as an excuse to conduct a big party in the middle of your course. This will reduce efficiency for all concerned.

3. Address problems or give guidance quickly and realistically. I might dwell on this a little as it is often a substantial hinderance. The inability or refusal of the owner's designated authority to make immediate or prompt decisions and answer questions. I have experienced delays or slow downs lasting weeks while waiting on a decision of how to handle a certain situation that has arisen.

Taking the side of the golf course just a minute, you should expect the contractor to:

1. Interrupt golf course activities and personnel as little as possible.

2. Use trained people that also know to respect current operations.

3. Properly staff and supervise the job. But you do not decide how many or how much people and equipment he should place on your job. Only, may you expect contracted for progress. Neither you nor your architect should try to build the job with the contractor's assets.

After or during completion, the owner accepts the maintenance of the product. You should be equipped and ready. Usually the area is freshly seeded or sprigged which requires detailed and timely maintenance to initiate the maximum possible growth.

This is probably the most frequent failing I have experienced. Shortcoming in this area cause reduced results and great disappointments. On a relative basis initiating the turf is a small thing; but, it often becomes one of importance to success.

Both the owner and contractor should wind up details expediciously. This includes move out and clean up by the contractor and prompt payment by the owner. Finally the owner should expect realistic results. I've heard too many times that play is expected four weeks after completion. Possibly some contractor or architect said this when selling the job or the greens chairman when proposing the project to the club/owner. Such promises embarrass all concerned, so be realistic.

Here are a couple of points to wind up with. The contractor should think of his customer and accomodate him and the owner should treat the contractor fairly and with respect. If such a relationship cannot be established with your proposed contractor, then do not award the job to him regardless of price or any other consideration because good will not occur.

EQUIPMENT OPERATION & SAFETY

by

Jim Joplin*

Its always good to make the Texas Turfgrass Conference and see people in our industry trying their best to improve on the job that they already do so well.

Lets discuss Equipment operation as it concerns safety.

All of us have seen the changes in the equipment we use in just a few short years. I know all of you are aware of the added cowlings, guards, and those troublesome safety switches. These are major changes in the equipment that is available for the turf managers use. Its highly sophistocated, well engineered, precision constructed, specialty equipment that has the latest government and industry specified safety features.

So what!

It doesn't mean a thing if it's not operated right or in a safe manor.

Before we get into the nuts and bolts of the equipment, let me lay something on you.

Safe equipment is a matter of how well its engineered, built, and maintained.

Safe operation is a lot harder. It has the human element. You don't have to train the equipment to be safe. You do people.

We must spend more time in training our operators. Poor operators probably cost most down time, maintenance expense, and accidents than anything else. We train our mechanics. We send people to service schools, irrigation seminars, and turf conferences. What kind of training do we have for operators? At this moment, there are two types of operator training, little and none.

Let me also define what I mean by safety. Safe operation not only means safely operating the equipment for the benefit of the operator and surrounding people, but also the machine. An operator that operates a machine safely and knows the actions and reactions of the equipment will have less down time, maintenance, and repairs needed.

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*Jim Joplin, Jacobson Manufacturing Co., Route 3, Box 513CC, Tyler, Texas 75701.

How must we go about training operators.

I feel that there are 3 main areas in which operator training should be given.

1) The limitations in which the particular machine may have, pertaining to the area in which it may safely be operated.

2) The physical operation of the machine, including controls, steering, braking, manuverability, actions, and reactions under normal and recommended use.

3) Economic safety. The operation of a particular piece of equipment in the best manner as to keep downtime and maintenance to a minimum.

Lets take these one at a time. Certainly knowing the limitations of a machine sometimes is very simple. It is clear that a triplex greensmower is not for cutting roughs. Or a gang mower is not for mowing greens.

But for the "multi-purpose" machines, such as rotary mowers it becomes more complicated.

For some examples:

Does your operator know the safest slope or degree of encline the mower was designed to operate on?

Does he know that when mowing on a slope or hillside he should have the deflector chute, if it is still on the machine, directed to the downhill side?

Have you gone with your operator to problem areas to show him the best approach the machine can take on mowing slopes? Straight up? Down? Which angle?

This is what I mean by training an operator on the limitations of the particular piece of equipment.

A thorough knowledge of all the controls of the machine is a must. There are people in this business that have machines supplied to them for their operation, that do not know what all of the controls on a piece of equipment were designed to do, or how or when to use them.

For some examples.

Does your operator know all the brake controls and their functions? Service, parking, and traction brakes are on many machines.

I've seen new operators get into situations where they have to back out of a tight spot with pull gangs.

They use the direction control on a hydraulic or hydrastatic transmission as a brake.

Try to operate equipment at transport speeds, not realizing that on dual range transaxles there is a mow range and a transport range.

Much of the preceeding, is overlapped into the third training area, that is operating the machine in such a way as to provide economic safety.

Basically well trained operators that know the limitations in which the machine should work, and all the operation controls, are providing safety for themselves and others around them. But for the safest operation of the piece of equipment he should also be trained on the adjustments, speed, and manner of action the machine should utilize.

Some Examples:

That guy that uses reverse in a hydraulic or hydrastatic transmission as a brake is flirting with replacement of a \$400-\$600 transmission instead of a \$75 brake job.

The guy that mows in high range, in a dual range transaxle, will possibly get through today a little quicker, but how fast can he mow the same area next week while the machine is down waiting for repairs?

An untrained operator that does not know enough about the ampmeter, oil pressure, and heat indicators on your equipment where they are supplied, may not be endangering himself or others, but can cause a real breakdown in your economic safety.

So to recap our concerns.

The machines themselves are, by design, safer than ever. The weak link in safe equipment operation is in the human area.

In many maintenance operations, we use people of very little education, little ambition, little care, and usually the least paid, to operate highly sophisticated, specialty use, and expensive equipment.

This winter, on bad days, you could have operator training at your own installation. How do you do it?

1) Use equipment owners manuals. You know what they are. Thats the little book that comes with the machine that in 2 weeks after you get it no one knows where it is.

2) Use your equipment distributor salesmen. They should know more about the operation of your equipment you buy from them, and can train your operator on it. If he doesn't I'm sure his employer will teach him.

3) Of course use your own experience and knowledge of your area to train operators in what machines to be used in certain locations.

4) Lastly, your mechanic would probably like to become involved in training operators to be aware of actions, adjustments, and possible problem areas in the machine to minimize downtime and repairs.

Next to a good mechanic, most installations need and have problems keeping good operators. With a little training you may not only have a safer operation but you may instil a little pride in the job he does.

Training people to operate equipment safely can save you accidents, injuries, downtime, maintenance dollars, insurance dollars, and maybe an expensive law-suit.

Its worth the effort.

DEVELOPING A FERTILIZER PROGRAM

by

Dr. William E. Knoop*

Many years ago early researchers identified and described the benefits derived from the application of various fertilizer materials to turfgrass. Since then turfgrass managers have been supplied with a great amount of fertilizer selection and application information from various informational and educational sources such as universities, private consultants, fertilizer companies and suppliers and fellow turfgrass managers.

With all this information available why then be concerned with developing a fertilizer program? Why not follow one of the programs available from one of the information sources? Well, maybe the suggested program will be adequate, but how do you know it is the best program for your conditions.

Fertilizer materials are basically growth regulators and as such under most conditions, as fertilizer rates of application are increased the rate of growth of the plant increases to a point at which additional fertilizer may cause a toxic condition and growth rates may be reduced. (Figure 1)

Of all the nutrients required by the turfgrass plant nitrogen has the greatest effect on its growth rate, especially foliar growth rate. For that reason, most turfgrass fertilizer programs are based on the rate and frequency at which nitrogen is required. The application rates of phosphorus and potassium are usually determined by their ratio to nitrogen. In other words, many researchers feel that fertilizer with a 3-1-2 (N-P-K) ratio is best for most fertilizer programs. The turf receives 1 unit of P_2O_5 and 2 units of K_2O for every 3 units of N. Fertilizers such as 12-4-8, 27-9-18, 18-6-12, etc. are 3-1-2 ratio fertilizers.

Since nitrogen has the greatest effect on foliar growth rates perhaps foliar growth should or could be used to determine the rate and frequency of fertilizer applications. Foliar growth rates are very important when considering fertilizer programs for high use areas such as athletic fields, golf putting greens, golf tees, etc. High use areas need higher growth rates than low use areas in order to repair the "ware and tare" caused by high traffic. In fact, many would consider it ideal in low use areas to develop a fertilizer program that would result in turf with a dark green

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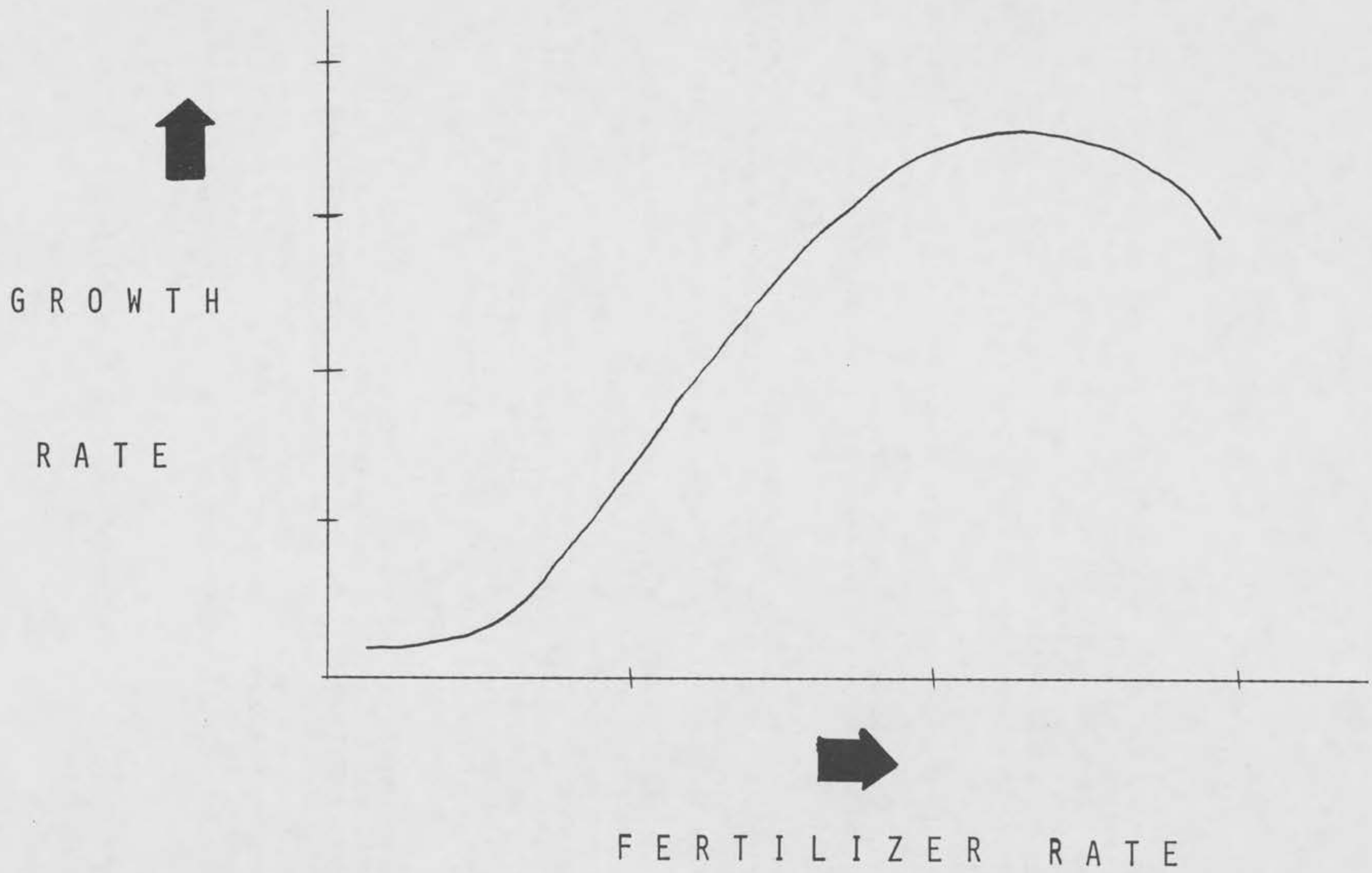

FIGURE 1

color and a growth rate so low mowing frequency could be reduced to once every two weeks or even once a month. While this doesn't seem to be possible now using growth rates as the critera for fertilizer rate and application timing may aid not only in reducing fertilizer needs in some areas, but also help reduce mowing requirements.

In a practical sense there are 2 methods by which growth rates may be determined. One method is to measure yield (i.e. - the amount or weight of clippings taken from a given area each time it is mowed). The golf course putting green lends itself to this method. Its about the only turf area, except for some home lawns, that clipping removal is normally practiced. The frequency at which a turf requires mowing can also be used as a method to determining growth rates. This method can only work if the same mowing frequency critera is used all the time. That is, if the turf is always cut so that no more than 1/3 of the leaf is removed at one time then the faster the turf is growing the more frequent it must be mowed and thus mowing frequency becomes an indicator of growth rate.

One of the first steps in developing a fertilizer program is to set a growth rate standard or goal. As indicated high use areas need higher growth rates than low use areas. The decision concerning what is the best growth rate for a given turf must be based on the experience of the turf-grass manager. For example, experience might indicate that the best growth rate for a particular golf putting green be defined as 4 buckets of clippings per mowing or perhaps in the case of a park experience might indicate that a mowing frequency of once a week is ideal.

The next step is to determine what N rate and how often should that quantity of N be applied in order to produce a growth rate that will come the closest to the desirable rate. In figure 2, using a golf course putting green as an example, the amount of clipping were recorded each time the green was cut. In this example, by the fourth day the growth rate exceeded the desirable range and after the seventh day fertilizer will need to be applied again.

For turf areas other than putting greens where mowing frequency becomes the criteria for fertilizer applications timing the number of days between mowing are recorded. As an example (figure 3) fertilizer has been applied at the beginning of the season and the turf was mowed 12 days later. The second mowing took place 8 days after the first and so on. When the mowing frequency slowed down to 10 days fertilizer was again applied and the frequency between mowings again became shorter.

In either example (figure 2 or 3) the slope of the curve will be a function of the nitrogen source. In other words, if a fast release nitrogen source is used (i.e. urea, ammonium, nitrate, etc.) the growth rate will increase faster and decrease faster than if a slow release source (i.e. urea formaldehyde, I.B.D.U., sulfur coated urea, activated sewage sludge) is used (figure 4). The height of the curve will be a function of the nitrogen rate (figure 5).

There is a great deal of flexibility in the development of a fertilizer program. Both nitrogen source (slow or fast) and nitrogen rate can be used to aid in the control growth rates. Of course, all the environmental factors play a major role in determining growth rates. These are not usually under our control. What has been presented here is an approach that should work. It perhaps will not work for everyone, but those that are willing to experiment and find out for themselves just how much growth rates are changed by a pound or two of nitrogen should find recording and evaluating growth rate data to be a reasonable approach to the development and maintenance of a fertilizer program.

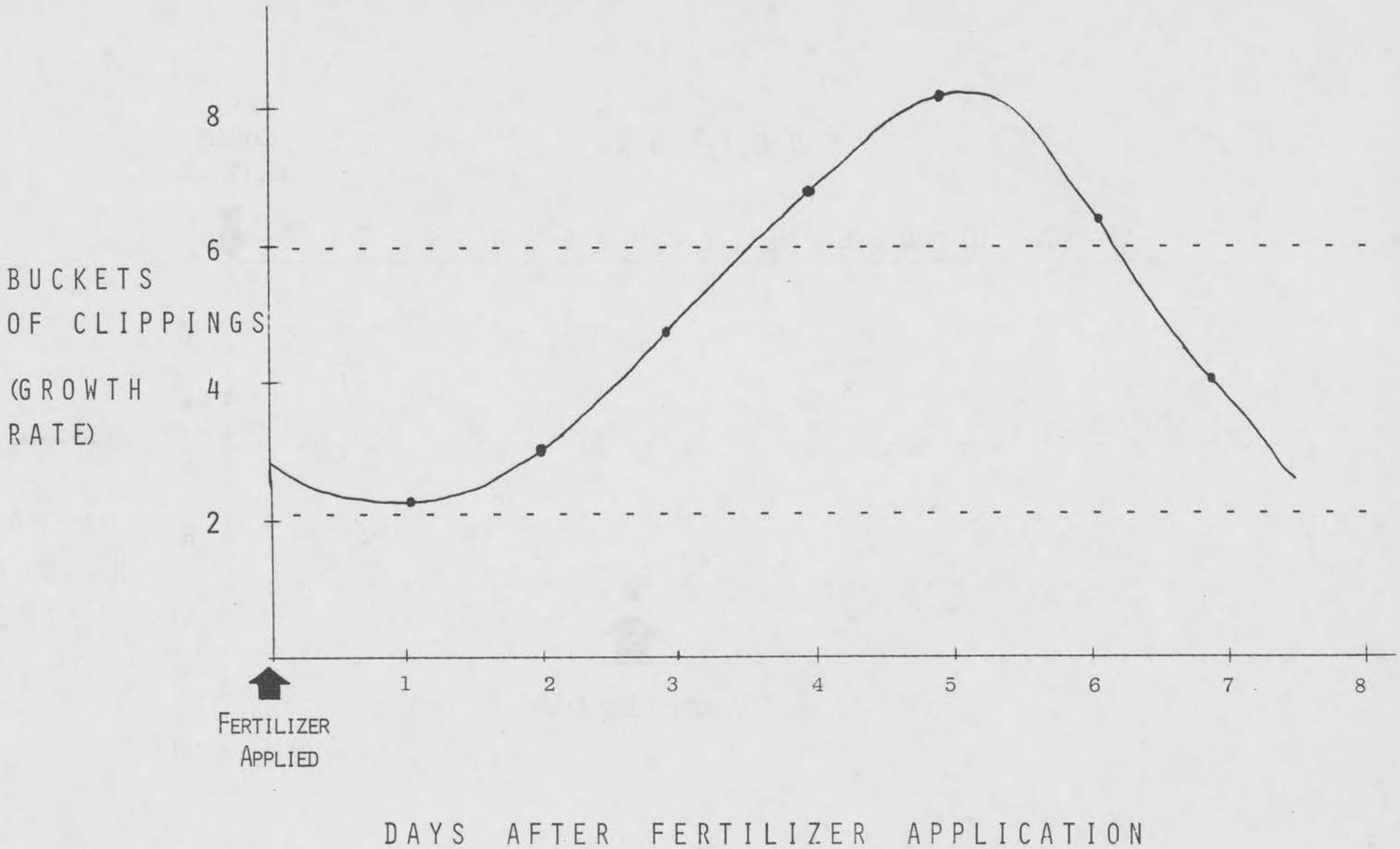
BUCKETS
OF CLIPPINGS
(GROWTH
RATE)
8
6
4
2
1
2
3
4
5
6
7
8
FERTILIZER
APPLIED
DAYS AFTER FERTILIZER APPLICATION

FIGURE 2

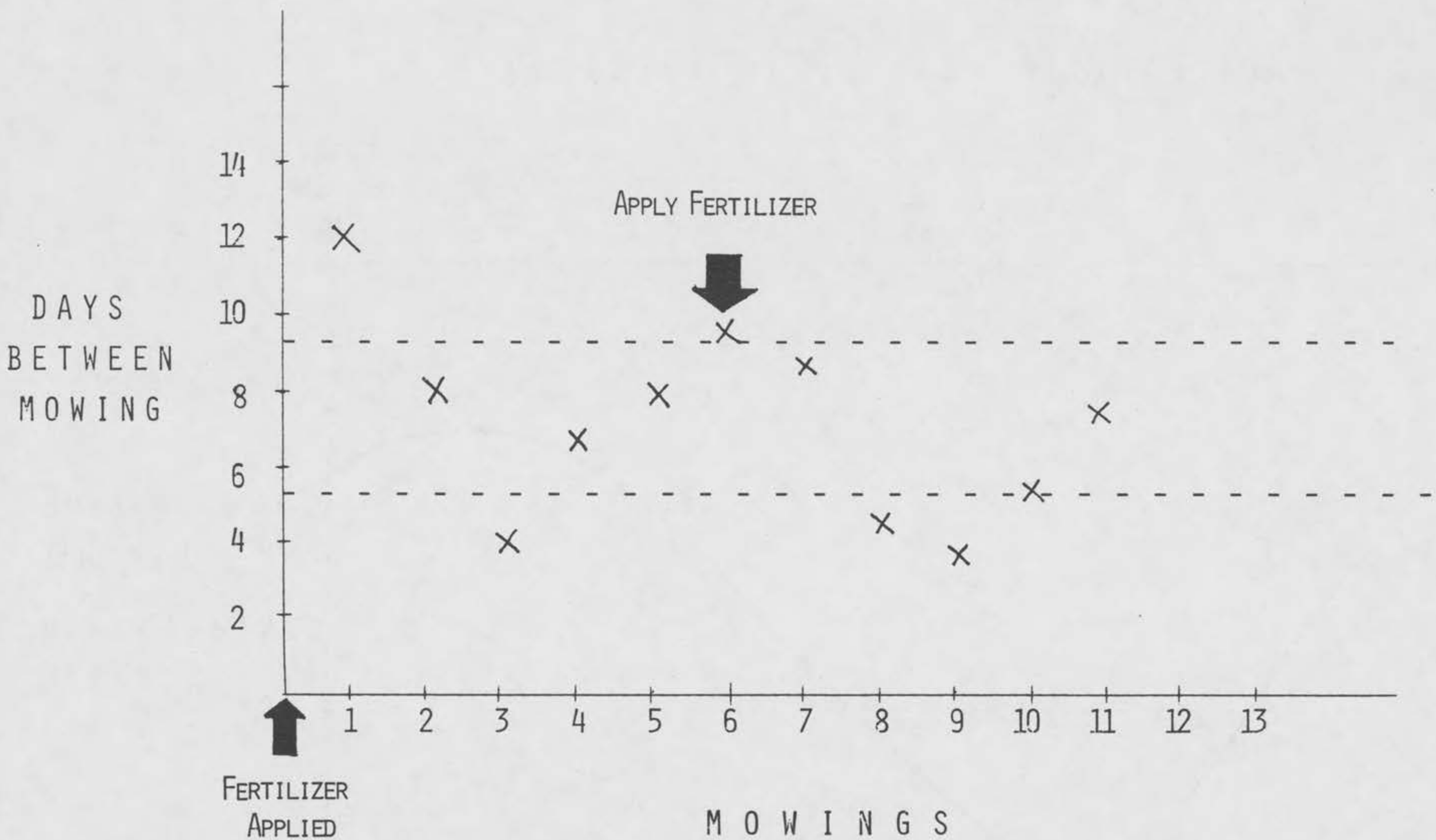
DAYS BETWEEN MOWING
14
12
10
8
6
4
2
APPLY FERTILIZER
1
2
3
4
5
6
7
8
9
10
11
12
13
FERTILIZER APPLIED
MOWINGS

FIGURE 3

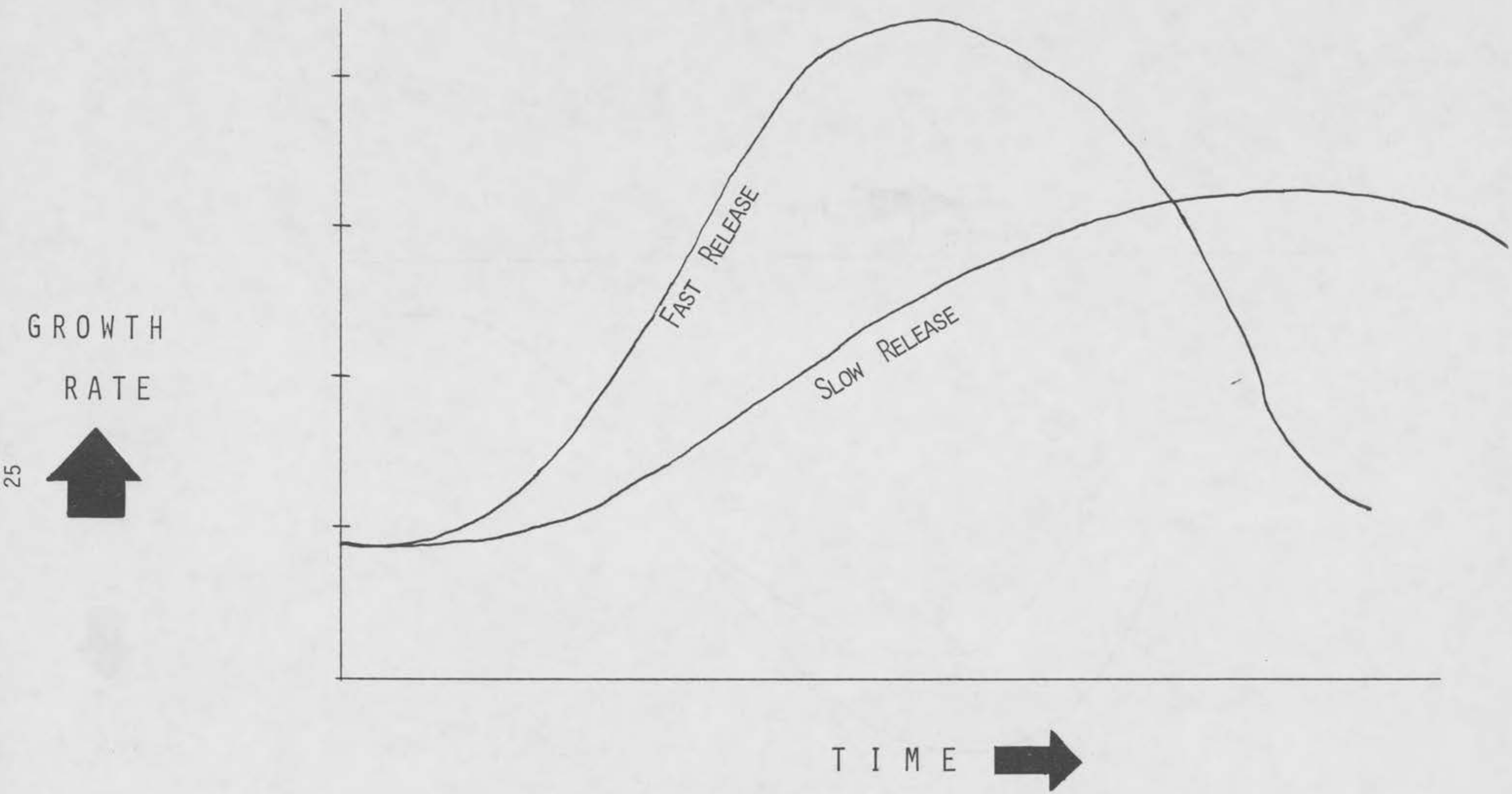

FIGURE 4

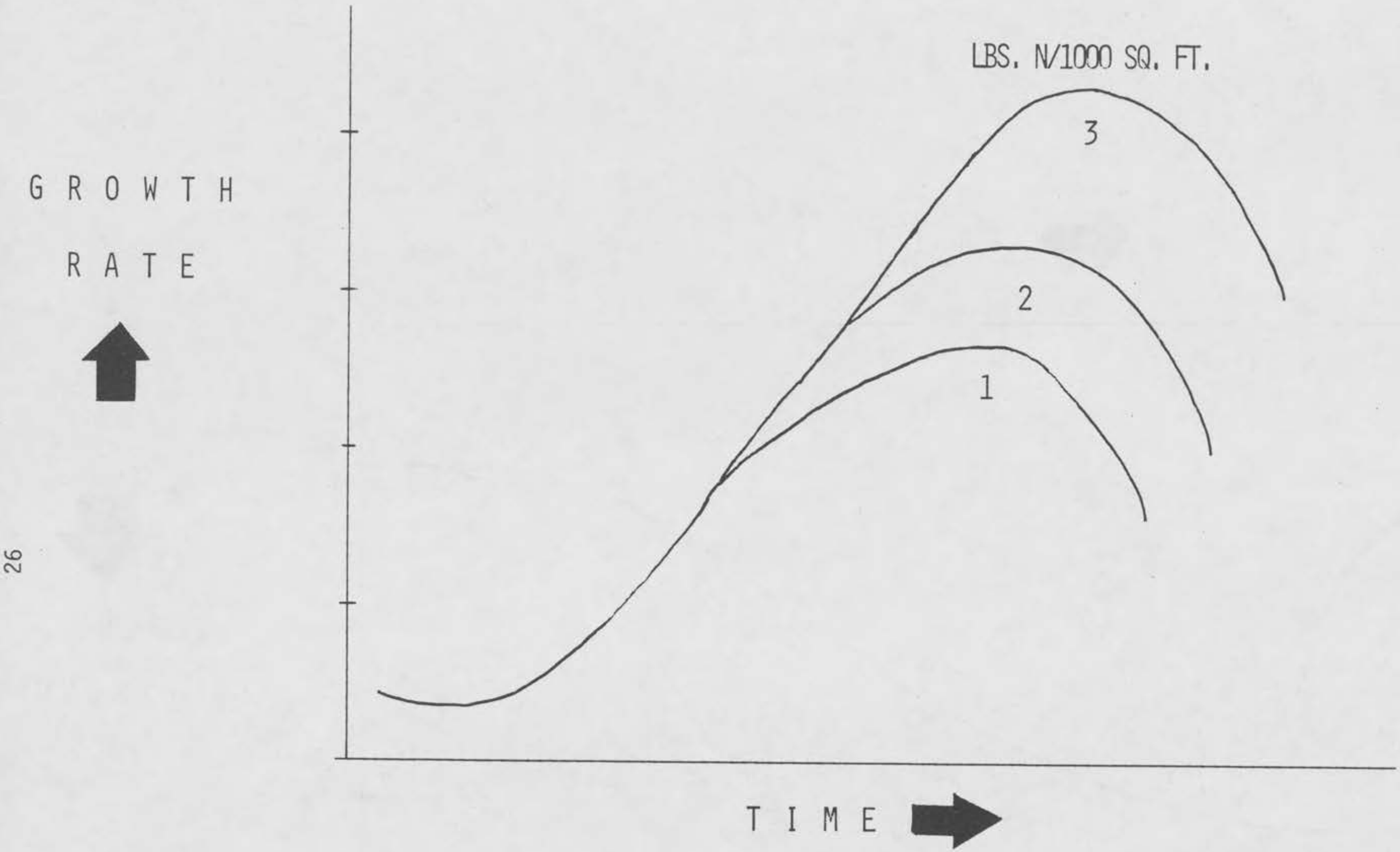

FIGURE 5

WATER CONSERVATION PRACTICES

by

J. R. Watson*

To apply the water needed to achieve a properly executed watering program to conserve water without sacrifice of turfgrass quality for a golf course requires the balance and adjustment of many complex factors. The basic requirements are the same for all turfgrass areas -- large or small, home lawn, park or golf course. On all it is necessary to consider soil conditions, the demand of climate and the physiological requirements of the plants -- grass, trees, shrubs and flowers.

There are complicating factors associated with the conservation of water on small areas like clubhouse grounds that are not necessarily found on the course proper. Examples would include the complexity of landscape patterns and designs, space limitations, concentrations of plants with widely differing water requirements, and, sometimes a limited water supply, poor quality of water, inadequate pressure and poor or restrictive distribution systems.

Yet, the need to develop techniques to conserve water on small areas may be more critical than on larger sites. If I may digress for a moment, in total, the small areas -- home lawns, industrial lawns, school playgrounds, small community parks, athletic fields, and in some cases, intensively used sections of larger areas-- constitute a very large part of the green and landscaped areas of our cities and towns. In this respect, they are, collectively, valuable and necessary, functional and aesthetic. They constitute places to play and to relax and they filter the atmosphere of our communities. They enhance the beauty and the value of property. When properly landscaped, maintained and groomed, they attract visitors and invite industry; thus, becoming economically important.

For these reasons, among others, watering systems and the techniques used in the application of the water on golf courses merit careful study, evaluation, selection and execution. Systems must be chosen on the basis of performance, efficient performance that results in production of the highest quality turf on greens and fairways with a <u>minimum amount</u> of water. The conservation of water is a vital issue in many parts of the country and will inevitably become so in all areas, and soon. I do not wish to be cast in the role of an alarmist, but I believe firmly

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that one of the first and most important requirements for irrigation practices that will reduce maintenance costs must be the application of water in a manner that results in maximum conservation. This can occur only when the watering program has incorporated the techniques and the flexibility to:

1) apply water in a manner suitable to a wide range of plant and soil conditions. Soil, for the most part, should be uniform on putting greens. However, practically all fairways have highly variable soil conditions.

2) Provide for maintenance of good soil-air-water relationships; and

3) if on city water, permit application of water in "off-peak" use periods.

In addition, minimization of water use on golf course turf requires an understanding of several basic concepts which, individually and collectively, affect water and its proper use. There can be no set or predetermined formula or prescription for effective watering of greens and fairways. Rather, the superintendent must balance the variables that affect his watering practices on <u>his</u> golf course and arrive at the solution that best suits each green, each tee, each fairway, as well as the rough and the clubhouse grounds.

To conserve water requires an understanding of the fundamental role water plays in plant growth, of the effects climate and weather have on growth rates and how they influence water-use rates and choice of grass. Effective and correct watering demands a knowledge of the basic physical and chemical soil properties and how these affect water absorption, storage and drainage as well as the frequency, rate and manner in which water must be applied. All such basic information must be correlated with the requirements for play and adjusted to fit the existing irrigation facilities. Let me review briefly several key factors involved in developing watering practices that conserve water.

Water transpired by the leaves and evaporated from the surface serves as a temperature regulator for the plant. Syringing of greens during periods of excessive evapotranspiration is based in these phenomena. The amount of water within the cells of the grass leaves plays a role in counteracting the effects of traffic. When the plant cells are filled with water, they are said to be turgid, a condition that helps leaves resist pressure from traffic (foot and vehicular) and avoid the damage, sometimes death, that may occur. Wilt is a condition that exists when cells do not contain enough water and are said to be flaccid. A ten percent loss of water from the plant body frequently will cause permanent wilting and death.

<u>Soil</u>

The soil for any turfgrass area must provide support for the grass, serve as a storehouse for nutrients, supply oxygen and act as a reservoir for moisture. Additionally, on greens, it must resist compaction. The texture (size of particles), structure (arrangement of soil particles), and porosity (percentages of soil volume not occupied by solid particles) of a soil are the basic physical factors which control the movement of water into the soil (infiltration), through the soil (percolation) and out of the soil (drainage). Texture, structure and porosity, along with organic matter content, determine the water-holding capacity and control and air-water relationships of the soil.

These characteristics directly affect water conservation. The intake of water is through the roots -- the root hairs are the organs through which water is taken in. Hence, the depth of rooting and the extent to which a given root system occupies the soil determines the depth to which the soil should be wet. The volume of soil occupied by roots represents the soil reservoir capacity for that plant. When the need for water by the plant is great (high temperature, high wind movement, low humidity) this reservoir may have to continually replenished--especially if the root system is shallow.

If the need for moisture is 0.25 daily -- as is the case during July and August in many areas of Texas -- the soil must supply to the plant 0.25 inches of water between irrigations. Soils that are otherwise very good for putting greens may only hold 0.5 to 0.75 inches per cubic foot. This would be an adequate amount of water for one to two days if all of it were available to the plant. For this to be the case, the roots must extend through (permeate) the entire volume of soil and the soil must have the capability to supply the needed amount of water, or have the characteristics necessary to move the needed amount of water at a rate rapidly enough to permit uptake by the root. The root systems on most putting greens frequently do not extend to a one-foot depth (especially in the summer). When they grow only to a depth of three or four inches, the volume of potentially available water is reduced by one-third to one-fourth. The reservoir (soil) insufficiently must be replenished by irrigation. Thus the advice to water deeply and infrequently is not valid for many putting greens, for that matter, for many turfgrass areas. It would be if the roots were deep enough.

Poor aeration, whether from poor drainage, compaction or an inherent soil condition, further complicates watering practices that will conserve water, especially on shallow soils of low water-holding capacity.

Amount of Water

The actual amount of supplemental water required to keep the grass green and healthy throughout the growing season is dependent, principally, on temperature, sunlight, wind movement and rainfall. In Texas, to sustain growth and to keep turfgrass green during the growing season, it has been estimated that supplemental water will have to be applied in varying amounts for six to twelve months -- a substantial percentage of the growing season. This calculation is based on average weather data for ten climatic regions for Texas over a thirty-year period.

Location	July Deficit	Location	July Deficit
Amarillo	-5.30	San Antonio	-6.12
Abilene	-6.56	Houston	-4.03
Dallas	-6.61	Laredo	-7.36
Bryan	-5.01	Brownsville	-6.97
El Paso	-5.82	San Angelo	-6.18

If reliable, well-trained manpower were available, the job of applying water to turf areas could be accomplished with any type of sprinkler device or means (flooding, hose end devices). However, since such operators rapidly are becoming unavailable, there seems little doubt that the most effective, most efficient, most convenient and most economical way to water golf courses -- any landscaped turf and recreational facility for that matter -- is by automatic underground sprinklers. Clock-controlled systems are flexible and constant -- always on duty and available on demand. They are a practical means of preventing waste (conservation of water) and of assuring good watering techniques.

The advance in controllers, valves and sprinklers that has occurred within the past few years has been substantial. It is well to keep in mind, however, that any system, old or new, irrespective of how well it has been installed, used and maintained can be no better than its basic design.

Basically, any system design is a compromise between cost and performance. Thus, the owner (or operator or golf course superintendent) must make certain basic decisions, all of which revolve around obtaining the best performance for the costs involved.

Design of a system starts with the owner, operator or turfgrass manager answering such questions as: area to be covered, hours available for watering, amount of water to be applied, type of system, precipitation rate, wind velocity and service life of the equipment. Answers to these questions, once incorporated into the system design, are fixed. They are nonvariable! The area to be covered or watered must be determined, preferably by use of an accurate plot plan. There will be no embarrassing questions later if this is scaled and laid out in advance.

A system is purchased to water grass and to keep it green during the growing season. This often coincides with the driest time of the year. Failure to specify a system large enough to provide adequate water will produce trouble for all concerned.

Summary

Techniques of watering that permit conservation of water require an understanding of the fundamental role water plays in plant growth; of the effects climate and weather have on growth rates; how they influence water-use rates and choice of grass or plant materials. Good techniques of watering demand a knowledge of the basic physical and chemical soil properties, how they affect water absorption, storage and drainage as well as they frequency, rate and manner in which water must be applied.

Irrigation systems must perform efficiently and effectively. They permit maximum conservation of water and they should be economical to operate. They should be designed by a specialist, installed properly, programmed to meet the requirements of the grass and other plants; and, to satisfy the demands for play or playability. And, above all, they must be serviced routinely.

Automatic underground sprinkler systems provide the best answer to the problems associated with reduced maintenance costs through conservation of water. Their flexibility permits correct and effective watering despite the varied conditions that exist on golf courses and other landscaped areas. And they are economical to operate. Most important, they do conserve water, because they permit control of its application.

Finally, the best advice I can give you for conservation of water on your golf course is to "treat each day's watering practices as if you are in the midst of a severe drought." And, develop your short and long range plans so as to combat drought.

OVERVIEW OF THE LAWN CARE INDUSTRY

by

Bob Earley*

We did a survey of the lawn care industry, and found out that about 85 percent of chemical lawn care companies are independent businesses, about seven percent are franchises and about five percent are company-owned chains. For lawn maintenance firms, about 78 percent are independents, eleven percent are franchises, and seven percent are company-owned chains.

Chemical lawn care companies average 13 employees year-round; maintenance firms average five year-round. At peak season, chemical lawn care companies average 18; maintenance firms average eight.

Types of services performed and percentages of lawn care companies that perform them: Aeration, 46 percent; reseeding, 54 percent; dethatching, 46 percent; rolling, 22 percent; mowing, 42 percent; watering, 17 percent; liming, 49 percent; snow removal, 26 percent; weed control, 96 percent; insect control, 96 percent; disease control, 77 percent; liquid fertilizing, 66 percent; dry fertilization, 73 percent (many companies obviously do both; preemergent crabgrass control, 91 percent; soil testing, 63 percent; soil conditioning, 39 percent.

The same data for mowing/maintenance companies, and I might add that this is based on the way the companies identified themselves in the survey: Aeration, 59 percent; reseeding, 80 percent; dethatching, 63 percent; rolling, 50 percent; mowing, 73 percent; watering, 21 percent; liming, 67 percent; snow removal, 35 percent; weed control, 89 percent; insect control, 75 percent; disease control, 67 percent; liquid fertilizing, 15 percent; dry fertilization, 87 percent; preemergence crabgrass control, 72 percent; soil testing, 46 percent; and soil conditioning, 33 percent.

Number of chemical applications and percentages of companies using that number: four trips, 40 percent; five trips, 22 percent; six trips, 15 percent; three trips, 14 percent.

The chemical lawn care companies participating in our survey averaged 1,028 customers, and gross receipts of $234,000 annually; mowing/maintenance firms averaged 219 accounts, and gross receipts of $74,000 annually.

*Bob Earley, Editor, Lawn Care Industry, 9800 Detroit Avenue, Cleveland, Ohio 44102.

Chemical lawn care companies, at least 77 percent of them, said they experienced an average 34 percent increase in their business from 1977 to 1978. 76 percent of these firms said they expected an average 75 percent growth in their business next year.

When asked if they serviced other than residential lawns, 96 percent of the chemical companies said yes, 86 percent of mowing/maintenance companies said yes. Most common types of non-residential accounts included condominiums, apartments, commercial buildings, industrial parks, churches and cemeteries.

More than 14 percent of the total companies said they installed or serviced residential irrigation systems.

1977 expenditures for supplies:

	Chemical companies	Mowing/maintenance
Seed	$ 3,840	$1,820
Fertilizer	13,900	3,630
Insecticides	5,070	1,170
Herbicides	4,740	731
Fungicides	3,580	481

When asked their main buying months for fertilizer, the majority of the companies listed March, May, February and September, in that order, with more than 35 percent naming March.

Main buying months for chemicals were January, February and March, almost 20 percent naming each month. For equipment purchases, March, April and May were the main months, more than 20 percent each.

Chemical lawn care companies said they owned an average of four vehicles with liquid application tanks, five granular applicators, three seeders, two aerators. Mowing/maintenance companies said they owned 14 walk-behind mowers; 30 percent said they owned an average of three tractors in the less-than-10-h.p. range; 64 percent said they owned an average of three tractors in the 10-20-h.p. range; 22 percent said they owned three tractors in the 21-30-h.p. range; 18 percent of the companies said they owned an average of two tractors in the 31-50-h.p. range; and five percent said they owned two tractors of more than 50 h.p.

Capacity of tanks for those companies that said they owned them:

Gallon capacity	% of response
0-50	3.4%
51-250	29.2
251-500	23.3
501-750	8.9
751-1,000	13.6
1,001-1,250	14.0
1,251-1,500	5.1
Over 1,500	2.5

When asked if they advertise, 76 percent of chemical lawn care companies said yes, 68 percent of mowing maintenance companies said yes. Ranking of advertising mediums as first choice was: In order, Yellow Pages, direct mail, newspaper, door hangers, with a lesser percentage mentioning phone solicitations, door-to-door solicitations, television, radio and home and garden shows.

When asked what their total ad budget annually was, we got answers from $1,000 to $105,000. The average was $5,900, although two-thirds of the answers were $3,000 or less.

We asked the companies which of the following methods they used for employee training:

Source	% responding
In-house	77%
Turf Conferences	50
Seminars	37
Extension classes	30
Consultants	13
University classes	13
Other	12
Community colleges	11
None	5

In a series of interviews with lawn care businessmen across the country, we asked them what changes will take place in the lawn care industry within the next five years.

They said that liquid application will dominate, but there will be a serious reappraisal of dry, particularly as new and improved products come on the market. There will be a thinning of profit margins as increased competition and inflation take a greater hold. Many "gardeners" who hoped to cash in on the chemical lawn care market will be forced back to their specialty.

Also, serious use of growth retardants will begin. Fewer independent lawn care companies will open their doors--but there will be more franchises. More pest control operators will offer lawn care as part of their services. Lawn care businessmen will have more year-round help being paid better wages.

Finally, there will be better equipment available--mowing/maintenance businessmen won't have to rely as much on having to "commercialize" common consumer garden tractors, and there will be more opportunities for small companies manufacturing equipment, especially spray equipment.

Some of their quick comments from lawn care businessmen about what will happen to the industry in the 80's:

The major metropolitan markets will continue to expand, but there will also be the emergence of a new small-town market. Commercial accounts will turn in increasing numbers to mowing/maintenance firms because they will see that their own in-house people would be better employed in other areas. A more full-service approach to lawn care will continue to provide stable and sensible growth not dependent upon economic cycles. But the trend to specialization, particularly for chemical lawn care companies, will also continue.

There will be a lot of new technology surfacing regarding material handling, specifically borrowing from agriculture. There will be more complete products developed combining fertilizers and pesticides.

There is the possibility that one, two or three large companies will dominate the chemical lawn care field. Possibly, a number of smaller--but still relatively large--regional companies might develop. Also, there is the possibility of many small companies developing to service the homeowner, much like the "gas station on every corner" type of marketing similar to the oil industry. Quite likely, all three types of development will take place within the next five to 10 years.

Large corporate retailers such as Sears and Montgomery Ward will become more of a factor in the industry.

Insecticides with more residual effect, but still environmentally acceptable will be developed. Growth retardants that really work without sacrificing the appearance of turfgrass will be developed.

Computers will be used more and more by medium to large companies for material and service control. Irrigation installation will come into its own in the East, offering more opportunities for lawn care businessmen.

Government regulation will be a factor in the industry in the future. The industry will emerge as a selective applicator of pesticides for the homeowner because of this regulation. But it might become more difficult for operators to become certified.

A growing percentage of lawn care business say that a "code of ethics" or standards will be necessary in the future for the growth of the lawn care industry. Some have advocated the formation of a national lawn care association to foster these goals and further educational facilities to the industry.

Barring any major technological breakthroughs, it will become difficult for prices to keep up with inflationary pressures. The effect will be a thinning of profit margins. This characteristic of any industry becoming increasingly competitive in an inflationary environment. Observing this, many companies will begin diversification into different turf and ornamental related services.

Despite the fact that the industry--from a nationwide perspective--will continue to grow in the 80's, many market areas will approach saturation. In those areas, the issue will become how to maintain and increase market share in the context of limited market expansion. This will cause increased emphasis on marketing strategies and product quality.

To sum it all up, one lawn care businessman probably speakes for most when he says:

"The demand is there, the services we perform are necessary and needed and the public will be served. The outlook for the industry as a whole is bright for the 80's and into the 90's."

WINTER WEED CONTROL IN LAWNS

by

B. J. Johnson*

Winter annual weeds are found in most dormant turfgrass areas throughout the southern United States during the winter and early spring. Mild temperatures favor rapid growth of these annuals. Weeds distract from the beauty and value of a dormant brown turf.

A weed-free turf does not happen by accident. It requires a well planned program. A good management program will influence weed population, but herbicides must be included in the program to maintain an attractive high quality turf.

General information: All experiments were conducted on natural weed infested golf course fairways. The turf areas were managed as the surrounding turf. Weed control data were obtained from averages of 2 to 4 years depending on weed species from 1 to 3 test sites. Ratings from preemergence treatments applied in summer or fall were made the following March and ratings from postemergence treatments were made 4 to 6 weeks after treatment. Ratings from 90 to 100 indicate excellent control, 75 to 89 as good or acceptable, and below 75 as poor or not acceptable. Weed infestations include annual bluegrass (*Poa annua*), parsley-piert (*Alchemilla microcorpa*), corn speedwell (*Veronica arvensis*), hop clover (*Trifolium agrarium*), henbit (*Lamium amplexicaule*), common chickweed (*Stellari media*), and spur weed (*Soliva sessilis*).

Trade names are given as information for the reader and do not imply any endorsement or preferential treatment over other similar products.

PREEMERGENCE TREATMENTS

Dates of treatment. None of the herbicides applied in mid-July or August satisfactorily controlled any of the winter annuals when ratings were made the following March (Table 1). Balan and Kerb applied in September resulted in good control of annual bluegrass. Similar control was obtained with October Balan treatment, but excellent control was obtained with October treatments of simazine and Kerb.

October treatments of Balan, Dacthal, Kerb, and simazine controlled a high percentage of corn speedwell and common chickweed than when treatments

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were applied in September (Table 1). Betasan and simazine were the only chemicals that controlled parsley-piert and hop clover satisfactorily, respectively. The control of these weeds was also higher when treatments were delayed until October.

This indicates that optimum weed control in bermudagrass turf was obtained with herbicide treatments in October. Overseeded areas should not be treated in this manner and label instructions should be followed.

Combination treatments. Combination of Betasan with Balan or Kerb controlled more weed species than either applied alone (Table 2). This occurred because Balan and Kerb controlled corn speedwell and Betasan controlled parsley-piert while both species were controlled with combination treatments. However, these combination treatments did not control hop clover or spur weeds.

Since no single herbicide will control all weed species, these results clearly indicate the importance of knowing the weeds in a given area before selecting a herbicide (Table 3). Annual bluegrass was controlled satisfactorily with more different herbicides than any of the other annuals. However, of the seven different weed species in these studies, none of the herbicides applied as single treatments controlled more than four species. Simazine controlled annual bluegrass, hop clover, spur weed, and common chickweed; Devrinol controlled annual bluegrass, corn speadwell, spur weed, and common chickweed; Ronstar controlled annual bluegrass, hop clover, corn speedwell, henbit, and common chickweed. Combination treatments of Balan + Betasan controlled parsley-piert in addition to the four species controlled by Balan applied alone.

POSTEMERGENCE TREATMENTS

Annual bluegrass: Annual bluegrass was controlled satisfactorily in dormant bermudagrass turf with several different herbicides (Table 4). Kerb, Paraquat, Roundup, and Sencor resulted in 98 to 100% control while atrazine and simazine had acceptable control of 82 to 86%. The optimum time of application for most of the chemicals is after annual bluegrass emerges, but before plants begin to flower. There are exceptions, since Kerb has both pre and postemergence activity on the weed.

Broadleaf weeds: Parsley-piert control. Sencor completely controlled parsley-piert when applied as a single application (Table 5). Two applications were required of either 2,4-D + silvex + dicamba, 2,4-D + dicamba, Paraquat, or Roundup for similar control. The control was not as good with other herbicides regardless of number of applications.

Common chickweed control. All herbicide treatments resulted in excellent control of common chickweed (Table 5). However, two applications were required for 2,4-D and silvex.

Spur weed control. The control of spur weed was 87% or higher from single treatments of all herbicides except silvex (Table 5). It is desirable to have complete control of this weed because of the many spiny stickers on seed pods.

Henbit control. Single treatments of either 2,4-D + silvex + dicamba, dicamba, silvex, or Sencor resulted in excellent henbit control (Table 5). Two applications of 2,4-D + MCPP + dicamba, 2,4-D + dicamba, Paraquat, or Roundup were required for similar control. 2,4-D applied alone failed to control henbit regardless of the number of applications.

Corn speedwell control. A single application of Paraquat, Roundup, Sencor, or 2,4-D + silvex + dicamba controlled corn speedwell excellent with a single application (Table 5). Similar control was obtained with two applications of silvex, but repeated treatments of 2,4-D + MCPP + dicamba, 2,4-D + dicamba, 2,4-D or dicamba failed to give effective control.

These postemergence studies with herbicide control of winter annuals in turfgrasses show that it is important to know the weed species present to permit selection of the chemical that will give the best control. Sencor was the only chemical evaluated in these studies that controlled all five weed species with a single application. Roundup and paraquat treatments resulted in similar control, but two applications were needed of either for parsley-piert and henbit. Bermudagrass should be completely dormant when Roundup treatments are made as various degrees of damage can occur to the turf. In general, most herbicides applied as postemergence treatments will control a broader weed spectrum (Table 5) than preemergence treatments (Table 3). However, it may be necessary to adjust treatments to include higher rates and repeated applications. These results show the importance of a second postemergence application of most herbicides for maximum weed control.

COMBINATION POSTEMERGENCE TREATMENTS

Kerb + other herbicides. It is often necessary to control both types of weeds (annual bluegrass and broadleaf) in turf areas. Since 2,4-D type herbicides will not control annual bluegrass, it was thought that by applying Kerb in combination with broadleaf type chemicals, this would control both types. Results shown in Table 6 represent poor annual bluegrass control in plots treated with combination of Kerb with other broadleaf type herbicides. The poor control between herbicide combinations may have been an antagonistic effect. When Kerb was applied as a single treatment at a higher rate (Table 4) annual bluegrass control was 98%. The chemicals require 3 to 4 weeks for maximum annual bluegrass control which indicates it may have been absorbed by the roots. The 2,4-D type chemicals are primarily absorbed by plant foliage within a few days. These results show that mixtures of Kerb with broadleaf type herbicides were not compatible at this rate. Therefore, if both type weeds are present in turf areas, each herbicide should be applied in separate applications.

The combination of Kerb with each of the broadleaf type herbicides also reduced the effectiveness in controlling parsley-piert (Table 6) when compared with control obtained by broadleaf type chemicals applied alone (Table 5). Each broadleaf type herbicide in this study was applied in combination with Kerb for the first application but applied alone when a second application was made. Performance of corn speedwell and spur weed was not influenced by the combination treatments.

Paraquat + other herbicides. Paraquat applied alone or in combination with any of the broadleaf type herbicides controlled annual bluegrass completely

(Table 7). This indicates that Paraquat applied as a mixture with other herbicides evaluated in this study performed equally as well on annual bluegrass as the chemical applied alone. These results differ from those where combinations of Kerb with broadleaf type herbicides did not control annual bluegrass as effectively as when Kerb was applied alone (Table 6).

Paraquat applied alone controlled 82% spur weed, 88% parsley-piert, and 98% corn speedwell (Table 7). Treatment of 2,4-D + silvex + dicamba was the only broadleaf type herbicide that controlled a higher percentage of spur weed than did paraquat applied alone. None of the broadleaf chemicals controlled a higher percentage of corn speedwell and parsley-piert than paraquat when each was applied alone.

Combination of paraquat with any of the broadleaf type herbicides resulted in a higher spur weed control when compared with either chemical applied alone (Table 7). The control in Paraquat treated plots was 82% compared with 91 to 99% in all combination treated plots. The control for parsley-piert was similar from combination of Paraquat with either 2,4-D + silvex + dicamba, 2,4-D + silvex, or dicamba. However, there was no appreciable difference in corn speedwell control from combination treatments when compared with Paraquat alone.

Whether Paraquat should be applied with broadleaf type herbicides for controlling winter annuals in dormant bermudagrass would depend on the following conditions.

a) Both annual bluegrass and broadleaf annuals included in the turf area.
b) Complete control of all weeds required with a single application.

This is especially true in areas infested with spur weed. Since spur weed has spiny stickers, complete control is desired in home lawns, golf courses, parks, and other recreation areas. Repeated applications of most broadleaf type herbicides will result in similar control.

c) Bermudagrass should be dormant when Paraquat is applied for weed control. A temporary browning or die-back of the turf will occur if not dormant at the time of treatment.

IMPORTANT FACTORS TO CONSIDER

1. Identify weed species before selecting a herbicide.

2. Know the correct use of each herbicide and do not use just because it is a weed killer.

3. Calibrate sprayer and check for proper chemical lap during treatment.

4. Handle all herbicides carefully by using gloves and other proper clothing. Chemical label will give this information.

5. Keep records as related to name of chemical, date of application, degree of control, and any other information that may be useful the following year.

Table 1. Effect of date of preemergence herbicide treatments for control of winter annuals in bermudagrass turf.

Treatments		% Weed control[a/]				
Herbicide	Rate	Annual bluegrass	Corn speedwell	Parsley-piert	Hop clover	Common chickweed
	lb/A					
				July		
Dacthal	10.0	30	51	16	21	56
Betasan	10.0	39	17	52	8	19
Balan	3.0	14	50	29	37	27
Simazine	1.0	8	20	15	22	4
	2.0	7	19	24	10	19
Kerb	0.75	26	43	0	22	37
				August		
Dacthal	10.0	43	70	14	9	50
Betasan	10.0	60	5	57	10	21
Balan	3.0	18	53	14	21	15
Simazine	1.0	10	25	11	24	33
	2.0	19	33	12	25	50
Kerb	0.75	58	51	0	16	60
				September		
Dacthal	10.0	39	80	17	33	60
Betasan	10.0	52	8	85	10	35
Balan	3.0	85	90	15	18	79
Simazine	1.0	36	37	31	57	61
	2.0	57	61	34	90	50
Kerb	0.75	87	60	0	17	61
				October		
Dacthal	10.0	44	99	21	25	98
Betasan	10.0	71	8	92	5	71
Balan	3.0	88	96	19	40	95
Simazine	1.0	91	56	30	94	100
	2.0	94	88	54	99	99
Kerb	0.75	98	97	4	9	98

a/ Control ratings were made in late March based on 0 = no control and 100 = complete control. An untreated check with no weed control was included at each date.

Table 2. Effect of single and combination of preemergence herbicide treatments for control of winter annuals in bermudagrass turf.

Treatments		% Weed control[a/]						
Herbicides	Rates	Annual bluegrass	Hop clover	Corn speedwell	Parsley-piert	Spur weed	Henbit	Common chickweed
	lb/A							
Oxadiazon	4.0	83	63	94	99	58	34	18
Devrinol	3.0	100	74	94	56	96	40	96
Balan	3.0	98	48	100	40	15	92	84
Betasan	10.0	79	5	0	99	26	10	0
Kerb	0.75	97	26	98	31	10	13	78
Balan								
+ Betasan	3.0+10.0	100	49	100	99	36	91	99
	1.5+5.0	93	30	96	98	25	67	72
Kerb								
+ Betasan	0.75+5.0	99	7	95	100	22	15	76

a/ Treatments were applied in September and control ratings were made in late March and based on 0 = no control and 100 = complete control.

Table 3. Summary of preemergence herbicide treatments for control of winter annuals in bermudagrass turf.

Herbicides	Weed species						
	Annual bluegrass	Hop clover	Corn speedwell	Parsley-piert	Spur weed	Henbit	Common chickweed
Dacthal	P	P	E	P	P	-	E
Balan	E	P	E	P*	P	E	G
Betasan	G	P	P*	E	P	P*	P*
Kerb	E	P	E	P	P	P	G
Ronstar	E	G	G	E	P	P	P
Devrinol	E	P	E	P	E	P	E
Simazine	E	E	P	P	G	-	E

E = excellent, G = good, and P = poor.
* Combination of Balan + Betasan = E.

Table 4. Effect of postemergence herbicide treatments for annual bluegrass control in dormant bermudagrass turf.

Treatments: Herbicide	Rate	% Annual bluegrass control[a/]
	lb/A	
Paraquat	0.5	100
Roundup	0.25	100
Sencor	0.5	98
Kerb	0.75	98
Cacodylic acid	11.0	92
Simazine	1.0	86
Atrazine	1.0	82

a/ Treatments were applied in late January or early February and control ratings were made 4 to 5 weeks later and based on 0 = no control and 100 = complete control.

Table 5. Effect of postemergence herbicide treatments for control of broadleaf winter annuals in dormant bermudagrass turf.

Herbicide	Treatments Rate	Application	% Weed control[a/] Parsley-piert	Common chickweed	Spur weed	Henbit	Corn speedwell
	lb/A	No.					
2,4-D+MCPP+dicamba	1.0+0.5+0.1	1	36	91	88	65	49
		2	78	100	100	95	74
2,4-D+silvex+dicamba	1.0+0.5+0.1	1	74	98	87	100	90
		2	98	100	98	100	99
2,4-D+dicamba	1.0+0.5	1	82	100	89	75	45
		2	96	100	98	96	70
2,4-D	1.0	1	34	43	96	43	57
		2	56	98	100	40	81
Dicamba	1.0	1	58	93	90	97	55
		2	79	100	100	100	78
Silvex	1.0	1	29	63	60	100	71
		2	77	100	86	100	97
Paraquat	0.5	1	61	100	91	57	98
		2	99	100	100	98	100
Roundup	0.25	1	71	100	90	77	96
		2	95	100	99	94	99
Sencor	0.5	1	99	100	91	100	99
		2	100	100	100	100	100

a/ Treatments were applied in late January or early February at 2-week intervals and control ratings were based on 0 = no control and 100 = complete control.

Table 6. Effect of combinations of Kerb with other herbicides for control of winter annuals in bermudagrass turf.

Treatments[a/]		% Weed control[b/]			
Herbicide	Rate	Annual bluegrass	Parsley-piert	Corn speedwell	Spur weed
	lb/A				
Kerb + 2,4-D	1.0	30	22	89	100
+ 2,4-D+dicamba	1.0+0.5	34	75	91	100
+ 2,4-D+MCPP+dicamba	1.0+0.5+0.1	55	64	94	100
+ dicamba	1.0	34	59	97	100
+ silvex	1.0	61	11	96	86

a/ Kerb was applied at 0.5 lb/A in combination with each broadleaf herbicide at the first treatment in February, but the broadleaf chemicals were applied alone at 2-week intervals for the second treatment.

b/ Control ratings were made 5 to 6 weeks after treatment and based on 0 = no control and 100 = complete control.

Table 7. Effects of combinations of Paraquat with other herbicides for winter weed control in dormant bermudagrass turf.

Treatments			% Weed control[b]			
Herbicide	Rate	Paraquat[a]	Annual bluegrass	Spur weed	Corn speedwell	Parsley-piert
	lb/A					
Paraquat	0.5	-	100	82	98	88
2,4-D + mecoprop + dicamba	1.0+0.5+0.1	no	7	78	52	76
		yes	100	94	99	89
2,4-D + silvex + dicamba	1.0+0.5+0.125	no	7	87	93	83
		yes	100	97	100	99
2,4-D + silvex	1.0+0.5	no	6	82	69	86
		yes	100	95	99	99
2,4-D + dicamba	0.75+0.25	no	5	79	29	84
		yes	100	91	99	86
Silvex	1.0	no	3	44	50	74
		yes	100	94	100	91
Dicamba	1.0	no	5	80	41	81
		yes	100	95	100	96

a/ Paraquat was applied at 0.5 lb/A with combination treatments in February. Each plot consisted of a single treatment whether treated alone with Paraquat, broadleaf type chemicals or combination of the two.

b/ Control ratings were made four weeks after treatment and based on 0 = no control and 100 = complete control.

WHITE GRUBS - A PEST IN TEXAS TURFGRASS

by

H. A. Turney*

White grubs are a pest of lawn grasses and in golf courses. This insect caused several million dollars worth of damage to Texas lawn grass last year. The amount of damage will vary from year to year depending upon infestations.

This insect goes through a life cycle of egg, larva, pupa, and adult. About 30-40 eggs are deposited by a female in soil, usually in clumps. Eggs hatch in about 30 days into small larvae which normally live about a year. Some larvae (about 10% of the population) go through a 2-year life cycle. The 2-year life cycle grub occurs more often in West Texas in the High Plains and in the Northern part of Texas. In the Gulf Coast region and along the Rio Grande, research information indicates it completes the life cycle in a single year. Grubs (or larvae) pass through three instars (they shed their skin and grow in three different stages). The third instar lasts the longest and will be most difficult to control. It only takes about 45-90 days for them to reach the third instar. A White Grub is the larvae stage of a May beetle. There are 90-100 species of May or June beetles in Texas. We are talking about one specifically, the genus Phyllophaga and the species Crinitia. The pupal stage lasts about 3 weeks.

The one year generalized life cycle around the Dallas-Fort Worth area is like this: the eggs usually appear in June or July; the larvae appear from July to April and the pupae will appear in April of the next year. Adults will hatch out in June or July, and the cycle will start again. In the Rio Grande Valley and Coastal Bend area, the time table can be backed up about one month. If you live in West Texas, you can delay it from 2 weeks to a month.

White Grubs damage lawns by cutting grass roots and allowing it to be rolled up like a carpet. The grass can be picked up and will have no roots. If you can pick the grass up and find grubs, then you can be sure that your damage has been from grubs. An infestation of grubs at the rate of about 40 per square foot, will leave very few roots on the grass. If you pull or cut a plug of grass and it has a tremendous amount of roots, then you should have a low population of grubs. Before you treat for grubs, inspect the lawn to see if it is infested with grubs. The only way I know to do

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a good job of checking is to actually cut one square foot of lawn area and examine the roots and soil for grubs. Take a shovel, cut the sample down three sides, make a flap and turn it over. Examine soil to a depth of 4-6 inches. In sandy soil, you may find grubs down as much as 16 inches. Finding an average of 4-5 grubs per square foot is enough to cause damage and to warrant treatment. Once you have examined the soil sample and roots, put it back in place. Tap it down and water it to make sure it will regrow.

If you have found that you have 4-5 grubs or more in one square foot, you may want to sample in several different locations to get an average, because grubs have been known to be unevenly distributed in the lawn.

In the Dallas-Fort Worth area, we treat sometime from July 15 to August 15. If you are in the Coastal Bend or Corpus Christi area, you may want to back this up a month and treat a month earlier. Lubbock-West Texas area may want to treatat little later time of the year than this.

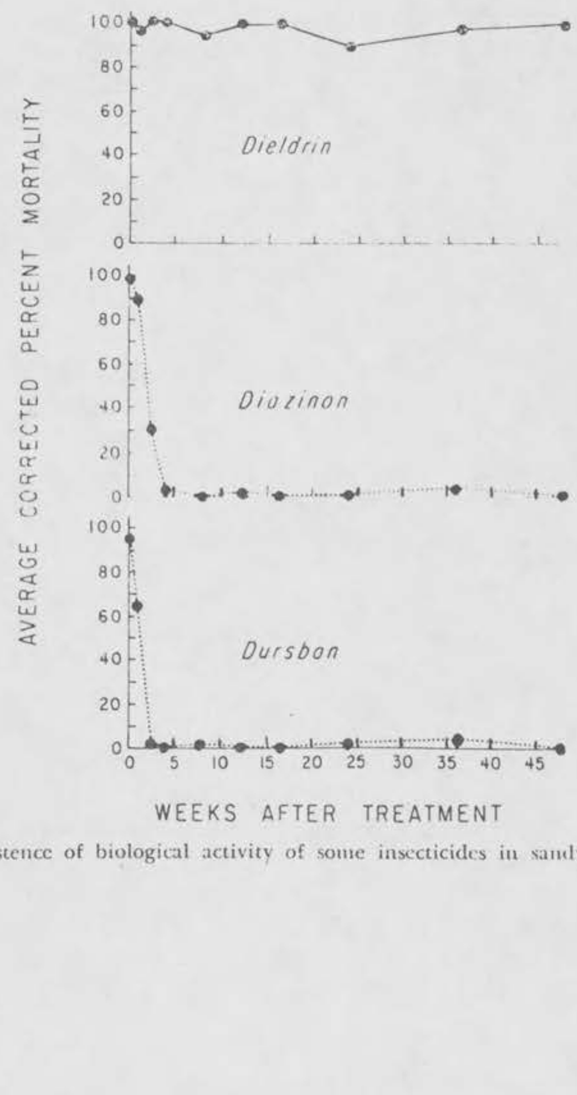
When treating with an insecticide, use either a spray formulation or granular formulation; whichever you prefer. There are three compounds presently labeled for control of White Grubs; they are Diazinon, Dursban and Dylox. Diazinon seems to be the one that has consistently given better control.

Thatch has a great influence on insecticides because of its restriction on penetration into the soil. Dursban is a compound that has been reported to be easily tied up in thatch and will not allow it to penetrate. Researchers are looking into using wetting agents or some type of material that will cause the insecticide to penetrate through thatch and on into the soil. Removing excessive thatch improves grub control.

Other items such as: organic matter, the type of soil, whether it is clay or sand, (sand is easier to penetrate than clay), the Ph of the soil (in the very high Ph soils these compounds will not be as effective as they would be at lower Ph), the height of the grass, whether it has a lot of roots, whether it is very thick or thin, all will have a great affect on the movement of the insecticides into soil. If you use emulsifiable concentrates and let them dry on the plants and soil before it is watered in, control will be poor. So, penetration is very, very important. The lawns need to be watered soon after treatment to get the insecticide down into the soil. Do not stand around "hand" watering, but use a water sprinkler in order to move the insecticide into the soil. When treating home lawns, do not allow pets or children to play on a treated lawn until after it has been watered and has had time to dry out.

Do a good job of applying the pesticides - use 25-30 gallons of water per 1,000 square feet and water this into the soil to make sure that you are getting good penetration. Remember, insecticides on top of the soil will not control grubs.

A lot of people ask how long will these insecticides last in the soil. Remember when deildrin was used it would last for weeks with very little breakdown. With the new compounds, like Dursban and Diazinon, they will break down fairly rapidly and you do not get the lasting qualities that you did with the Deildren. (See chart below) This means that you must time the applications more closely to obtain control. Treat grubs while they are small rather than waiting until they get large. There are many things that will alter the effectiveness of Dursban and Diazinon as they are applied. Remember that Dylox is also effected by Ph. Reduced effectiveness may occur if used in high alkaline water and soil. However, if you have acid soils such as in sandy areas of Texas, you would not have any real problem with Dylox.



Persistence of biological activity of some insecticides in sandy loam soil.

DIAGNOSING TURFGRASS DISEASES

by

P. F. Colbaugh*

At first glance, turfgrasses seem to represent the ideal community of plants for the development of constant disease problems. Every factor necessary for disease development appears to be present. Turfgrass pathogens reside in the thatch and on dead or dying plant parts and can easily be observed by using a microscope. Considerations such as the environment wounding for entry of pathogens, and varietal susceptibility to disease favor constant disease activity on turfgrasses.

In reality, diseases of turfgrasses are mostly seasonal in their occurrence. Environmental factors as well as turf management programs are known to influence turf disease expression greatly. Early and accurate recognition of turfgrass disease problems is essential to provide proper disease control measures. The following is a list of common fungal and nematode diseases on Texas turfs as well as considerations used to identify these diseases.

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.

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.

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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.

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 75-80 F. and the presence of free moisture is ideal. High night (70 F.) temperatures also encourage disease. Higher temperatures in summer reduce disease activity.

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 and fungus can be seen on the foliage as a cobwebby 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.

6. FUSARIUM BLIGHT - Caused by species of *Fusarium*. Especially *F. roseum* and *F. tricinctum*.

   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 75-100 F. and high humidity are necessary for disease.

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.

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.)

9. SPRING DEAD SPOT - Causal agent has not been determined but thought to be a fungus disease active during the winter months.

    A. Symptoms - Dark brown - black rot on roots and stolons of bermudagrass. Well defined circular areas a few inches to 3-4 ft. diameter appear in early spring. Regrowth into diseased areas is very slow.

    B. Conditions favoring the disease - Thatch accumulation and high fertilization have been shown to increase the severity of disease.

USE OF PESTICIDE IN THE PUBLIC DOMAIN

by

Robert C. Robinson*

I was asked to talk about pesticide safety, but what I would like to do is divide my talk into two separate parts. First, the use of pesticide in the public domain and last, a portion on cholinesterase.

Most of us in the lawn care industry have probably had a bad incident with the use of pesticides in the public. One must remember that there is a bad connotation with the term pesticide. I find myself caught in this same trap as I am sure many of you do too. I have house detergents and cleansers in the cabinet beneath my sink where my children can easily get to them, but my pesticides I have in my garage high enough that my wife would have trouble getting to them. Yet, purely on toxicology some of the compounds in my garage are safer than the ones stored beneath the sink. I guess I am just a product of our society that has adopted a bad connotation of pesticides.

Each of you that are in or are going to be in the lawn care industry or green industry, where we use pesticides in the public should be prepared for some unusual incidents. Sometimes these incidents will be very difficult to deal with because you will be dealing with an irrational person. Dealing with an irrational person, no matter how sound and logical you may be, is next to impossible. Dealing with someone that's son just got leukemia or whose child was crawling on the grass and went into a coma, or dealing with a lady who recently had a miscarriage can be extremely difficult and very trying. The general public, however, should not be blamed for their lack of education, afterall, the media has done an excellent job of exploiting the toxic effects of pesticides. The environmentalist have discussed pesticides and talked about carcinogenicity rather than their many benefits. ChemLawn has had incidents of people calling and blaming us for incidents that those of us who have knowledge of pesticides would consider a joke. But to them, it isn't a joke it is very serious and you must deal with these matters in a very serious way also. You must put yourself in their perspective and try to understand. My suggestion to each of you is to find a physician that will deal with you about pesticides.

If possible, one that has an excellent background in pesticides. This may be very difficult and you might not even find one in your city that has this amount of experience. Finding someone does not have to be

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costly. Sometimes many physicians will do it for no fee at all because of their interest in pesticides in the environment. Other times, a minor fee will secure an excellent physician and he/she is much more able to talk to individuals if they have a problem or believe have an alleged problem, than you would be able to do. I would also suggest that rather than trying to talk to these individuals yourself, that you refer them straight to this physician. If possible, it is even best if physicians deal with other physicians rather than lay people.

Broadcasts like ABC's 20/20 show this summer will become more frequent. Education by you and by your employees is the best way to combat these inaccurate reports. For any of you that have not read the CAST report in response to the television show this summer, I suggest that you do so. Coincidence will also continue to occur. When you treat lawns several times a year with pesticides and each lawn has neighbors the likelihood of this illness or sickness occurring close to your application of pesticides becomes more and more frequent. Whether the illness or sickness be a pet or a human being, it is best to listen than just go in and absolutely deny any responsibility. Pet situations can also be very difficult and you are going to find that some veterinarians, when they can't find what is wrong, will blame them on pesticides without any knowledge of the actions of those specific pesticides. We have retained a veterinarian that has a working knowledge of the common pesticides. At times he has called veterinarians and explained the actions of these pesticides and that their diagnosis could not be correct based upon the known toxicological actions of the blamed pesticide. So, in summary, the best thing for me to tell you is that as your businesses expands you can expect to have people complain about the use of pesticides. The public, the media, will continue to exploit the negative points of pesticides. Most of the people who call you with complaints will have an application of pesticide on their lawn or neighbor's lawn recently and have linked the coincidence of your application with the illness or sickness of their daughter or son or pet. They will be extremely difficult to deal with logically. Most doctors and veterinarians that you talk to will have a limited experience with pesticides and their effect on the body. Therefore, to deal with this subject, you should become as knowledgeable as possible and seek to acquire the service of a qualified veterinarian and doctor with adequate background in pesticides and their effects on the body. Try not to argue with your customers or the people who complain about their use, but at least view it from their side also. Many more friends will be made this way rather than arguing that there was no possibility of you causing that problem.

The second portion of my talk is about cholinesterase and cholinesterase testing programs. It is not my intention to relate medical information about cholinesterase and there is abundance of written information available. If you would like an excellent piece of information, I suggest you obtain from DOW Chemical a booklet called <u>Dursban - Insecticides - Suggested Handling Procedures for Custom Lawn Spray Application.</u> Briefly, however, I will review a little bit about cholinesterase. Cholinesterase is an enzyme that is present in everyone's system. This enzyme allows us to have coordinated muscle control. More specifically, the function of cholinesterase is to neutralize acetylcholine. There are two basic types of cholinesterase. One that is called true cholinesterase or red blood cell cholinesterase and the other one is called pseudo or serum cholinesterase. Either cholinesterase can be picked when you have a monitoring system. We would suggest that both are monitored at the beginning. The monitoring program should, at a minimum, always include a pre-exposure level. This is because inherently about one in every 4,000 people has low cholinesterase levels and would be extremely susceptible to the use of any cholinesterase inhibitor. Generally, cholinesterase inhibitors would include organophosphates and carbamate type insecticides. When you are choosing a particular blood test to run make sure that it is interruptible. We recommend the Michel Methodology for organophosphate materials and it is also recommended by the NIOSG criteria document. How frequently you chose to monitor people's cholinesterase level will depend upon your own experience.

Plasma cholinesterase, using the Michel Methodology, would be normally adequate to monitor. This will give you an insight as to how much contamination or exposure to insecticides is actually taking place in the field. The most important thing that I can remind you about cholinesterase testing programs is that someday they will be mandatory. We can start now and decide how we are going to run them in the industry or we can wait and the government will regulate us and tell us how we will run them. I think we would be better off if we take that positive step and initiate testing programs today rather than wait for the government to decide how the program should be initiated. If you have trouble finding a qualified laboratory, I would suggest that you contact CLC Laboratory. It is located at 1046 Crupper Ave. in the Busch Corporate Center, Columbus, Ohio 43229 and they will be able to send you information about cholinesterase testing programs.

EQUIPMENT RECORDS

by

Quinton Johnson*

When I was asked to speak on the subject of "Equipment Records", several thoughts came to mind as to what, how, etc. I decided that "Equipment Records" should 1) Record details of new equipment purchases, 2) records of maintaining equipment, and 3) Records of replacement schedule of old equipment.

1) New equipment purchased - All equipment owned by an operation regardless of size should have some type of inventory number assigned to each piece of equipment costing above a "give dollar" value. Below the "given dollar" value should be considered dispensable ie. hand tools, gas cans, hand rotary fertilizer spreaders, etc. (Slide 1). This assigned number should show up on the Master Equipment Record where all equipment is listed including "Equipment types, brands, model numbers, serial numbers, date of purchase, purchase cost and replacement year." All this information is very useful to all concerned in both private and public operations and is very valuable information for insurance purposes.

   Slide #2 - After one gets a new piece of equipment on the premises and the supplier is still interested in your purchase, one may like to use such forms as this whereby you can list all component parts and system vendors, vendor numbers, type, settings, gap. Slide #3 - best sizes, lengths, types of lubricants and where applicable, etc.

2) Now for records of maintaining - a very simple but complete system is generally the most efficient and useful. A suggestion to fill this need is (Slide 4) as shown by using a simple 3X5 card listing your own assigned equipment number, the manufacturers and its model and number, the manufacturers serial number, actual cost and date of purchase. Below this show work date, work done and parts cost. A complete example of this is shown (Slide 5) here where all work parts were used along with cost showing. Note no labor is included although one may want to put labor on this same card particularly in a large operation.

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Show slides of trucksters - before, during, after - and tell of amount of dollars spent.

Next Slide - This shows a multi-purpose maintenance record which we use for all purposes listed but hardly all at same time.

Next Slide - This form is a recommended maintenance schedule to keep on equipment.

This by now shows that maintenance records can vary with shape, size, item, etc., and it doesn't matter which one you choose but what does matter is that you keep records of maintaining, no matter how simple or complicated.

3) Replacement Records -

A record that very few, it any, of us use and that is replacement records. This is a record which we as users of equipment should turn in annually to assure our company of necessary planning and budgeting for said capital improvements/expenditures. We all realize that some purchases get passed over due to cash flow, therefore, equipment that doesn't get replaced in a designated year gets passed on to the following year. Plans to replace are necessary for financial planning of each operation and should begin at purchase time - not breakdown time! Each person is going to get a different length of service out of a piece of equipment but each of us have a feel as to how long a greensmower, for example, will last for us, therefore, assign that piece of equipment a year to be replaced. One must realize that this year of replacement may need to be adjusted for whatever the reason is.

Slide #1

EQT	EQUIPMENT	BRAND/MODEL	S #	PURCHASE DATE	COST	REPLACEMENT YEAR
11	Greensmower	Toro 20136	672	11/72	2,000	78
12	Greensmower	Jake 6023	864	4/73	2,100	79
13	Tee Mower	Nat'l 83	1062	4/71	800	81
14	Push Mower	Jake 8246	623	5/76	100	79
15	Push Mower	Jake 8246	624	5/76	100	79
16	Push Mower	Jake 8246	625	5/76	100	79
17	Fairway Mower	Toro 7 gang	824	2/74	7,000	79 & 84
18	Rough Mower	Jake 5 gang		3/75	3,000	80
19	Tractor	Jake G/O	14623	3/75	3,000	85
20	Top Dresser	Jake	8640	5/75	875	79
21	Top Dresser	Jake	8441	5/76	950	80
22	Rotary, Riding	Yazoo YR-60	7564	5/75	1,650	80
23	Tractor	Massey Ferguson 245	9A6243	9/70	6,000	80
24	Tractor	Massey Ferguson 135	74A2631	10/71	4,500	81

Slide #2

Unit Number

MAKE ______ YEAR ______ MODEL ______

VOLTS ______ CYL. ______ ENGINE ______

CONVENTIONAL IGNITION

DISTRIBUTOR NUMBER ______
Contacts ______
Condenser ______
Cap ______
Rotor ______

IGNITION COIL ______
Coil Resistor ______

ELECTRONIC IGNITION

DISTRIBUTOR NUMBER ______

Cap ______
Rotor ______

IGNITION COIL ______
Coil Resistor ______

FOOTNOTES: ______

CHARGING SYSTEMS: ______
Unit # ______
AMPS. ______
Brush Set ______
Volt. Reg. ______
Pos. Diode ______
Neg. Diode ______

FOOTNOTES: ______

STARTER SYSTEM: ______
STARTER # ______
Start. Sw. ______
Repair Kit ______
Starter Le. ______
Brush Set ______
Relay ______

FOOTNOTES: ______

TUNE-UP SPECS.
Contact Gap ______
Dwell ______
Spark Plug Gap ______
Ignition Timing ______
Distr. Air Gap. Electr. ______

SWITCHES
Ignition ______
Dimmer ______
Oil Pressure ______
Temp. Sender ______
Horn Relay ______
Neutral Safety ______
Stoplite ______
Flasher ______

FILTERS ______

SPARK PLUGS ______
Wires ______

CARBURETOR INFORMATION
O.E.M. CARBURETOR NO. ______
Replacement Carburetor ______
Carburetor Kit ______
Carburetor Fuel Filter ______
Choke Pull-Off ______
Choke Thermostat ______
Idle Stop Solenoid ______
P.C.V. Valve ______
Other ______

IDENTIFICATION NUMBERS
Body ______
Engine ______
Transmission ______
Front Axle ______
Inter. Axle ______
Rear Axle ______
License # ______
Serial # ______

OTHER INFORMATION TO BE FILLED IN BY FLEET OWNERS:

LUBRICATION
Engine ______
Steer. Gear ______
Differential ______
Transmission ______

For vehicles equipped with electronic ignition conversion systems:
Trigger Wheel ______
Sensor ______
Control Box ______
Wiring Harness ______
Resistor ______

BELTS ______
______
______

HOSES ______
______
______

BATTERY ______

MARKER LIGHTS ______
Lenses ______

TRAILER CONNECTORS ______
______
______

RECORD OF UNIT CHANGES OR REPAIR

ELECTRICAL
TUNE-UP

CONTACTS &	DATE				
CONDENSER	MILEAGE				
CAP &	DATE				
ROTO	MILEAGE				
COIL &	DATE				
RESISTOR	MILEAGE				
SPARKS	DATE				
PLUGS	MILEAGE				
CHARGING SYSTEM					
GENERATOR OR	DATE				
ALTERNATOR	MILEAGE				
VOLTAGE	DATE				
REGULATOR	MILEAGE				
STARTING SYSTEM					
	DATE				
STARTER	MILEAGE				
STARTER	DATE				
SWITCH	MILEAGE				
STARTER	DATE				
DRIVE	MILEAGE				
	DATE				
BATTERY	MILEAGE				
FUEL SYSTEM					
	DATE				
CARBURETOR	MILEAGE				
FUEL	DATE				
PUMP	MILEAGE				
FUEL	DATE				
FILTER	MILEAGE				
P.C.V.	DATE				
VALVE	MILEAGE				

OTHER

Slide #4

Eqt # Brand/Model	S#	Initial Cost	Purchase Date
Date	Work Done	Parts Costs	

Slide #5

#19	Jake G10 14623	$3,000	3/75
4/75	Radiator Hose	$6.00	
5/75	Head Light Unit	$4.75	
11/75	Brake Job	$84.60	
11/75	Core for Radiator	$105.00	
6/76	Tune Up Kit - P,P,C	$25.00	
7/76	R. Rear Tire	$165.00	

MAINTENANCE RECORD

Date	Engine Oil	Engine Oil Filter	Air Cleaner	Fuel Filter	Power Steering Oil Change	Cooling System	Trans. Lube	Rear Axle Lube	Univers. Joints	Steering Gear	Front Wheel Bearings	Clutch Adjm't.	Brake Adjm't.	Hydraul. Oil Change	Hydraul. Oil Filter Change	Chassis & Frame Lube	Engine Tune-Up

SLIDE #6

Slide #7

DAILY MAINTENANCE REPORT
DATE__________________

Eqt.#	Grease	Oil Ck.	Oil Chg.	Oil Filter	Bat. Ck.	Air Filter Ck.	Radiator	Gas Tank Fill

Slide #8

EQUIPMENT REPLACEMENT SCHEDULE

1979

#12 Greensmower	$ 5,000
#14 Push Mower	200
#15 Push Mower	200
#16 Push Mower	200
#17 Fairway Mower (Units Only)	3,500
#20 Top Dresser	3,000
#11 Greensmower (78)	5,000
#18 Rough Mower (Units Only) 5	2,500
	$19,600

Note:

#11 Not replaced in '78 per schedule

#18 Needs to be replaced in '79 due to excess wear on reels, bearings and bed knives.

Slide #9

1980 -

#21 Top Dresser	$ 3,300
#22 Rotary Riding	2,500
#23 Tractor	9,000
	$14,800

1981 -

#13 Tee Mower	$10,000
#24 Tractor	10,000
	$20,000

1982 -

1983 -

etc.

WORK SCHEDULES

by

Palmer Maples, Jr.*

My remarks today on work schedules are based on the fact that good management is a part of taking care of a golf course and is a responsibility of the golf course superintendent.

You've all heard the statement, "Plan your work - work your plan," and there are many reasons to do just that. If not, if you don't plan, then how can you tell others what you want to do, or later, to be able to say what we did, what we are doing now, and what are we going to do tomorrow. And the answer to what are we doing anything at all for - is to fulfill our responsibility as a golf course superintendent and present an area to the paying members that they can play the game of golf and play it by the rules of golf.

We heard George Toma talk yesterday at lunch about grooming athletic fields for games. He mentioned the distance of the field, how wide and long it was, where the stripes are marked and how the goal posts are located.

Now if some fields were only 90 yards long and 85 yards wide and the goal posts were 6 ft. wide and placed in the left hand corner - the question might be asked - can a game of football be placed on this field by the rules of football. I think that it could not be properly played. Another question may be asked by the officials and players - who set up this field like this? that crazy so and so! How does he expect us to play a game of football on this field?

He talked of the time it takes to get a field ready to play and all of this is done so that the work is completed by a certain time and at 2:00 in the afternoon, everything is ready for the kick-off.

The same general rules apply to a golf course or any other area you may be responsible for.

Work schedules help you plan your work, and then work your plan. I guess if you don't do any planning at all - you might be like the man that said "the hurrier I go - the behinder I get." And this is very true. If you don't plan - how do you know that you are accomplishing your goals or are carrying out your responsibility?

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In cooking - it's too late to sprinkle some baking soda on top of the cake or biscuits after they come out of the oven and are flat in the bottom of the pan. The plan called for baking soda to be mixed in with the other ingredients at time of mixing - before being put in the oven.

The recipe was a plan, a work schedule, and we can tell what we did, where we are, and predict the outcome if we follow the plan. I'd much rather have the baking soda in the mix at the right time and be able to put some butter and jam on the biscuits and enjoy the flavor. Just like the football coaches and players want a field that is in the proper dimensions and properly marked - Just as the golfer wants a golf course prepared for him to play his game of golf by the rules of golf.

As I stated earlier, work schedules are just good management, and help you to MOVE, move.

Most of you have heard the management term of plan - coordinate, observe, inspire, charge, control - well, MOVE is a way to remember these areas of getting things done through people, the basic definition of management.

M = motivate
O = organize
V = visualize
E = execute

This is the main thought I'd like to get across to you today - and that is work schedules are a way to MOVE.

Quickly - motivate - you've got to get the people interested in what they are doing and one way is to have a plan. Basically, people are goal oriented. If they have put before them a task to complete and have explained to them how to go about completing the task, then they will know where they are going and how they are to get there - and they will know when they get there, when the task is completed, and they have reached their goal. This is what a work schedule does - it gives direction.

After getting the people willing to do a job - you have to do the right job in the right place. Remember the baking soda in the recipe. It had a time specified when it was to be placed in the mix. You don't water greens and fairways from 1:00 p.m. to 3:00 p.m. on Saturday and Sunday-you don't overseed bermuda grass greens in Texas in July. You don't aerify and topdress greens during the finals of a club championship.

All of the jobs are necessary and must be done - but within a plan and according to a work schedule, at the proper time, and that's organizing.

Visualize - means keeping an eye on what is happening. As the supervisor, you must be aware of the overall happening of the operation.

If you see a dry spot - you check the sprinklers, the man or the timing clocks, and make sure that spot gets watered. You check to see if the greens are being mowed properly, if the cups are changed, if the traps are raked, if the equipment is adjusted and cutting properly. All of these items are a review of what is going on and making sure everything is going according to the plan.

And, last but not least is Execute - get the job done. Execute not only means to put the plan in action, it also means that as we evaluate work progress through visualizing, we re-organize to get around any problems and keep the project moving -- MOVE.

All my discussion so far is on one aspect of work schedules and those have been as a look at management, good management. Plan your work and work your plan.

Another aspect of Work Schedules is their importance to the record system of the club or organization.

Not only in the presentation of a budget, but in the preparation of a budget, work schedules are a must.

I don't know of too many organizations that will give you $200,000 and the responsibility of the golf course investment, and not ask you for some plans of how you expect to use that $200,000. Just to answer that you're going to grow some grass, and then cut it, is not enough.

And so, Work Schedule - or in the plan - a schedule of all the work that is to be completed is written down and placed in order. This schedule of work then can start at two levels - one - you can start by making the statement to the members that you will provide them with a golf course to play on. Out of this comes a schedule of planting, mowing, watering, fertilizing, spraying, topdressing, cleaning, and on and on and on, down to the detail of each Monday, Thursday, and Saturday, all rest rooms are washed clean, paper supplies are checked, deodorants are renewed, mirrors are cleaned, lights are checked, and waste baskets are emptied.

What I'm trying to say is that there are many jobs and tasks that have to be completed in order for the golfer to play golf; that must be performed and completed at a certain time and the only good way to make sure all of the tasks are completed is to schedule their time for completion in the passing of a week, month, or year.

I mentioned earlier the importance of work schedules to the record system of the organization. I have just discussed the first part of the saying Plan Your Work - now Work Your Plan.

How can you know or tell if a job is completed? How do you explain 10 men, 40 hours a week, 400 hours per week, 52 weeks a year - 20,800 hours. And you say nothing ever goes wrong. How do you know?

You know because you have scheduled the mowing of greens, you explained the job procedure to the employee, you instructed him to complete the job, you checked his progress during the operation and when it was complete, you made a record of the happening.

Monday - mowing greens - 2 men - 6 hours. And through your work schedule, you checked off and recorded all the other jobs that were completed -- the cup changing and tee marker moving, the application of fertilizer, the cleaning of the tractor, the service of the mower, the checking of safety equipment, the repairing of a bridge, the replacement of oil filters, and again - all of the jobs that are completed, you make a record of its completion.

And then you use these records as a guide to predict expected cost and time to do the job next year.

But what if something didn't come out right? You have the same records to look at, evaluate the problem, and a new procedure is developed and put into the work schedule for next season.

But, if you didn't have a plan or a work schedule or a record, you wouldn't know what to do - when - or if it in fact got done.

You would end up with some flour and water in the bottom of a pan that were supposed to be nice, raised biscuits, but the baking soda was left out.

Another use of work schedules is in judging job performance. For instance, if the work schedule calls for traps to be raked, and our records show that for two years it has taken 4 hours to rake all traps and lately it has been taking 5 hours to complete the job, then it is time to review the operation, visualize, and determine why it is taking longer.

To begin with, the employee was instructed how to do the job, given some training and then asked to complete the job by himself. Now it is taking 5 hours for the work to be completed - why? you ask. Upon going around and checking the condition of the traps, a determination is made. The new man was doing an excellent job of taking care of traps and was spending a little bit more time working on slopes, was picking up paper and cans in the rough as he went from one trap to another and thus got delayed sometimes by players that got an early start and caught up with the employee before he completed the job. This employee was doing a good job and even a little extra, and because of the schedule of work, was checked on, and his job performance was evaluated.

Work schedules can be divided into: regular job - seasonal job- and special job. I think you understand regular and seasonal jobs but special job or schedule could be a list of things to do on:

1) rainy days

2) during freezing weather

3) 30 to 45 minute jobs that can be completed when regular jobs are finished.

And many forms are available that can act as a check list for jobs completed that are worked in coordination with a master work schedule.

Each man may have his own system and the end product is the same, but work schedules are important.

It's a way to plan your work and work your plan.

It's a way to M O V E.

PREPARING RAISED BEDS

by

William D. Adams*

There are a number of reasons for growing plants in raised beds. In high-rainfall areas, such as along the gulfcoast, probably more plants die from drowning than from lack of moisture. In other areas high-salt content, alkalinity, or other factors may make it easier to build beds on top of the soil than to try to work with the soil as it exists.

In actuality, raised beds don't always ignore the existing soil. In many instances, because of high rainfall or poor drainage, it's necessary to build raised beds, but, if the existing soil is worth working on, it's often better to simply add organic matter and nutrients to the soil. This increases the volume of the soil bed area which, of course, raises the bed slightly. This technique involves mixing 2 to 4 inches of organic matter, such as pine bark, peatmoss, composted rice hulls, well-rotted manure, etc., with existing soil along with 2 to 3 lbs. of complete fertilizer such as 12-24-12, per 100 sq. feet. In areas where soils are compacted because of a sodium problem, the addition of 5 lbs. of gypsum per 100 sq. ft., mixed thoroughly with the soil at the time of organic matter and fertilizer incorporation is also beneficial. In some instances it might be of value to mix some sulphur with the soil to try to acidify it at the rate of 2 lbs. per 100 sq. feet. Usually a bed prepared in this matter will be worked up first and then some type of edging material such as brick will be placed around it to define it's edges and to reduce erosion.

On the other hand it's frequently necessary for one of the previously mentioned reasons, or simply for speed and ease of operation, to ignore the soil and build on top of it. In this regard I've found that it's possible to take old newspaper, wet them so they won't blow all over the place, put down a thick layer in the proposed bed area (eight sheets or more thick) and then build the bed over this newspaper layer. A light sprinkling of fertilizer (about 2 lbs. per 100 sq. feet of 12-24-12 or a similar sprinkling of ammonium sulphate) is then applied over this layer of newspaper to aid in decomposition once it has served it's purpose - essentially to retard the development of existing ground covers

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and weed seeds underneath the bed. A soil mix is then placed on top of this and the plants are planted in it.

Numerous soil mixes have been devised. If I were going to maintain the area myself, I would personally lean toward a slightly heavier mix than has often been suggested. Although the synthetic soil (or soiless mixes) do have their value their disadvantage of being low in nutrient and water holding capacity can make them difficult to maintain. Most urban areas have a local "dirtyard" specialist who has a prepared soil mix and if time is a factor this may work fine. However, they're rarely prepared uniformly and a mix that you can learn to work with and anticipate the characteristics of will be of great value even if you have to make it yourself.

An old standby formula was a 1-1-1 mix, usually one part loam top soil, one part coarse sand and one part organic matter (usually peatmoss, although pinebark is an excellent substitute where available). This mix would make a good starting point for almost any raised bed. It is, however, relatively low in nutrients. The addition of fertilizer, using the following ratio of soil elements per cubic yard is advised for trial. Five pounds of a complete fertilizer (8-12-4), 5 lbs. dolomitic limestone, 2 lbs. 20% superphosphate, 5 lbs gypsum. If a heavier mix is desired, the ratio could easily be shifted to two parts soil, one part organic matter and one part sand. Use of a fine "banksand" would also make the mixture denser and reduce the cost.

Substitution of a controlled release fertilizer for the "standard" fertilizer would be worthy of trial.

Finally, more imagination could be used in the types of bordering materials used to make raised beds. Railroad ties would almost seem to be of more value out from under the trains and in the landscape than they are supporting trains. There are a number of companies making landscape timers available. Brick is, of course, nice but expensive and thus materials such as native stone or in some cases, even old, discarded concrete could be used for an edging. In the latter case, washing the material down with an iron sulphate solution would give it a more natural appearance by staining it a rusty-red.

As a necessary afterthought, consideration of some type of irrigation system, whether drip or sprinkler, that can be put in at the time of bed preparation would be an additional aid to easy maintainance of beds in future plannings.

USING PLANTS IN THE LANDSCAPE PROPERLY

by

Dr. William C. Welch*

Plants are the most important material of the landscape designer. When properly used they can perform numerous practical and aesthetic tasks in our environment. To use plants most effectively it is necessary to thoroughly understand their cultural requirements and landscape values. It is also necessary to have insight into the landscape design process.

Plants are often divided into groups according to the way they are used. For our discussion purposes, we will talk briefly about trees, shrubs, vines, groundcovers, annuals, perennials and container plants. Each group has practical and aesthetic uses. Observing plants in these "use groups" tends to help us make more practical and functional landscape design decisions. Maintenance is a major consideration in all that we do in landscaping and grounds maintenance. Good design and properly selected plants should reduce maintenance as well as provide an attractive and functional environment.

<u>Trees</u> - It is often said that well placed and selected trees along with turf are by far the most important landscape materials. Trees not only offer shade and beauty, but are valuable as noise barriers, wind and erosion control and energy conservation within structures.

There is a tendency to plant the fastest growing species available, especially when few native trees are present. In almost every case it is better to choose trees of more moderate growth rate. These tend to be longer lived, have fewer insect and disease problems and generally require less maintenance. Selection and placement of tree species is a decision with long-term ramifications. Not only is there a major investment made in dollars but valuable time is lost when poor selections are made.

Emphasis on landscaping for energy conservation has resulted in using more trees to provide afternoon shade on buildings. Small deciduous trees such as redbuds, crapemyrtles and others can sometimes be used within 5 to 10 feet of the structure providing fast shade for wall and glass areas. Shading the outside portion of split system air conditioners has also been shown to be an effective way of reducing energy consumption during the summer.

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Windbreaks are another practical use of trees. Fuel consumption has been shown to be reduced 12% in homes that effectively use windbreaks to provide protection from winter winds.

By carefully studying the growing conditions on your site, determining tree needs and selecting well adapted species you are well on the way to a successful landscape development.

Shrubs - There is a tendency to use shrubs only for ornament when there are some very practical possibilities. Providing privacy, wind and noise protection, circulation barriers and erosion control are some good reasons for giving indepth thought to the selection and placement of both deciduous and evergreen shrubs.

Color the year round can be provided by selecting shrubs with seasonal foliage, flowers or fruit. Dwarf shrubs are becoming more and more important in the landscape because of the minimal pruning required to keep them attractive. Large masses of low growing shrubs such as dwarf Yaupon or Nandina are often used effectively in lieu of or in addition to more typical groundcover plants.

Vines - can provide shade and privacy while adding color and beauty to the landscape. The combination of vines and structures can heighten the beauty of both. The vining form provides an aesthetic quality all its own. Some vines are also used as groundcovers.

Groundcovers - Under certain circumstances groundcovers can be a highly practical alternative to turf grass. Actually many types of vines and some shrubs are included in this rather broad category. Groundcovers are especially appropriate in areas too shady to establish and maintain good turf on steep slopes or where a textural contrast to turf is desired.

Perennials and Bulbs - are a good way to add color to groundcover and planting areas usually with less maintenance than annuals. These plants are often overlooked and in many cases deserve wider use.

Annuals - probably provide more color than any other group of landscape plants. They also require high maintenance. Take a tip from nature's wildflowers when using annuals. Large masses of single colors and species are usually more effective than extensive but poorly maintained plantings. Three or even four plantings per year are usually necessary to keep annual areas at their best. Even then much of the time the plants will not be at their peak unless large container grown plants are set out initially.

People are tremendously responsive to color provided by plantings of annuals. For planting dates and seasonal suggestions ask your county Extension agent for a copy of MP-1207 "Annual Flowers in the Home Landscape."

Container Plants - Many trees, shrubs, annuals and even groundcovers are appropriate for container use. Container size is important with the most common mistake being containers that are too small. Not only are they often too small to support the plant growing in them, but often containers are too small to be in scale with their surroundings.

Even ordinary plants tend to be unusually dramatic when placed in containers. High maintenance requirements are the major restriction in their use. As with annuals, it is far better to have a few well-cared-for specimens then numerous poorly maintained ones.

From a practical point of view, containers may be grouped to direct or restrict pedestrian traffic. Since the growing media, drainage, pH, water and fertilizer can all be manipulated, we can often grow plants better in containers than in the ground. Portability is another asset. Containers can be moved to a less noticeable location when not at their peak.

PESTICIDE SAFETY -

MINIMIZE LIABILITIES AND SAVE MONEY

by

Dave Bumgarner*

Many factors influence the safe performance of a pesticide, not the least of which is the applicator. Application of crop protection chemicals has become an exact science and a multimillion dollar business. As a professional certified applicator you assume the responsibility for accurately and safely placing the pesticide in the target area. Sloppy application usually yields poor control or the possibility of injury to adjacent property. Either way the end result is a loss of time and money. With inflation biting into everyones budget and profits the safe use of pesticides has become an economic necessity. Let's look at some problem areas where safe application practices can improve control and minimize liabilities.

Herbicides marketed for complete vegetation control such as Hyvar, Krovar, Karmex and others may seriously damage valuable trees and shrubs. They should not be applied to the root system or to areas where they may wash into the root systems of valuable plants. On level terrain do not use bare ground herbicides closer to the tree than three times the drip line. The drip line being defined as the distance from the trunk to the tip of the longest limb. When treating a ditch or slope the drip line rule does not apply. Do not use bare ground herbicides on a ditch, slope or within six feet of the slopes crest. To do so could result in movement of the material into untreated areas potentially killing desirable trees and grasses.

Residual herbicides are usually absorbed by clay or organic matter and disappear from soil at a rate of 80 percent per year. If misapplication is noticed immediately than most damage can be prevented by simply removing the upper soil layer. As a precautionary measure, seven pounds of activated charcoal per 1,000 square feet should be spread evenly throughout the area and then lightly incorporated with a rototiller. The use of activated charcoal absorbs the herbicide from the soil and reduces its' availability to plant roots.

As time elapses following application the chemical penetrates deeper into the soil and mechanical removal becomes more difficult. If the

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herbicide has been broadcast throughout the root system area and noticed before rain, remove about one inch of soil. If some time has elapsed and rainfall has been received, remove the soil to a depth of four to six inches. Broadcast charcoal over the area and incorporate.

If the herbicide has been applied to a portion of the root system, a trench four to six inches wide and two feet deep should be dug between the trunk and two feet inside the edge of the treated area. Then remove about two inches of soil, spread activated charcoal and incorporate to a depth of three inches. Stimulate root development away from the treated area by applying water and fertilizer on the side opposite where the herbicide was applied.

All of the above suggestions offer no guarantees against damage or kill of valuable trees and plants.

When using bare ground herbicides proper clean up is essential. Avoid cleaning out application equipment on sloping bare ground, pavement or other areas where the herbicide may be carried by surface runoff to valuable plants or portable water supplies.

Another problem area common to pesticide application is drift. Drift is defined as the movement of spray particles away from the spray site before they reach the target area. Why be concerned with drift? Chemicals are expensive. Why waste them by letting them drift off target, possibly injuring adjacent crops.

Physical drift is primarily a function of droplet size. Drift reduction requires the elimination of the small droplets most responsible for drift. Although a complex problem, here are some practical tips.

Nozzles - Use flooding type nozzles which work well at pressures under 20 PSI. Their wide angle pattern allows for operation low to the ground, reducing the winds effect on the spray droplet. Use a nozzle size which delivers as large a droplet as is consistent with adequate coverage. Never use a metal object to clean a nozzle as it will damage the precisely finished edges and ruin nozzle performance.

Pressure - Do not spray at pressures over 40 PSI. High pressure produces more of the spray as small droplets which are most responsible for drift.

Weather - Avoid spraying when the wind velocity is above 7 MPH. Above 10 MPH there is a significant increase in the amount of spray material drifting away from the target area.

Additives - Antidrift control agents such as Nalco-Trol have proven to be effective in reducing drift. This product works by increasing fluid viscosity, eliminating the smaller droplets responsible for drift. It has shown high activity in protecting vegetation outside the spray site.

Another possible application error will most likely take place unknown to you, for when an incompatibility problem occurs it is usually well hidden within the confines of your spray tank. Incompatibility in the spray tank produces a nonuniform spray mixture that gives a nonuniform deposition of pesticide over the target area. The result is poor control that cost you time and money. It can also mean the rejection of a potentially beneficial new pesticide.

Incompatibility problems can be avoided by following some basic procedures: Always perform a small scale compatibility test for all new pesticide formulations and tank mixes. When working with registered pesticides follow label instructions on preparation of spray mixture. Provide good spray tank agitation throughout pesticide addition and spraying. Preslurry wettable powders prior to the addition of a liquid formulation. Use clean water and evaluate on a small scale any formulation suspected of being contaminated or degraded. Finally use a compatibility agent where the dispersion uniformity of a formulation in liquid fertilizer is poor.

Safe use of crop protection chemicals to control weeds and other pests plays a major role in the effective and economic management of high quality turfgrasses. If we wish to keep most of our good pesticides available, we must not only continue to make the good applications most of us have been making but improve on them. Surely the safe use environmental chemicals is a prime concern of everyone.

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CALIBRATION OF SPREADERS

by

Dean Bottlinger

If you don't know how to calibrate your spreader, my first suggestion is to hire someone to do the spreading for you that knows the business. Calibration of Spreaders is about like saying, "how long is a string"? If a little common sense is used, with any type of dry spreader, much can be accomplished. The first thing that has to be established is the weight of the material per cubic foot. Most of the fertilizer material, we use on turf, will weigh between 45 and 65 pounds per cubic foot. Most of our dry herbicides, fungicides, insecticides, and nematicides, weigh in the range of 25 to 30 pounds per cubic foot. The granular size will cause variations as to the width a rotary type spreader will throw the material.

The above ideas, will have to be used with common sense. With any type of rotary spreaders (example: Cyclone, Lely, etc.) a test run will have to be done on a particular given area because there isn't any way to catch the material from the spreader. Some of our Chemical Companies such as Elanco print spreader settings on their Balan bag advising you how to set rotary type spreaders.

Drop type spreaders are very easy to calibrate since most all the major manufacturers of drop type spreaders supply us with a calibration pan. A given area has to be measured. Preferably, 4,356 square feet, which is 1/10 of an acre if you are trying to establish an acre rate. If the thousand square feet rate is being established, mark off 100 X 10 or 50 X 20 and cover that area with the spreader, calibration pan attached, at a given speed, then weigh the material. Most of the time, several runs have to be made before the setting can be established.

If in doubt, it is best to contact your supplier and they usually can be of assistance to you.

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FUNGICIDE STUDIES ON ST. AUGUSTINEGRASS DOWNY MILDEW

by

Benny D. Bruton and Robert W. Toler*

Introduction

Disease and insect pests controlled by the mechanism of resistance is the easiest and most economical method of control. St. Augustine Decline (SAD strain of Panicum Mosaic Virus) (1, 4, 7), and the southern chinch bug (Blissus insularis Barber) (4, 5, 6) are examples of control using host-plant resistance.

Downy mildew on St. Augustinegrass caused by Sclerophthera macrospora (Sacc.) Thirum., Shaw and Naras. (2, 3) has been difficult to control since little or no resistance to infection has been observed in any of the 25 cultivars and accessions thus far tested. Severe damage caused by the downy mildew fungus has been observed on St. Augustinegrass growing in flood prone areas in the coastal bend area of Texas. Fungicidal control has been ineffective since the fungicides previously employed were not systemic in their action.

The objectives of this study include: (a) Determining the effect of the Ciba-Geigy systemic fungicide (CGA-48988) on disease development of the down mildew on St. Augustinegrass, (b) dosages and (c) effects on plant growth of diseased and healthy St. Augustinegrass.

Methods and Materials:

The Ciba-Geigy Corporation has developed an experimental systemic fungicide (CGA-48988) which has demonstrated activity against Phycomycetous fungi. Since S. macrospora is a member of this group, CGA-48988 was chosen in an effort to control downy mildew on St. Augustinegrass. Dexon, a non-systemic fungicide, which is also active against Phycomycetes was used for comparative purposes.

The St. Augustinegrass cultivar, Scott 1081, was used for fungicide evaluation under greenhouse conditions because of susceptibility to ex-

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tensive systemic infection by the downy mildew fungus. CGA-48988 at the rate of 0.5, 1, 2, 3 oz ai/1000 sq. ft., Dexon at 1.87 oz ai/1000, and the water treated control were replicated six times for each treatment. Tween 200 was added as a surfactant to each chemical treatment as well as the control and applied as a foliar spray. Effects of fungicidal applications were evaluated by counting the number of diseased leaves in each treatment 7, 14, 21, and 28 days after application. Growth effects of the treatments applied to diseased and healthy St. Augustinegrass were evaluated 28 days after application. Growth measurement included height (cm) and green weight (gm) of clippings. Phytotoxicity ratings were taken 7 days after fungicide application.

Results and Discussion:

There was no difference in percent diseased leaves on the Dexon treatment as compared to the control. All CGA-48988 rates were effective in controlling downy mildew on Scott 1081 based on percent diseased leaves 28 days after application. At the end of 7, 14, 21, and 28 days the CGA-48988 treatments had progressively reduced the number of diseased leaves as compared to the control (Table 1). By the end of 28 days, the CGA-48988 treated plants showed no symptoms of downy mildew infection. The results of this study demonstrated that CGA-48988 was equally effective at the rates employed i.e. 0.5, 1.0, 2.0, and 3.0 oz ai/1000 sq. ft.

Increases in plant height and foliage weights of downy mildew diseased plants were observed in the CGA-48988 treatments 28 days after application as compared to Dexon and water sprayed infected controls (Table 2). Growth rate as measured by plant height and fresh weight of the CGA-48988 treated plants was approximately twice that of the other treatments.

When the same treatments were applied to healthy St. Augustinegrass and evaluated 28 days following application, no effect on plant growth as measured by height and clipping weights were obtained (Table 3). Phytotoxicity on healthy and downy mildew diseased St. Augustinegrass was negligible with Dexon and CGA-48988 at 0.5 and 1.0 oz rates. However, slight tip burn was observed 7 days after application of CGA-48988 at the 2 and 3 oz concentrations.

The Ciba-Geigy experimental systemic fungicide was effective in controlling downy mildew of St. Augustinegrass at 1/2, 1, 2, and 3 times the recommended rate as a foliar spray in greenhouse studies. Growth of the St. Augustinegrass doubled when down mildew was effectively controlled although the fungicide had no stimulatory or inhibitory effect on growth of healthy plants.

Table 1. Effect of Fungicide Application on Disease Development of Infected St. Augustinegrass

Treatment	Days After Application	Leaves Infected Percent
Diseased Control	7	95
	14	91
	21	90
	28	93
Dexon 1.87 oz[a]	7	97
	14	99
	21	95
	28	96
CGA-48988 0.5 oz ai	7	70
	14	44
	21	15
	28	0
CGA-48988 1 oz ai[b]	7	85
	14	39
	21	5
	28	0
CGA-48988 2 oz ai	7	70
	14	40
	21	10
	28	0
CGA-48988 3 oz ai	7	85
	14	50
	21	25
	28	0

[a]Manufacturers recommended rate/1000 sq ft (Chemagro Corporation)
[b]Manufacturers recommended rate/1000 sq ft (Ciba-Geigy Corporation)

Table 2. Mean Foliage Weight and Height of Each Treatment on Downy Mildew Infected St. Augustinegrass After Twenty-Eight Days

Treatment	Application Rate oz ai/1000 sq ft	Foliage Weight Grams	Plant Height Centimeters
Control	--	12.88[a]	8.12
Dexon	1.87[b]	11.09	9.01
CGA-48988	0.50	23.57	18.05
CGA-48988	1.00[c]	25.00	20.13
CGA-48988	2.00	24.08	17.95
CGA-48988	3.00	19.37	18.00

[a]Mean fresh weight of six replications
[b]Manufacturers recommended rate
[c]Manufacturers recommended rate

Table 3. Mean Foliage Weight and Height of Each Treatment on Healthy St. Augustinegrass After Twenty-Eight Days

Treatment	Application Rate oz ai/1000 sq ft	Foliage Weight Grams	Plant Height Centimeters
Control	--	28.33[a]	21.37
Dexon	1.87[b]	28.61	20.61
CGA-48988	0.50	25.29	18.99
CGA-48988	1.00[c]	20.75	20.00
CGA-48988	2.00	23.00	19.75
CGA-48988	3.00	26.90	20.11

[a]Mean fresh weight of six replications
[b]Manufacturers recommended rate
[c]Manufacturers recommended rate

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CULTURAL MANIPULATION OF SPORE POPULATIONS FOR TURF DISEASE CONTROL

by

P. F. Colbaugh and J. B. Beard*

Most fungi found on turfgrasses are capable of producing large numbers of spores during periods of active growth. Even though fungal spores are microscopic in size, they play a very important role in insuring the constant presence of fungi on turf. Spores produced by fungi are generally capable of surviving long periods of environmental extremes. Fungal spores also function like "tiny seeds", and are often transported long distances before continuing fungus growth activities at other locations. Some type of fungus spores allow the growth of beneficial fungi which aid in decomposing turfgrass plant debris, while other types of spores are produced by fungal pathogens of turfgrasses and have the capacity to cause disease on living plants.

Spores of fungal pathogens of turfgrasses play an important role in the spread and the initiation of many diseases of turfgrasses. Most spores of fungal turfgrass pathogens are produced on dead or dying plant parts which comprise the turf litter or upper layer of thatch. Spores of fungal turfgrass pathogens which are produced on litter can be spread to healthy plants by mowing operations, foot traffic, and splashing water or wind. The thatch layer thus serves as a continuous reservoir of fungal spores which can cause turf diseases.

Little is known concerning the role of environmental and cultural factors in regulating spore production by fungi on turf. Recently, studies of fungal spore populations on turfgrasses were started at the TAMU Research Center at Dallas. Samples of turfgrasses from home lawns in the Dallas area indicated the types and numbers of fungus spores present varied greatly among different types of turfgrasses. Field surveys in the spring demonstrated that higher numbers of fungus spores were present on tall fescue and hybrid bermuda home lawns than on common bermuda and St. Augustine grass lawns. Differences in total spore number when expressed on an equivalent basis (gm. dry wt.) were 450,000 spores on St. Augustine grass, 550,000 on common bermudagrass, 920,000 on improved bermudagrass and 1,670,000 on tall fescue. Fungal spore numbers on improved bermudagrass or tall fescue lawns were 2-4 fold greater than on St. Augustine grass lawns; this difference is thought to reflect differing management practices for these turf types.

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Spore population studies were initiated on experimental plots of improved bermudagrass during 1977 to determine the role of clipping height and fertilization on fungal spore production. The relationships between fungus spore populations and turf management practices indicate that cultural manipulation of fungus spore production could provide significant disease control of many turf pathogens.

Cultural Practices and Fungal Spore Production on Improved Bermudagrasses

Turf samples were removed from the improved bermudagrass cultural study area at College Station in September, 1977, for an assessment of spore populations. The bermudagrasses sampled were Tifway and Tifgreen maintained at cutting heights of 0.5, 1.0 and 2.0 inches and receiving monthly applications of nitrogen fertilizer at rates of 0.5 and 3 lb. nitrogen per 1,000 square feet, in all possible combinations with three replications. Spore populations were determined by county spores in aqueous suspensions removed from flasks containing water and turf debris shaken vigorously for 1 minutes.

Fertilization rate had a pronounced effect on the number of fungal spores recovered from the plots. The number of total fungal spores recovered (all types of fungus spores) was greatest on samples from turf plots receiving high rates of fertilization (3 lb.N/1000 ft^2/mo.) Spore numbers recovered from plots receiving 3.0 lb N were 3 to 4 fold greater than the number recovered from plots receiving 0.5 lb. N.

The effect of fertilization on spore recovery was greatest at the higher cutting heights of 1 and 2 inches.

Cutting height of the bermuda turf also influenced fungal spore recovery greatly. The greatest recovery of total fungal spores was from plots maintained at the lowest cutting height (0.5 inch). The effect of cutting height on spore recovery was most obvious on plots receiving the low rate of fertilization (0.5 lb). Differences in spore numbers recovered on tifgreen turf receiving 0.5 lb N and maintained at the lowest clipping height (0.5 inches) were 3 fold greater than the same turf maintained at 2.0 inches.

Of the two varieties of improved bermudagrasses used in this study, total fungal spore recovery was greater for Tifway than for Tifgreen. This trend was particularly evident at the 1.0 and 2.0 inche clipping height.

Counts of distinct spore types within a population of fungal spores is possible because the shape, color and size of spores are characteristic for distinct groups. Spore counts of Helminthosporium spp. within the total population of recovered spores was possible using spore morphology as a basis for separation.

The numbers of Helminthosporium spp. spores recovered from hybrid bermuda turf followed the same trend as total fungal spore populations. Helminthosporium spores were determined to be highest on hybrid bermuda turf receiving 3 lb. nitrogen per 1,000 square feet when compared to turfs receiving 0.5 lb. nitrogen. *Helminthosporium* spp. spores recovered from Tifway (419) turf were generally higher than those recovered from Tifgreen (328). Spore recovery was 3 to 5 fold greater at low cutting heights when compared to high cutting heights.

Discussion

Fungal spore populations on Dallas area homelawns and on experimental turf plots indicate turf management practices influence spore production greatly. The numbers of *Helminthosporium* spp. spores occurring in samples from improved hybrid bermudagrass plots were influenced by the same management variables as those found to influence the production of all types of fungal spores on turf.

On the basis of the initial spore population studies on tifway and tifgreen bermudagrass, low cutting heights and high rates of nitrogen favor the production of spores by *Helminthosporium* fungi. This spore group represents a potential pathogen on hybrid bermudagrasses and management variables could also influence disease activity as well. Studies are in progress to determine if the relationships influencing fungal spore production exist throughout the growing season. It is hoped that a greater understanding of the effect of management practices on fungal spore production will provide cultural disease control programs for use in the future.

CRABGRASS AND GOOSEGRASS CONTROL WITH HERBICIDES IN BERMUDAGRASS TURF

BY

B. J. Johnson*

Crabgrass (Digitaria sanguinalis) and goosegrass (Eleusine indica) are major weeds that invade bermudagrass (Cynodon sp.) during late spring and summer months. When weeds are not controlled, they will compete with turfgrass for moisture and food nutrients and this usually results in turf of low quality.

GENERAL INFORMATION

Weed control experiments were conducted on bermudagrass golf course fairways with a natural uniform weed population. These data are averages from two or more years. Weed control ratings were based on a scale of 0 for no control and 100 for complete control. On this scale 90% or greater weed control will be referred to as excellent, 75 to 89% as good, and below 75% as poor and unacceptable. The tolerance of four bermudagrass cultivars to annual repeated herbicide treatments was conducted on turf plots at the Georgia Station, Experiment. The ratings were based on 0 to 100. Turf green-up ratings were made in April where 0 = no green plant color and 100 = complete uniform green plant color; turf quality ratings were made in May where 0 = turf brown or completely dead and 100 = dark green in color; and turf cover ratings were made in August where 0 = no ground cover and 100 = complete ground cover.

CRABGRASS

Preemergence treatments. Good to excellent short-season crabgrass control was obtained from all herbicides included in this study when ratings were made in June (Table 1). However, bensulide, oxadiazon, and prosulfalin were the only chemicals that controlled crabgrass effectively throughout the summer without additional treatments. For optimum control it was necessary to apply all preemergence type chemicals prior to crabgrass emergence in the spring. If general, crabgrass control was about the same whether treatments were applied mid-February or mid-March.

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Sequential March + May treatments of napropamide resulted in excellent crabgrass control, whereas, similar benefin treatments resulted in barely acceptable control (Table 2). The effectiveness of both herbicides was reduced during the period from mid-May to mid-June as crabgrass seed began to germinate. Repeated DCPA treatments in June failed to significantly increase the amount of crabgrass control when compared with the single March treatment. However, if the second treatment had been applied in May as was benefin and napropamide, the control may have improved.

These results indicate that several chemicals will control crabgrass satisfactorily in bermudagrass turf. However, it is necessary to know the length of period they will provide acceptable control.

Fall vs spring treatments. Bensulide was the only herbicide that controlled crabgrass satisfactorily during the following summer after a single fall treatment (Table 3). However, excellent control was obtained with oxadiazon or napropamide when each was applied as a full rate in the fall followed by one-half rate in the spring. The advantages of fall herbicide treatments are for controlling winter annuals with some carry-over for crabgrass the following summer. These results indicate that selective winter and summer weeds can be controlled with lesser amount of chemicals than when they are applied at full rates in fall and again in the spring.

Postemergence treatments. MSMA applied in each of two applications at 1.0, 1.5, or 2.0 lb/A resulted in excellent crabgrass control (Table 4). The control was good (84 to 86%) with single treatments at 1.5 or 2.0 lb/A rates. There was no advantage in the control obtained with metribuzin when compared with MSMA. Since metribuzin injures bermudagrass more than MSMA, it should not be used for crabgrass control.

MSMA at 1.0 lb/A controlled crabgrass, but the control was best when a second MSMA treatment was delayed until 12 days following the initial treatment (Table 5). Similar results occurred when treated at higher rates, except the delay in treatment could be extended up to 10 days. In all instances, when second application was applied at either a 4 or 8 day interval, the control was not as good. Therefore, these results suggest that when a second MSMA treatment is needed for crabgrass control it should be applied at 12-day intervals.

GOOSEGRASS

Goosegrass is not as easily controlled in turf as crabgrass. Of the number of preemergence herbicides that controlled crabgrass (Table 1) only three, oxadiazon, prosulfalin, and napropamide controlled goosegrass satisfactorily (Table 6). In the Southeast, goosegrass germinates approximately one month later than crabgrass. Therefore, oxadiazon applied in mid-April controlled a higher percentage of the weed than when applied earlier or later (Table 6). However, the control was acceptable from one application applied at any time from February until May. This indicates that the chemical will give long-term results.

Good goosegrass control was also obtained with a single March treatment of prosulfalin (Table 6). Sequential March + May treatments increased the control only sightly when compared with the single March treatment. However, it was necessary to apply two treatments of napropamide in March + May for acceptable control.

MSMA did not give consistent postemergence control of goosegrass. In our study, two applications at 3.0 lb/A resulted in temporary top kill (86%), but goosegrass recovered rapidly and total population was not affected (Table 7). In a later study it was found that metribuzin applied at 0.5 lb/A in each of two applications controlled goosegrass almost completely. A disadvantage from this treatment was severe yellowing and slight stand reduction of bermudagrass turf. However, combinations of MSMA at 2.0 lb/A with metribuzin at 0.12 lb/A applied in two applications controlled goosegrass and did not injure bermudagrass as severely.

Results indicate that goosegrass population in bermudagrass can be reduced or eliminated with selected herbicides without permanently affecting bermudagrass turf.

TURFGRASS INJURY

For herbicides to be practical, they must control weeds in turf areas without injuring the turfgrass.

Annual repeated preemergence treatments delayed green-up of four bermudagrasses when compared with respective untreated plots in April (Table 8). In some instances, the amount of green-up varied between bermudagrass cultivars for selected treatments. Even though DCPA reduced green-up of all cultivars, Tifgreen (38%) was delayed more than Tifway (38%) while Tifdwarf (43%) and Ormond (43%) were intermediate. Similar results also occurred from prosulfalin treatments. However, green-up of Tifway was slightly less than Tifgreen and Tifdwarf when treated with napropamide and less than all other cultivars when treated with oxadiazon. Delayed green-up from these treatments did not affect quality of turf in May or reduce stand when final ratings were made in August. It has been observed in some years that a lower turf quality and stand reduction occurred in early spring and throughout the summer from herbicide treatments. These results indicate that herbicides applied as preemergence treatments for crabgrass and goosegrass control may injure one bermudagrass cultivar and not another.

MSMA applied for postemergence control of crabgrass caused only slight or no injury to common bermudagrass (Table 9). In all instances the turf had fully recovered within 2 to 3 weeks after the final treatment.

Metribuzin at 0.5 lb/A in each of two applications caused moderate injury to common bermudagrass (Table 9). In some instances the bermudagrass stand was reduced from these treatments. The turf was not injured as severely from lower rates, but they did not provide consistent goosegrass control (Table 7).

It was found in a later study that combination of MSMA + metribuzin at 2.0 + 0.125 lb/A applied in two applications controlled goosegrass as well as did the repeated metribuzin at 0.5 lb/A rate (Table 7) with less turf injury (Table 9). The bermudagrass turf recovered rapidly without any stand loss.

These results indicate that it is important to select a herbicide that will not injure the turf when it is applied for weed control.

Table 1. Effect of preemergence herbicide treatments for crabgrass control in bermudagrass turf.

Treatments		% Crabgrass control[a/]	
Herbicide	Rate	June	August
	lb/A		
DCPA	10.0	85	65
Benefin	3.0	88	67
Bensulide	10.0	97	89
Oxadiazon	4.0	98	92
Napropamide	3.0	92	65
Prosulfalin	3.0	98	97

a/ Treatments applied March 5 ± 10 days and ratings were based on 0 = no control and 100 = complete control. Ratings taken in June represent short-season control and August ratings represent full-season control.

Table 2. Effect of single vs repeated preemergence herbicide treatments for crabgrass control in bermudagrass turf.

Herbicide	Treatments Rate	Date	% Crabgrass control[a/]
	lb/A		
DCPA	10.0	Mar.	59
	10.0 + 5.0	Mar. + June	61
	5.0 + 10.0	Mar. + June	38
	10.0 + 10.0	Mar. + June	66
	5.0 + 5.0	Mar. + June	28
	5.0 + 5.0 + 5.0	Mar. + May + July	56
Benefin	2.0	Mar.	33
	3.0	Mar.	41
	2.0 + 2.0	Mar. + May	73
	3.0 + 2.0	Mar. + May	76
	3.0 + 3.0	Mar. + June	61
	2.0 + 2.0 + 2.0	Mar. + May + July	81
	3.0 + 3.0 + 3.0	Mar. + May + July	86
Napropamide	3.0	Mar.	69
	2.0 + 2.0	Mar. + May	96
	3.0 + 2.0	Mar. + May	98
	3.0 + 3.0	Mar. + June	81
	2.0 + 2.0 + 2.0	Mar. + May + July	95
	3.0 + 3.0 + 3.0	Mar. + May + July	98

a/ Ratings were made in August and based on 0 = no control and 100 = complete control.

Table 3. Effect of fall, spring, and combination of fall + spring preemergence herbicide treatments for crabgrass control in bermudagrass turf.

Treatments		% Crabgrass Control[a/]		
Rate[b/]	Applied	Bensulide	Oxadiazon	Napropamide
1X	Fall	92	67	57
1X + 1/2X	Fall + Spring	99	94	90
1X + 1X	Fall + Spring	99	97	95
1X	Spring	90	90	73

a/ Ratings were made in August and based on 0 = no control and 100 = complete control.

b/ The 1X rates for bensulide are 12.5 lb/A in fall and 10.0 lb/A in spring, oxadiazon 4.0 lb/A and napropamide 3.0 lb/A applied in fall or spring.

Table 4. Effect of postemergence herbicide treatments for crabgrass in bermudagrass turf.

Herbicide	Treatments Rate	Application	% Crabgrass control[a/]
	lb/A	No.	
MSMA	0.5	1	47
		2	84
	1.0	1	73
		2	92
	1.5	1	84
		2	98
	2.0	1	86
		2	99
Metribuzin	0.25	1	4
		2	47
	0.5	1	37
		2	87

a/ Ratings were made 4 to 5 weeks after treatment and based on 0 = no control and 100 = complete control.

Table 5. Effect of time interval between first and second MSMA treatments for crabgrass control in bermudagrass turf.

Days between treatments	Rates lb/A 1.0	1.5	2.0
	% crabgrass control[a]		
4	67	73	79
8	66	78	83
12	91	99	99
16	76	96	99
19	82	99	99

a/ Ratings were made 4 to 5 weeks after treatment and based on 0 = no control and 100 = complete control.

Table 6. Effect of preemergence herbicide treatments for goosegrass control in bermudagrass turf.

Treatments			% Goosegrass
Herbicide	Rate lb/A	Applied	control[a]
Oxadiazon	4.0	Feb.	76
		Mar.	82
		April	93
		May	83
Prosulfalin	3.0	Mar.	81
	3.0 + 2.0	Mar. + May	88
Napropamide	3.0	Mar.	42
	2.0 + 2.0	Mar. + May	92
	3.0 + 2.0	Mar. + May	100

a/ Ratings were made in August and based on 0 = no control and 100 = complete control.

Table 7. Effect of postemergence herbicide treatments for goosegrass control in bermudagrass turf.

Treatments			% Goosegrass
Herbicide	Rate	Application	control[a]
	lb/A		
MSMA	2.0	1	13
		2	58
	3.0	1	38
		2	86
Metribuzin	0.25	1	32
		2	73
	0.5	1	71
		2	98
MSMA + Metribuzin	2.0 + 0.12	1	46
		2	98

a/ Ratings were made 4 to 5 weeks after treatment and based on 0 = no control and 100 = complete control.

Table 8. Effect of repeated annual preemergence herbicide treatments, turf green-up, quality, and stand of four bermudagrasses in 1977.

Herbicides[a]		Bermudagrasses[b]			
Treatment	Rate	Tifway	Tifgreen	Tifdwarf	Ormond
	lb/A	0 to 100			
			Turf green-up		
Untreated check	-	65	69	66	64
DCPA	10.0	48	38	43	43
Oxadiazon	4.0	46	53	59	54
Prosulfalin	3.0	58	43	51	49
Napropamide	3.0	45	53	54	46
			Turf quality		
Untreated check	-	90	81	83	74
DCPA	10.0	90	81	80	71
Oxadiazon	4.0	93	83	84	73
Prosulfalin	3.0	90	75	79	69
Napropamide	3.0	90	79	81	73
			Turf stand		
Untreated check	-	100	100	100	100
DCPA	10.0	100	100	100	96
Oxadiazon	4.0	100	100	100	94
Prosulfalin	3.0	98	99	100	94
Napropamide	3.0	96	96	100	93

a/ Herbicides were applied for 3 consecutive years for prosulfalin and napropamide and for 6 consecutive years for DCPA and oxadiazon.

b/ Turf ratings were based on 0 to 100. Turf green-up ratings were made in April where 0 = no green plant color and 100 = complete uniform green plant color; turf quality ratings were made in May where 0 = turf brown or completely dead and 100 = dark green in color; and turf cover ratings were made in August where 0 = no ground cover and 100 = complete ground cover.

Table 9. Effect of postemergence herbicide treatments on injury of common bermudagrass.

Treatments: Herbicide	Treatments: Rate	Application	% Turf injury[a/]
	lb/A	No.	
MSMA	2.0	1	0
		2	0
	3.0	1	2
		2	17
Metribuzin	0.25	1	0
		2	14
	0.5	1	8
		2	30
MSMA + metribuzin	2.0 + 0.12	1	6
		2	20

a/ Ratings made at 2 weeks after the second treatment and based on 0 = no injury and 100 = complete kill. The ratings are averages from 2 years.

KENTUCKY BLUEGRASS GROWTH AND ADAPTATION

TO SOUTHWESTERN ENVIRONMENTS

by

Garald L. Horst and Jerold M. Carter*

The growing southwest is changing turfgrass cultural practices. The need for year-round park and recreational areas is enhanced because of mild winters and population pressures. Cool-season grasses may be used when warm-season grasses go dormant. However, environmental stresses such as high summer temperatures cause problems in maintaining cool-season grasses through the summers. In addition, there has been little or no research on the adaptability of the improved cool-season grasses to the southwest.

Objectives of this turfgrass research were to develop management and evaluation methods for measuring turfgrass response to environmental stress conditions and to evaluate cool-season turfgrass responses on a continuing long-term basis.

Materials and Methods

The research procedure was as follows: We selected thirty-four Kentucky bluegrass varieties from a wide range of environments and grew these diverse bluegrass varieties under the best presently accepted cultural practices used in the southwest. Then we measured various morphological and physiological plant responses under these conditions.

As conditions permitted, the bluegrass plots were mowed, fertilized, and irrigated once each week. Color estimates were based on a visual one to nine scale with nine being the darkest green color. Disease and heat injury were also based on a visual one to nine scale with nine being the most disease infestation and greatest amount of heat injury. Growth or dry matter production was estimated by harvesting every fourth weekly mowing.

Estimates of tall fescue invasion of bluegrass cultivars was based on the numbers of tall fescue plants growing in each plot. Competition was estimated by evaluating the relative amount of surface area covered by tall fescue plants in relation to bluegrass in each plot.

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Results and Discussion

Dry matter production is one method of evaluating the growth responses of grass cultivars to environmental conditions. As indicated by Tables 1 and 2 there are drastic genetic differences in growth response to seasonal changes in temperature. Cultivars such as South Dakota Common grow well under cool temperatures, but become dormant under high summer temperatures. In contrast, cultivars such as Bristol produce relatively little harvestable top growth under both cool and warm temperatures. These differences in growth response may be used to fit a particular bluegrass cultivar into specific environmental and cultural practice situations.

Color which is sometimes used synonymously with turfgrass quality is also a very important consideration in turfgrass evaluation. Bluegrass cultivars which ranked high in color evaluation during cool weather did not necessarily maintain good color during warm weather (Tables 3, 4). The cultivar that ranked high in color under both cool and warm temperatures was Bristol. In contrast, Delta consistently ranked low in color during winter and summer conditions.

Environmental stress such as high summer temperatures often produce microclimate and plant physiological conditions favorable to disease infection. Turfgrasses which tend to be heat resistant, may or may not also be resistant to disease infection. As the data (Table 5) indicates, some bluegrass cultivars which exhibit low amounts of heat injury also exhibit low disease infestation. However, cultivars such as Aldelphi and Baron which had low amounts of heat injury had low to moderate disease damage (a rating greater than the top five for least disease injury, Table 5).

Invasion and coverage of bluegrass cultivars is a good indication of their relative competitiveness. As may be noted, (Table 6, 7) cultivars which had lower numbers of tall fescue plants established in the plots also kept these plants from becoming very large. This was not always the case as some of the cultivars which had low to moderate infestation rates allowed these tall fescue plants to enlarge.

Conclusions

The performance of these bluegrass cultivars after five years is a good indication as to which cultivars will do best when grown under southwestern conditions. Perhaps some of these that are the more heat and disease resistant as well as high in color rating may grow well under more humid conditions in the south.

Table 1

Average Dry Matter Yield (gm) of Kentucky Bluegrass Genotypes (Feb. 1978).

Top Five		Bottom Five	
Genotype	Yield	Genotype	Yield
Kenblue	112 a[1]	Arista	30 b
Nu-Dwarf	106 a	Baron	27 b
S.D.K. Common	105 a	Nugget	21 b
Park	103 a	Bristol	17 b
Vantage	96 a	Victa	14 b

[1] Means within a column followed by the same letter are n.s. at 0.05 level.

G. L. Horst

TABLE 2

AVERAGE DRY MATTER YIELD (GM) OF KENTUCKY BLUEGRASS GENOTYPES (SEPT. L978).

TOP FIVE		BOTTOM FIVE	
GENOTYPE	YIELD	GENOTYPE	YIELD
OREGON COM.	153 a[1]	S.D.K. COM.	89 b
WTN 1-13	134 a	DELTA	87 b
WTN 1-2	132 a	TROY	83 b
NEWPORT	131 a	BRISTOL	82 b
PRATO	122 a	FYLKING	81 b

MEANS WITHIN A COLUMN FOLLOWED BY THE SAME LETTER ARE N.S. AT 0.05 LEVEL.

G. L. HORST

TABLE 3

AVERAGE VISUAL ESTIMATES OF WINTER GREEN COLOR (1-9) FOR KENTUCKY BLUEGRASS GENOTYPES (FEB. 1978).

Top Five		Bottom Five	
Genotype	Rating	Genotype	Rating
Arista	5.75 a[1]	Warren A-20	2.00 b
WTNI -2	5.75 a	Windsor	2.00 b
Flyking	5.25 a	S-21	1.50 b
Bristol	5.25 a	Delta	1.50 b
Cougar	5.00 a	Nugget	0.75 b

[1]Means within a column followed by the same letter are n.s. at 0.05 level.

G. L. Horst

Table 4

Average Visual Estimates of Summer Green Color (1-9) for Kentucky Bluegrass Genotypes (July, Aug., Sept., 1978).

Top Five		Bottom Five	
Genotype	Rating	Genotype	Rating
Glade	7.25 a[1]	Delta	4.00 c
Bristol	7.25 a	S-21	4.00 c
Warren A-10	6.75 ab	Park	3.75 c
Adelphi	6.25 a	Kenblue	3.50 c
Majestic	6.25 a	Prato	3.50 c

Means within a column followed by the same letter are n.s. at 0.05 level.

G. L. Horst

TABLE 5

RELATIONSHIP OF HEAT INJURY AND DISEASE INJURY ESTIMATES (1-9) FOR KENTUCKY BLUEGRASS GENOTYPES.

Disease Injury		Heat Injury	
Genotype	Rating	Genotype	Rating
Adelphi	1.00	Baron	3.00
Bristol	1.00	Adelphi	3.00
Glade	1.25	WTNI-13	3.25
Victa	1.25	Bristol	3.25
WTNI-13	1.25	Glade	3.50

$R = 0.91^{**}$[1]

[1]**Significant at 0.01 level.

G. L. Horst

TABLE 6

AVERAGE NUMBER OF TALL FESCUE PLANTS INVADING KENTUCKY BLUEGRASS GENOTYPES AFTER FIVE YEARS.

Least Invasion		Most Invasion	
Genotype	#Plants	Genotype	#Plants
Fylking	3.00 a[1]	Bonnieblue	9.75 bc
Oregon Com.	3.50 a	Park	9.75 bc
Nu-Dwarf	5.00 a	Newport	10.00 bc
Glade	5.25 a	Cougar	10.25 bc
Troy	5.50 a	Delta	11.75 c

[1]Means Followed by the same letter are n.s. at 0.05 level of significance.

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Table 7

Average Amount of Coverage (Percent) by Tall Fescue of Kentucky Bluegrass Genotypes After Five Years.

Least Coverage		Most Coverage	
Genotype	% Coverage	Genotype	% Coverage
Fylking	3.00	Merion	9.00
Glade	3.00	Arista	9.25
Nu-Dwarf	3.25	Prato	9.25
Windsor	3.50	S-21	10.00
Touchdown	3.75	Park	10.00

G. L. Horst

BIG-EYED BUGS: BENEFICIAL MEMBERS OF THE TURFGRASS INSECT COMMUNITY

by

Robert L. Crocker

There is always the temptation to lump insects together and to brand them as undesirable. Yielding to that temptation, however, would a serious error, because only about 750 of the 2,500,000 + known species of insects in the world are considered pests. A far greater number than that are highly beneficial parasites and predators of potential and actual pests. Without the unseen assistance we receive from these beneficial insects, there is no way that we could hope to hold off the populations of pests with insecticides. Present pesticide applications merely treat those pests that escape from their natural enemies - a minute fraction of those that otherwise might confront us.

One of the most important groups of beneficial turfgrass insects in the big-eyed bugs (Geocoris punctipes, G. bullatus, G. uliginosus, and other Geocoris spp.). These insects often suffer the mistaken wrath of lawn specialists and homeowners who take them for chinch bugs and spray them. In fact, big-eyed bugs are predators: they feed on spider mites, catepillars, aphid, Rhodesgrass scales, leafhoppers, thrips, pameras, beetles, collembola (springtails), fleahoppers, stink bugs, mealybugs, ants, and spittle bugs - probably on chinch bugs as well. The fact that big-eyed bugs eat so many kinds of pests is even more important when you consider that big-eyed bugs are often among the most abundant insects in a lawn. A single female big-eyed bug may consume an impressive average of 47.5 moth eggs (or their food-value equivalent) per day.

Description

The mistaking of big-eyed bugs for chinch bugs is somewhat understandable (they are similar in size and color, the mouthparts of both consist of a slender beak which is held under the body when not in use, and in fact are both members of the same insect family - the Lygaeidae). On the other hand, there is no reason why a well-informed person should make that mistake. Big-eyed bugs, although small (3-5mm long), are robust insects with well-developed eyes that protrude to the side and make their head appear short and broad; in fact, the head is slightly wider than the anterior

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portion of the body (the thorax). Chinch bugs, by comparison, are moderately slender; their eyes, although well-developed, are small in proportion to the rest of the head; the head is more slender than the body when viewed from above. Immature big-eyed bugs are generally like the adults, except that they are even more robust (almost oval), may be of a different color (gray-black), and lack functional wings (older nymphs have visable wing-pads on their backs). Nymphs of some species have streaks or specks of color on their backs. Nymphs are sometimes mistaken for beetles as they scurry rapidly about amid the turfgrass, but a close examination of these nymphs will disclose the long, slender beak which they stick into their prey; beetles all have chewing mouthparts.

Biology

Big-eyed bugs generally overwinter near the soil as adults, although nymphs may be found throughout the year in areas with mild winters. The times required to complete development at 68^{O}F (20^{O}C), 77^{O}F (25^{O}C), 86^{O}F (30^{O}C), and 95^{O}F (35^{O}C) are ca. 60, 30, 17, and 15 days, respectively. Generations are not synchronous, for adults and nymphs are producers continuously throughout most of the warm seasons. Adults may live for several months. Eggs are stuck onto the surfaces of leaves and stems - especially in crevices - or are inserted into the soil. More eggs are produced per day in warm (86^{O}F) than in cool (68^{O}F) weather; at 86^{O}F, a female will lay an average of about 8 eggs daily. Nymphs emerge in a few days and begin to hunt for prey. Adults and nymphs have similar feeding habits.

The number of prey consumed daily is highly dependent on the developmental stage and sex of the individual big-eyed bug as well as on the temperature. Larger (older) individuals consume more prey daily than do younger nymphs, adult females (because of the demands of egg production) kill more prey daily than do males, and all stages consume progressively more prey at higher (86^{O}F) than at lower (68-77^{O}F) temperatures. This temperature-dependency tends to counteract the ability of their prey to reproduce more rapidly at higher temperatures, and thus increases the ability of the big-eyed bugs to prevent pest outbreaks.

SPRING ROOT LOSS OF BERMUDAGRASS AND ST. AUGUSTINEGRASS

by

J. M. DiPaola and J. B. Beard*

An understanding of turfgrass root behavior in response to both cultural practices and environmental conditions is essential for the development of improved cultural systems for the maintenance of high quality turfs. Observation of the turfgrass root system however, is a difficult task, and thus current turfgrass cultural systems are based almost entirely upon the responses of the grass shoots. The potential importance of the turfgrass root system characteristics and seasonal behavior under such cultural systems has not been realized and is only recently being investigated in detail.

The findings presented here are a part of a continuing investigation conducted in the Texas A&M University Turfgrass Rhizotron at College Station, Texas. The rhizotron or field root observation facility is one of only eight in existence throughout the world and is the first to investigate turfgrass root system characteristics. The TAMU Turfgrass Rhizotron is comprised of 48 root observation boxes, each having dimensions of 10 inches wide X 12 inches long X 30 inches deep. Each individual root observation box has one glass side which faces the interior of the rhizotron, thus allowing continuous, direct root observation. Further details concerning the rhizotron have been reported in an earlier conference proceedings (1).

Turfs of Tifgreen bermudagrass and Floratam St. Augustinegrass were transplanted onto the root observation boxes of the rhizotron in August, 1976. Phosphorus (P) applications were made annually at a rate of 3 pounds of actual P per 1,000 square feet, while nitrogen and potassium applications were made at a rate of 1 pound of actual nutrient (N or K) per 1,000 square feet per growing month. The bermudagrass and St. Augustinegrass turfs were clipped weekly at 1 and 2 inches, respectively. Soil temperatures were continuously recorded at 4 and 12 inch soil depths.

The root system characteristics of both these turfgrasses vary from day to day, and season to season thoughout the year. New root initiation and maturation death of older roots continues throughout the summer months. The average daily root growth rate (1 inch/day) for these two warm season species during the summer months was some 5 times the rate previously observed for creeping bentgrass, a cool season turfgrass species.

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Root growth rates of bermudagrass and St. Augustinegrass gradually decreased as fall soil temperatures declined. The root growth rate of Floratam St. Augustinegrass was approximately half the summer rate during the last two weeks of October 1976 and 1977. Root growth continued for some 30 days after shoot dormancy (loss of green shoot color) occurred in the fall of 1977. During the winter months the shoots remained 'dormant', while the turfgrass roots remained inactive but maintained the same white to light-tan color they possessed during the summer and fall.

The spring months have been observed to be a time of rapid change in the root systems of these two turfgrasses, which has much practical importance in relation to the survival and quality of turf during the early spring. A severe and rapid root browning of the entire root systems was observed to occur on both these turfgrasses within a few days following new leaf emergence in the spring of both 1977 and 1978. This onset of rapid root death and loss occurred 4 and 5 days after new spring leaf emergence in 1978 for St. Augustinegrass and bermudagrass, respectively.

Floratam and Tifgreen turfs produced significant amounts of new green leaves following root browning without any outward signs of new root initiation. New root initiation took place 1 and 14 days after root browning for Tifgreen and Floratam turfs, respectively (Table 1). An additional 20 days and 13 days passed before the first individual root of Tifgreen and Floratam reached a one foot soil depth. In total, Tifgreen and Floratam were observed to have a 21 and 27 day delay, respectively, between old root browning and an individual new root reaching a one foot depth during the spring of 1978. Such a spring root loss has not been observed on the cool season turfgrasses.

Delay in the development of new roots of Tifgreen and Floratam following old root death in early spring results in a shoot-to-root ratio imbalance, since shoot growth is very rapid during this same period. Spring root loss increases the susceptibility of these turfgrasses to low temperature stress, spring iron chlorosis, pesticide phytotoxicity, desiccating winds, traffic, stress, diseases, and peat insects. Reports throughout the southern United States have noted such problems during the early spring.

Other spring turfgrass cultural problems which have been reported include the following. Herbicide applications to St. Augustinegrass soon after leaf greenup in the spring are often phytotoxic, while such applications, at the same rates, during other times in the growing season result in no visible shoot injury. Winter survival ratings of Tifway bermudagrass have been markedly lower when turfs are evaluated 2 to 3 weeks following new leaf greenup in the spring in comparison to the initial greenup ratings. Vertical cutting of bermudagrass greens during this root loss period has resulted in severe reductions in turfgrass stand. Furthermore both sodding and vegetative establishment of either bermudagrass or St. Augustinegrass is much more difficult during this root deficiency period then in late spring or summer.

Several cultural practices may prove useful in maintaining quality St. Augustinegrass and bermudagrass turfs during the early spring. Previous turfgrass research shows that raising the cutting height, delaying the first mowing, and lengthening the intervals between mowings are helpful in maximizing root growth, and thus may be important positive cultural practices during this early spring root loss period. Other positive cultural practices may include early applications of potassium and adequate availability of soil water.

On the other hand, lowering the cutting height, excessive nitrogen fertilization application of certain pesticides, and the use of some growth regulators have been observed to restrict and reduce root growth and should probably be avoided during this early spring root loss period. Finally, any additional stresses (i.e. vertical cutting) should probably be delayed until after the root loss period in the spring.

Each of these cultural practices may be either beneficial or harmful towards the maintenance of quality warm season turfs through the spring. Each must be completely investigated in order to ascertain the optimal use of these practices in light of this spring root loss phenomena of these warm season turfgrasses.

REFERENCES

1. DiPaola, J. M. and J. B. Beard. 1976. Development of a turfgrass rhizotron at Texas A&M. Proceedings of the Thirty First Annual Texas Turfgrass Conference. pp. 114-117.

Table 1. Shoot and root development of Floratam St. Augustinegrass and Tifgreen bermudagrass during the spring 1978.

Soil Temperature* (^{o}F)	Date	Status	Root Growth Rate (in/day)**
FLORATAM			
63.7	3/22	First new leave appear	--
54.3	3/26	Root browning occurs	--
67.3	4/9	First new root initiation	--
64,8	4/15		0.9
63.0	4/22	First root reached 1 ft depth	0.8
TIFGREEN			
61.0	3/21	First new leaves appear	--
54.3	3/26	Root browning occurs	--
53.6	3/27	First new root initiation	--
63.0	4/2	Turf shoots 61 % green	0.4
67.3	4/9	Turf shoots 86 % green	0.6
64.8	4/15	First root reached 1 ft depth	0.6

* Mean soil temperature (3-day average) at a 4 inch depth.
** Mean root growth rate (3-day average) in inch/day.

1977-78 WINTER OVERSEEDING EVALUATIONS AT TEXAS A&M UNIVERSITY

by

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D. Schwepler, and D.E. Chaffin*

I SEASONAL PERFORMANCE STUDIES:

This study is the third in a four year investigation to evaluate the many recently released cultivars for their potential use in winter overseeding of dormant bermudagrass turfs.

Research Procedure. This winter overseeding study was conducted on a one year old bermudagrass turf located at the TAMU Turfgrass Field Laboratory in College Station, Texas. Cultural practices employed on the bermudagrass during the previous growing season included: daily mowing at 0.25 inch; a 1 pound per 1,000 sq. ft. application of nitrogen per growing month; applicationa 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 threatenting serious injury to the turf. No preemergence herbicides have been applied. The plot size was 4 by 6 feet in a randomized block design of three replications. Two replications were on Tifgreen bermudagrass, while one replication was on Tifdwarf bermudagrass. No significant differences were observed between the two bermudagrasses in terms of species and cultivar performance. However, the annual bluegrass incidence was substantially greater on the Tifdwarf area regardless of the species or cultivar treatment.

The overseeding procedure consisted of the following series of steps. On October 14, 1977, the bermudagrass turf was vertically mowed in three directions with the clippings removed by means of a mower and catcher. Mowing ceased on October 26 and the fungicide captan was applied at the recommended label rate. Seeding of the treatment plots was accomplished on October 27. The individual plot boundaries were marked with a string prior to planting. The weight of seed required for an individual plot was poured into a Scotts three foot drop spreader. The spreader was adjusted so that several passes over the plot area were required to spread all the seed, thus achieving a uniform seed distribution. Subsequently, the entire area was topdressed to a depth of 1/8 inch using a mechanically powered topdresser. The plot area was then kept constantly moist for 14 days by irrigating as needed. No visible evidence of seedling disease injury was observed and thus no fungicide was required. Mowing was reinitiated 6 days after seeding on November 3 at 5/16 inch.

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Cultural practices followed on the overseeded experimental area during the winter period were: mowing three times per week at 0.25 inch with clippings removed; fertilizing at biweekly intervals at rates of 1 and 2 pounds of actual nitrogen per 1,000 square feet on a split plot basis of 3 foot widths. Irrigation was applied as needed to prevent wilt. No fungicides or insecticides were utilized.

The experiment was visually evaluated for shoot density three times per week during the establishment period. Subsequently the plots were visually estimated for turfgrass quality at 15-day intervals. Other experimental evaluations conducted on the plots during the winter period included (a) turfgrass wear tolerance, (b) surface roll characteristics, and (c) *Pythium* blight susceptibility. Evaluations were made at more frequent intervals as needed during spring transition. The same species and cultivars were also evaluated at sites in Houston, San Antonio, and Dallas, plus a selected group of grasses in El Paso. Differential susceptibility data concerning the proneness to dollar spot were obtained at the San Antonio plots.

Results. The winter performances of 16 perennial ryegrass cultivars overseeded onto dormant bermudagrass are shown in Table 1. As in the previous two years, all 16 cultivars performed well in terms of overall winter turfgrass quality. The winter of 1977-78 was extremely cold and wet, particularly in January and February. This favored the perennial ryegrasses in comparison to the fine leafed fescues and creeping bentgrasses.

During the extremely cold conditions of late January and early February most species and cultivars ceased growth and entered a semi-dormant state, including some browning of shoots. The outstanding exception among the monostands was Loretta perennial ryegrass. This ability to grow under extremely cold temperatures when most other cultivars were dormant resulted in it being the outstanding cultivar during the 1977-78 winter. This constrasts with the previous winter when it was not top ranked under less severe but cold conditions. Most of the cultivars rank in comparable positions to previous years except for Citation which dropped considerably from its top ranking of the previous two years.

Ten fine leafed fescues, three creeping bentgrasses, and two rough bluegrasses (*Poa trivialis*) were also evaluated (Table 2) All except Sabre rough bluegrass ranked significantly lower than a majority of the perennial ryegrass cultivars. Sabre rough bluegrass is definitely an improved cultivar over Denmark (Common) based on three years evaluations in Texas. It has good overall winter performance ranking comparable to most of the improved turf-type perennial ryegrass cultivars. It has rapid seed germination and good establishment vigor. However, it was very prone to ball marking and slow recuperation from this injury in the Houston study. In addition, Sabre has less favorable wear tolerance and ball roll characteristics than most of the perennial ryegrass cultivars as shown in another progress report contained in this 1978 series. These initial observations would suggest that Sabre rough bluegrass should not be considered for use in monostands or as a dominant component of polystands. However, it may contribute significantly as one component in a compatible seed mixture.

Table 1. Winter performance of sixteen perennial ryegrass cultivars overseeded[1] on dormant bermudagrass. 1977-78, College Station, Texas.

Perennial Ryegrass Cultivar	Winter Performance Ratings[2] Dec.	Jan.	Feb.	Mar.	Average for Winter (11 ratings)[3]
Loretta	7.2	6.8	7.3	7.0	7.1
Caravelle	6.7	6.2	6.7	6.4	6.5
Regal	6.6	6.0	6.6	6.6	6.4
Pennfine	6.5	6.1	6.5	6.6	6.4
Diplomat	6.4	6.0	6.5	7.0	6.3
Derby	6.4	6.1	6.5	6.3	6.3
Manhattan	6.6	5.8	6.3	6.8	6.3
Pelo	6.6	5.8	6.2	6.7	6.3
NK-200	6.8	6.0	5.8	6.0	6.2
Omega	6.4	5.8	6.2	6.5	6.1
Eton	6.1	6.1	6.1	6.1	6.1
Citation	6.4	5.8	6.0	5.8	6.1
Yorktown II	6.2	5.8	6.3	6.5	6.0
Birdie	6.1	5.7	5.9	6.8	5.9
NK-100	5.5	4.6	5.2	5.8	5.2
Linn	5.4	3.5	4.8	5.8	5.0

[1]All perennial ryegrass cultivars were seeded at 40 lb./1000 sq. ft.

[2]Visual rating of 9-best and 0-poorest; December 1, 1977 to March 31, 1978.

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

Table 2. Winter performance of fifteen non-ryegrass cultivars overseeded on dormant bermudagrass. 1977-78. College Station, Texas.

Cultivar and Species	Seeding Rate (lb./1000 ft.[2])	Winter Performance Ratings[1] Dec.	Jan.	Feb.	Mar.	Average for Winter (11 ratings)[2]
Sabre rb	12	6.7	6.1	6.3	6.7	6.4
Jamestown cf	30	6.2	4.9	5.2	5.0	5.4
Kensington cf	30	6.1	4.9	5.3	5.2	5.4
Penncross cb	3	5.3	5.4	5.7	5.3	5.4
Dawson rf	30	5.7	5.2	5.8	4.7	5.3
Emerald cb	3	5.5	5.0	5.2	5.2	5.2
Seaside cb	3	5.1	4.9	4.8	5.3	5.0
Pennlawn rf	30	5.8	4.0	4.2	4.2	4.7
Syn W cf	30	5.4	4.0	4.0	4.0	4.5
Ensylva cf	30	5.0	3.8	3.5	4.7	4.2
Atlanta cf	30	5.0	3.7	3.3	4.2	4.1
Wintergreen cf	30	4.9	3.6	3.5	3.2	4.0
Highlight cf	30	4.8	3.0	2.8	3.2	3.6
Denmark (common) rb	12	2.2	2.5	2.3	2.2	2.3
Centurian hard fescue	30	2.5	0.8	0.8	1.7	1.5

LEGEND:

cb	creeping bentgrass
cf	chewings fescue
rb	rough bluegrass
rf	red fescue

[1]Visual rating of 9-best and 0-poorest; December 1, 1977 to March 31, 1978.

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

Among the fine leafed fescues evaluated, Jamestown, Kensington, and Dawson were top ranked similar to previous years. However, the superiority of Dawson observed in past years was not evident under the extremely cold conditions of 1977-78. The hard fescue, Centurian, was very inferior. As a result of the severe growth restriction during the extreme low temperature conditions of January and February, there was a substantial amount of Poa annua invasion into the fine leafed fescue plots during March and April. This had not been observed under the warmer conditions of the two previous years.

Penncross ranked highest among the creeping bentgrasses followed by Emerald and then Seaside. The performance of the bentgrasses during this relatively cold winter has been better than in the two previous years.

As was found in the two previous years, there were no significant differences among most of the seed mixtures and blends evaluated for winter overseeding purposes (Table 3) The combination of 80% Dixiegreen plus 20% Sabre performed very well as it did during the cold winter of 1976-77. This polystand was the only one that maintained an acceptable color and growth rate during the extremely cold February conditions. It ranked with Loretta perennial ryegrass in terms of this capability. This was the primary factor that caused it to rank highest of the 16 polystands evaluated.

For the first time in three winters, significant differentials in disease incidence were observed. An extensive dollar spot attack occurred in San Antonio. Observations indicate that Manhattan perennial ryegrass had minimal susceptibility to this disease under Texas conditions. The low temperature Pythium disease development reported in another progress report within this 1978 series, also resulted in significant species and cultivar susceptibility differentials at the College Station site. No visible evidence of Pythium blight was present on any of the three creeping bentgrasses. However, there were significant differentials among the perennial ryegrasses with Linn, Regal, Caravelle, and Eton performing best in terms of least proneness to the disease.

Table 3. Winter performance of sixteen polystands overseeded on dormant bermudagrass. 1977-78. College Station, Texas.

Seed Mixture or Blend	Seeding Rate (lbs./1000 ft.[2])	Winter Performance Ratings[1] Dec.	Jan.	Feb.	Mar.	Average for Winter (11 ratings)[2]
80% Dixiegreen + 20% Sabre	35	7.3	6.9	7.3	7.9	7.2
Winterturf I	40	6.6	6.3	6.7	6.9	6.6
CBS Blend	40	6.8	6.1	6.6	6.5	6.4
Medalist 5	40	6.5	6.2	6.5	6.9	6.4
Medalist 300	29	6.6	6.1	6.8	6.5	6.4
702 (50% Caravelle + 30% Derby + 20% Pennfine)	40	6.7	6.0	6.3	6.6	6.4
50% Diplomat + 50% Yorktown	40	6.6	5.7	6.4	7.2	6.3
Medalist 200	32	6.4	6.0	6.5	6.6	6.2
70% Yorktown + 30% Jamestown	35	6.4	5.9	6.3	6.6	6.2
Dixiegreen	40	6.3	6.0	6.0	6.7	6.2
70% CBS + 30% Syn W	35	6.3	5.9	6.2	6.3	6.1
70% Birdie + 30% Banner	35	6.4	5.6	6.2	6.5	6.1
60% Yorktown + 40% Jamestown	35	6.3	5.8	5.9	6.9	6.1
703 (60% Caravelle + 40% Highlight)	35	6.2	5.8	6.2	6.3	6.1
Medalist 400	38	6.0	5.8	6.2	6.6	6.0
70% Diplomat + 30% Jamestown	35	5.8	5.5	5.8	6.3	5.7

[1]Visual rating of 9-best and 0-poorest; December 1, 1977 to March 31, 1978.

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

II WEAR TOLERANCE STUDIES:

Traffic is projected to be an increasing problem on turfs because of the greater intensity of use on park, resort, sport, and recreational areas. The two major effects of traffic are (a) the above ground bruising and tearing of turfgrass shoots termed wear, and (b) the below ground "hidden effect" of soil compaction. Turfgrass wear results from the pressure of traffic crushing the leaves, stems, and crown tissues of the grass plant.

A wear simulator was designed and constructed by Beard and associates in 1972 under a grant from the United States Golf Association Green Section. Test comparisons revealed this wear simulator could separate turfgrass wear from soil compaction; could be operated on a samll plot experimental basis; and could distinguish the relative wear tolerances within species, cultivars, and specific turfgrass cultural practices.

The wear simulator is constructed to rotate around a pivotal center point with an adjustable diameter of up to 8 feet. The center pivot is anchored by four steel rods and is also the connecting point for the electrical source required for the 0.25 hp motor which drives the wear wheel. Two types of wear stress can be stimulated by this unit. One involves a 4 by 8 inch pneumatic tire which exerts a pressure of 1 psi on the turf. In addition, a weighted metal sled is attached to the wear simulator and applies a pressure equivalent to 2 psi. This weighted sled device more nearly simulates the sliding, twisting action of foot traffic.

Research Procedure. The establishment procedures, subsequent cultural practices, and soil conditions during the coarse of this experiment have been described. The wear simulator was utilized during the winter of 1978 to evaluate the comparative wear tolerance of 47 turfgrass cultivars in monostands and species polystands. The simulator applied 500 revolutions of wear stress over 4 plots per run. Each of three replications were stressed separately during a 4 day period. There was no visual evidence of disease or insect damage on the turf at the time the wear stress was applied. The wear tests were conducted during the second and third weeks of March. This was somwehat later than would be desirable but was necessitated because most of the overseeded treatments were dormant, brown, and inactive through the extremely cold winter of 1978 with green-up and active growth not occurring until after February 20. Then several weeks of rainfall occurred before conditions were favorable to conduct the winter stress experiments. A similar test was conducted during the winter of 1977 during February. Visual estimates of percent verdure (green shoots) remaining were made (a) immediately after wear application, (b) three days after wear treatment, and (c) two weeks later.

Results. The comparative wear tolerance of 16 perennial ryegrass cultivars after 500 revolutions of the wear simulator is shown in Table 4. As a group, the improved turf-type perennial ryegrass cultivars have superior wear tolerance compared to the fine leafed fescue, rough bluegrass, and creeping bentgrass cultivars. As has been observed in the case of overall winter turf performance, there is not a great deal of difference among many of the recently released turf-type perennial ryegrass cultivars in terms of wear tolerance.

In both years, Caravelle perennial ryegrass has ranked at or near the top in overall wear tolerance. Cultivars consistently ranking inferior in wear tolerance during the initial two years of the test evaluations include NK-100, Linn, NK-200, Pelo, and Eton.

Comparative wear tolerance among the find leafed fescue, rough bluegrass, and creeping bentgrass cultivars is shown in Table 5. This group of cultivars is definitely inferior in wear tolerance to the perennial ryegrasses. In both years, Kensington chewings fescue has ranked at or near the top in wear tolerance.

In both years, Pennlawn, Wintergreen, and Centurian have ranked decidedly inferior in wear tolerance to the other fine leafed fescue cultivars. It should be indicated that the fine leafed fescues have exhibited better comparative wear tolerance in winter overseedings on dormant bermudagrass turfs, than they have in higher cut monostands maintained under lawn conditions in Michigan. Also, the winters of 1977 and 1978 have been unusually cold which causes the fine leafed fescues to be inferior compared to the perennial ryegrasses. Perhaps a warm-dry winter such as 1976 which favored the fine leafed fescues compared to the perennial ryegrasses would also improve the wear tolerance.

Between the two rough bluegrasses (Poa trivialis) Sabre has consistently ranked superior to Denmark (Common) in both years. Among the creeping bentgrasses, Penncross ranked higher than Seaside and Emerald in wear tolerance. Penncross exhibited improved wear tolerance during the March wear tolerance tests, whereas in the previous year Penncross ranked considerably lower during the February wear stress evaluations. This is associated with its superior spring growth and inferior early winter establishment and performance.

Among the mixtures and blends a large number have performed well with no significant differences (Table 6). Similar results have been observed in terms of overall turfgrass quality and winter performance. Plans call for the more wear tolerant cultivars from this study to be combined into specific mixtures to determine if such polystands exhibit superior wear tolerance to the commercially available seed mixtures and blends.

There are some distinct variations in cultivar performance between the initial two years results. This can be partially explained because the wear simulation tests were conducted at different times during the winter growing season because of weather conditions. This could have an effect on the comparative performance among cultivars. These experiments will be conducted for a final third year which should help in clarifying this situation.

Table 4. Percent verdure[1] remaining after 500 revolutions of the wear simulator on sixteen perennial ryegrass cultivars overseeded on dormant bermudagrass. March, 1978. College Station, Texas.

Perennial Ryegrass Cultivar	Type of Wear Simulation	
	Wheel Wear	Sled (foot) Wear[2]
Citation	78.3	86.7
Caravelle	86.7	78.3
Derby	66.7	75.0
Omega	76.7	75.0
Loretta	81.7	73.3
Manhattan	76.7	73.3
Pennfine	60.0	71.7
Diplomat	70.0	68.3
Pelo	65.0	66.7
Birdie	66.7	66.7
Yorktown II	70.0	65.0
Regal	78.3	65.0
Eton	61.7	63.3
NK-200	50.0	50.0
Linn	48.3	46.7
NK-100	56.7	43.3

[1]Visual estimate of percent green shoots remaining three days after wear application. Average of three replications.

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

Table 5. Percent verdure[1] remaining after 500 revolutions of the wear simulator on fifteen non-ryegrass cultivars overseeded on dormant bermudagrass. March, 1978. College Station, Texas.

Cultivar and Species	Type of Wear Simulation	
	Wheel Wear	Sled (foot) Wear[2]
Kensington chewings fescue	48.3	73.3
Penncross creeping bentgrass	55.0	68.3
Sabre rough bluegrass	53.3	60.0
Ensylva red fescue	48.3	58.3
Jamestown chewings fescue	55.0	56.7
Seaside Creeping bentgrass	48.3	53.3
Denmark (common) rough bluegrass	30.0	53.3
Dawson red fescue	41.7	50.0
Highlight chewings fescue	20.0	45.0
Syn W chewings fescue	33.3	45.0
Emerald creeping bentgrass	40.0	43.3
Wintergreen chewings fescue	41.7	41.7
Pennlawn red fescue	26.7	40.0
Atlanta chewings fescue	30.0	36.7
Centurian hard fescue	21.7	21.7

[1]Visual estimate of percent green shoots remaining three days after wear application. Average of three replications.

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

Table 6. Percent verdure[1] remaining after 500 revolutions of the wear simulator on sixteen polystands overseeded on dormant bermudagrass. March, 1978. College Station, Texas.

Seed Mixture or Blend	Type of Wear Simulation	
	Wheel Wear	Sled (foot) Wear[2]
Dixiegreen	63.3	86.7
Medalist 400	78.3	83.3
Medalist 5	75.0	81.7
Winterturf I	71.7	78.3
Medalist 300	78.3	78.3
70% Diplomat + 30% Jamestown	65.0	76.7
703 (60% Caravelle + 40% Highlight)	68.3	75.0
50% Diplomat + 50% Yorktown	71.7	71.7
60% Yorktown + 40% Jamestown	63.3	68.3
702 (50% Caravelle, 30% Derby, + 20% Pennfine)	65.0	66.7
80% Dixiegreen + 20% Sabre	68.3	66.7
Medalist 200	55.0	65.0
70% Birdie + 30% Banner	65.0	63.3
70% Yorktown + 30% Jamestown	65.0	60.0
CBS Blend	56.7	58.3
70% CBS + 30% Syn W	36.7	38.3

[1]Visual estimate of percent green shoots remaining three days after wear application. Average of three replications.

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

SURFACE ROLL CHARACTERISTICS STUDIES:

The uniformity and speed of close cut greens used in such sports as golf and lawn bowling is an important concern. Information is lacking concerning the comparative surface quality characteristics of overseeded cool season turfgrass cultivar monostands and polystands

Research Procedure. This experiment utilized an inclined plane with ball release at the upper end which produced a known initial momentum of ball roll for use in the evaluation of surface quality characteristics. The apparatus had a tripod support stand with adjustable legs to achieve the desired degree of leveling on all sites. The actual test procedure consisted of measuring the distance of ball roll in two opposite directions over the same surface area. Three individual opposing direction tests were conducted over each of three replications, giving a total of nine. The data are expressed in terms of distance of ball roll in inches for the average of two opposing directions.

The establishment procedures, subsequent cultural practices, and soil conditions during the course of this experiment have been described. The experiments were conducted on six different days. The repeatability from one experiment to the next was excellent which gives good confidence to the results reported herein. The only question that could rise is whether these relative rankings would shift depending on the particular season of the year.

Results. Citation, Regal, Derby, and Caravelle perennial ryegrasses, in that order, were the top ranking in terms of distance of ball roll (Table 7). Among the monostands, the perennial ryegrasses as a group ranked superior to the fine leafed fescues, creeping bentgrasses, and rough bluegrasses.

Among the fine leafed fescues Highlight ranked highest, being in a comparable range with a number of the perennial ryegrasses and polystands. Pennlawn, Jamestown, and Dawson ranked very low in distance of ball roll. These results might be surprising to many. However, an examination of the fine leafed fescue monostands evaluated reveals that although they are extremely uniform and dense, the leaf blades are quite stiff in comparison to the perennial ryegrasses. This may be a partial explanation for the slowness of ball roll of this particular species shown in these experiments. Also, the winter of 1978 was unusually cold which restricted the shoot growth of the fine leafed fescues. As a result some annual bluegrass invasion did occur which could impair the ball roll distance. Annual bluegrass encroachment did not occur during the warm-dry winter of 1976. Similar results were obtained with Sabre rough bluegrass which ranked in the lowest category with three of the fine leafed fescues.

Emerald ranked highest among the creeping bentgrasses, Penncross intermediate, and Seaside quite low in distance of ball roll. This was the case even though these experiments were run in mid-March when the creeping bentgrasses were performing better than any other time during the winter growing season.

Of the polystands evaluated, most ranked in the intermediate grouping. The most striking observation drawn from these results is that the polystands as a group ranked inferior to monostands of perennial ryegrass cultivars. The basic explanation for these results is unclear at this time, although the differences in leaf texture, growth habit, and leaf blade stiffness may be contributing factors.

This study will be repeated during the upcoming year at several different times during the growing season to assess the seasonal variability in surface quality characteristics, assuming weather conditions permit. From these results some final conclusions can be drawn regarding surface characteristics of closely mowed turfs.

Table 7. The cool season species and cultivar influence on the surface quality of closely mowed (0.25 inch) winter overseeded bermudagrass as measured by distance of ball roll. College Station, Texas.

Cultivar & Species	Average Distance of Roll (inches)[1]
Citation pr	85.5 [2]
Regal pr	84.6
Derby pr	83.9
Caravelle pr	83.2
Pennfine pr	82.1
NK-200 pr	80.2
Manhattan pr	79.2
Dixiegreen mx	78.3
Yorktown II pr	78.2
CBS Blend prb	78.1
Pelo pr	77.8
Omega pr	77.0
Highlight cf	77.0
Winterturf I mx	76.7
Diplomat pr	75.9
Eton pr	75.6
Medalist 200 mx	75.6
Medalist 5 prb	74.6
Medalist 400 mx	74.0
Emerald cb	72.9 [3]
Linn pr	72.4
Medalist 300 mx	72.2
Loretta pr	72.1
Penncross cb	70.5
NK-100 pr	69.8
Birdie pr	69.7
Pennlawn rf	69.4
80% Dixiegreen mx + 20% Sabre rb	67.9
Sabre rb	67.8
Seaside cb	67.4
Jamestown cf	67.3
Dawson rf	65.0

LEGEND:
- pr - perennial ryegrass
- cf - chewings fescue
- rb - rough bluegrass
- cb - creeping bentgrass
- mx - mixture
- prb - perennial ryegrass blend
- rf - red fescue

[1]Average of three replications.
[2]Values joined by the same line are not significantly different at the 5% level for Duncan's Multiple Range Test.
[3]Lines continued in right hand column.

CONSTRUCTION AND MAINTENANCE OF ATHLETIC FIELDS IN EUROPE

by

James B. Beard*

INTRODUCTION

In many aspects, the application of existing technology to the maintenance of sports turfs is more advanced in Northern Europe than in North America. This is true in spite of the fact that a great amount of the basic principles and information on which these practices are based has been generated from research conducted in the United States. Much of this can be attributed to poor decisions made by those responsible for establishing budgets and specifications concerning sports field construction and maintenance. The two major areas where drastic errors occur are: (1) failure to provide a proper root zone for turfgrass culture in terms of optimum drainage and minimum compaction proneness and (2) a tendency to employ inexperienced, untrained personnel to supervise the maintenance of these sports fields. This is done with the false hope that money can be saved by hiring the cheapest man available. In most cases a knowledgable, properly trained individual can more than pay for his higher salary through proper decision making processes which will provide the best functioning, highest performing sports turf at the lowest possible cost. One of the major distinctions between North America and Northern Europe is that there is a grand tradition of professional grounds maintenance personnel who have devoted their lives to the field and have "come up" through the ranks as apprentices and have sought out the available educational opportunities. A similar system exists in golf course operations in the United States, but the U. S. is decidedly deficient in the area of qualified sports grounds maintenance personnel.

CHARACTERISTICS DESIRED FOR SPORTS FIELDS

As a basis for the following discussion it is important to recognize those characteristics which are of most concern in developing a turfed sports facility which will provide the best possible playing conditions for the particular game involved. The major characteristics generally include the following:

1. Moderately close mowing of 0.5 to 1.2 inches.

2. Firm footing.

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3. High shoot density.

4. Good wear tolerance.

5. Tolerance to the action of cleats and spikes.

6. Good recuperative rate from divot damage.

7. A moderate resiliency or cushion.

8. Uniform, level surface.

9. Rapid removal of excess water.

The cutting height employed on soccer fields in Europe is generally considerably shorter than that practiced in the United States. No doubt as the game continues to increase in popularity and we become more sophisticated in the techniques of soccer play, the shorter cutting height will be recognized as being of increased importance to the game in North America. A number of the subsequent criteria listed relate to traffic effects and recovery from traffic stress. The effect of resiliency or cushion is important in terms of minimizing injury to participants caused by falling on the turf surface as well as to cushion the shock effect to players legs when running upon the surface. Rapid removal of excess water, both by surface runoff and subsurface drainage, is extremely important in terms of maintaining a quality, playable surface since many sporting events are continued regardless of the weather conditions. The excess water removal also minimizes the chance of mud problems developing.

CHARACTERISTICS DESIRED IN TURFGRASSES FOR SPORTS FIELDS

Relatively few turfgrass species are well adapted for sports turf use. Characteristics desired include the following:

1. A low, prostrate growth habit and tolerance to close mowing.

2. Excellent wear tolerance.

3. Good recuperative rate.

4. Uniformity.

5. No surface runners (stems) which can entangle cleats.

Fortunately we in Texas have bermudagrass (*Cynodon* spp.) which is one of the better adapted turfgrasses for use on sports fields for such recreational activities as soccer, football, softball, and baseball. Bermudagrass possesses outstanding wear tolerance, a rapid recuperative potential, and tolerance to close mowing, which are particularly desirable traits. A potential limitation is the restricted late fall shoot growth and recuperative potential caused by the bermudagrass entering dormancy due to mid to late fall low temperature stress.

SPORTS FIELD CONSTRUCTION

The foundation of successful, efficient turfgrass culture on intensively trafficked sports fields is a root zone soil mix of sufficiently coarse texture so that rapid downward internal drainage of excess water will not be impaired and thus minimize proneness to soil compaction. The typical scenario in sports field construction in the United States is to spend generous sums of money on the construction of a stadium, but at the same time, try to find the cheapest "dirt" available for the sports field itself. Within the last 8 to 10 years the northern Europeans have awakened to the need for coarse textured root zones in order to achieve a favorable environment for turfgrass culture. Investigations have been conducted by the Europeans utilizing a wide range of synthetic soil amendments with little success. A sand of the proper particle size distribution range still remains the most widely available material for use in root zone modification of sports fields. Unfortunately, the Europeans do not have easy access to a physical soil analysis lab as in the United States and particularly in Texas since the main laboratory for this type of work is located at Texas A&M University under the direction of Dr. Kirk Brown.

Fortunately, we in the United States are also seeing an encouraging awakening of the "directors" of sports grounds to the need for root zone modification. Much of this seems to be related to the backlash from the high cost of artificial turfs. Suddenly, the amount of expenditure required to construct a sports field with the proper root zone for optimum turfgrass culture does not look prohibitive when compared to that required for an artificial surface. Still, all too many fields in the States are being constructed with impermeable root zones of high compaction proneness. Continual educational efforts will be needed to correct this problem. Fortunately, more progress is mow being made than at any time in the past.

There are two other key aspects in sports field construction that are required to insure adequate drainage. They include (1) a properly designed subsurface drain line system and (2) a sufficient surface contour or grade to allow rapid removal of excess surface water.

SPORTS TURF CULTURE

Assuming the proper turfgrass species has been selected and the appropriate root zone, surface contours, and subsurface drainage system provided; then the subsequent cultural practices utilized will be simplified and of lower cost.

Mowing. The specific cutting height selected will range from 0.5 to 1.2 inches, depending on the particular turfgrass species involved and the type of sports activities for which the turf is to be utilized. Bermudagrasses respond quite well to cutting heights in the 0.5 to 1.0 inch range, whereas the Kentucky bluegrasses and perennial ryegrasses should be mowed somewhat higher. Raising the cutting height of the latter species during the off-season will enhance the recuperative rate of badly thinned areas. However, the cutting height must be lowered back to the desired height for the playing season and should be achieved in gradual increments initiated sufficiently early so that the adjustment can be achieved with minimum negative effects on the turf. Soccer fields should be mowed lower than football fields for optimum playability. The European sports fields are maintained at a closer mowing height than those in North America. As a result, a relatively high population of annual bluegrass is present in many of the fields, particularly where soil drainage is poor.

Clippings do not need to be removed if the turf is mowed at a sufficiently frequent interval so that the individual clippings readily fall down through the turf into the zone of decomposition. A mowing interval of 1 to 2 times per week may be required during periods of rapid shoot growth, with the greater frequency required on the more intensively maintained sports fields having a close cutting height, frequent irrigation, and high nirtogen nutritional level. The careful planning and execution of mowing patterns to give an attractive visual appearance is widely practiced almost as an art form on a number of European sports fields. Many types of checkerboard and linear patterns can be obtained which give the spectator a very favorable impression of the sports facility.

Fertilization. In comparing fertilization practices between North America and Europe there is not a great deal of difference in the basic principles involved. Adequate phosphorus and potassium levels are maintained based on soil tests. In terms of nitrogen nutrition, there is a tendency for Europeans to fertilize their sports fields with lighter amounts applied at more frequent intervals than is practiced in the United States. An important principle to keep in mind is that there is a minimum level of nitrogen needed to maintain good overall health and vigor. At the same time, there is always the potential problem of a restricted root system and sod strength due to the application of excessive amounts of nitrogen fertilizer. This can be due to the nitrogen applications being made at too high an annual rate or too much in any one single application. Slow release forms of nitrogen are receiving considerable interest in Europe as is the case in the United States. Iron deficiences are generally not as great a problem in Europe as in those parts of Texas where alkaline soil conditions exist.

Irrigation. The irrigation of sports fields is not as critical a need in Europe as in Texas. If anything, too much water is a greater problem than too little. As a result, the sophistication of the irrigation systems that are being utilized is not at the level found in parts of the United States, including Texas. It is important to schedule irrigation timings such that the field is relatively dry just prior to scheduled dates for individual sporting events. High soil moisture contents during periods of anticipated intense traffic only increase the potential for soil compaction. This dimension of sports turf culture is of most concern on soils having a relatively high clay content, which is not uncommon in Texas unless root zone modification has been accomplished.

Pest Control. Those responsible for sports turf maintenance in Europe are faced with weed, disease, and insect problems just as we experience in North America. The specific causal species need not be discussed as thay vary considerably from those occurring in Texas. However, it should be mentioned that a national law exists in the Netherlands which prohibits the use of most herbicides on public recreational and sports turfs. This situation emphasizes the value of the turf manager in selecting and executing turfgrass cultural systems that will provide maximum competition by the desired turfgrass species in order to minimize the invasion of potential weed problems.

MINIMIZING TRAFFIC EFFECTS

The effects of traffic include (a) turfgrass wear or the above ground bruising and thinning of the turf, (b) soil compaction which is a "hidden", below ground increase in soil density, and (c) divoting of the turf caused by the twisting and turning action of cleated shoes. Preventive and corrective approaches that can be used in minimizing these traffic effects include:

1. Use of a coarse textured (sandy) root zone.

2. Provisions for rapid removal of surface water.

3. Providing as dry a turf and root zone as is practical during periods of intense play.

4. High shoot density.

5. High potassium level.

6. Moderate to minimal nitrogen level.

7. Soil cultivation by coring or slicing as needed.

8. Capability of alternating play between several sports fields, as dictated by the degree of turfgrass wear.

9. Constant, open communications with coaches and recreation personnel concerning your approaches and objectives in relation to their needs.

Compaction is best prevented by means of a coarse textures root zone combined with an adequate subsurface drain line system and proper surface contours to insure rapid removal of surface water. Unfortunately, budgets are not abiliable to provide the desired degree of root zone modification on all sports fields. In this situation where a compaction problem has developed on a fine textured soil, it may be necessary to utilize turfgrass cultivation techniques. This typically involves either coring or slicing. Both are generally preferred to spiking due to the deeper penetration and greater degree of lateral shattering than can be achieved. Keep in mind that soil compaction is most severe in the surface 2 to 3 inches. The frequency of soil cultivation will vary depending on the intensity of traffic and degree of compaction that is developing. It may range from once a year immediately following the playing season to monthly intervals throughout the offseason. Soil cultivation is widely practiced on most European sports fields. The need for soil cultivation can be assessed by means of two primary indicators. One is a lack of surface resiliency indicated by a hard feel when walking over the area and difficulty in pushing a soil probe into the soil surface. A second very good indicator is a declining rate of water infiltration into the soil, providing the same rate of irrigation water application is being provided. Soil cultivation is best accomplished when the soil is moist, but not water saturated; the intensity of use is low; and the week invasion potential is minimal.

Insuring a relatively dry turf and root zone during periods of intense play through the proper timing of irrigations is very beneficial in minimizing soil compaction problems. In large stadiums the effective use of tarps can also be very important in insuring a dry root zone during scheduled sporting events. Both approaches will minimize compaction proneness and the chance that mud problems will develop.

Maximum turfgrass wear is achieved by providing a high shoot density or a large a surface biomass as is practical. In addition, providing high levels of potassium and modest to minimal levels of nitrogen during the actual playing season can be important contributing factors in enhancing wear tolerance.

A very significant difference between Europe and the United States in their approaches to minimizing traffic effects is the use of alternate fields. The municipal planners in Europe have been much more forward thinking in terms of providing adequate outdoor recreational surfaces for the general public. For example, in Yugoslavia a minimum of 8 square meters of outdoor green area must be provided per resident, while in Sweden national law dictates a minimum of 4 square meters per resident. Thus, the number of fields available for sporting activities per participant or team is much greater and also allows the turfgrass manager to alternate events between fields. It allows a periodic resting period as needed so that the turf can recover before the wear becomes so great that the turf is thinned beyond a point of recovery without extensive renovation.

Providing facilities so that fields can be alternated is viewed as a "luxury" by some U. S. parks and recreational leaders. Isn't it better to invest money in providing adequate, quality recreational facilities for our youth in densly populated urban areas rather than forcing them on the streets where the atmosphere is conducive to criminal activities which are detrimental to society? Would it not be better to invest in recreational facilities of adequate quality to prevent development of a criminal rather than spending that money on maintaining prisons or "corrective institutions" for such individuals? Obviously, we have a lot to learn from the Europeans from this standpoint. This approach of alternating sports fields may be one of the key reasons that Europeans tend to be more successful in maintaining adequately turfed sports fields in comparison to the typical situation found throughout the United States if bare soil existing from the mid-point of the season onward. Obviously we in the United States have a long way to go in this regard.

CORRECTING TURFGRASS WEAR AND DIVOT DAMAGE

It is a widespread practice in Europe to continually replace divots and/or overseed these damaged areas immediately after each sporting event. Such an approach is used much less commonly in the United States. There are many sports fields in North America which would benefit from such a program.

THE CURRENT TAMU TURFGRASS PHYSIOLOGY AND CULTURAL RESEARCH PROGRAM TO ENHANCE THE CONTRIBUTIONS OF TURFS TO OUR QUALITY OF LIFE

by

James B. Beard*

Lawn turfs evolved in England during the 13th century, and by the 16th century were in comparatively widespread use as a major component of ornamental gardens and on village greens for recreational activities. Similar turfs were also being used in the 16th century in Austria, France, Germany, and the Netherlands. From that time, the types of grasses and cultural techniques utilized in turfgrass culture have steadily expanded. Today, turfs are widely used throughout the industrialized nations of the world to provide a more favorable environment for human activities.

For many years turfs were considered simply ornamental surfaces. However, turfs and other forms of green vegetation actually make many contributions to the quality of life in functional, recreational, and ornamental ways.

TURF FUNCTIONS

Turfs make significant functional contributions to the quality of life in seven distinct areas.

Soil Erosion Control through use of grasses is by far the most effective and least costly method available to stabilize soil against loss by water erosion, whether it be on a roadside, park, lawn, ditch bank, institutional ground, or ski slope.

Dust Stabilization value of an established lawn is well known to those who have lived in a newly-constructed house. Wind-blown dust can permeate a house or other building decreasing comfort and increasing cleaning problems.

Heat Dissipation is a valuable by-product of green, actively-growing grasses which release water to the atmosphere by transpiration. This conversion of water from liquid to vapor requires energy and, in effect, cools the leaf surface. This process significantly dissipates heat, and is particularly valuable in urban areas where there are high concentrations of hard surfaces that absorb and radiate heat. Transpirational cooling effects from turfs during midday may be as great as 8 to 12 degrees. A football field of natural turf can have a cooling capacity of a 70-ton air conditioner, while temperatures exceeding 150 degrees F have been monitored on artificial turfs. A 100 X 60

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foot lot covered with turf can equal 10 tons of air conditioning.

Noise Abatement is helped by turfs, plus surrounding tree and shrub vegetation. Properly placed, vegetation can decrease the noise level by 15 to 45 percent at a distance of 30 to 70 feet along intensely-trafficked urban freeways.

Glare is reflected incident sunlight. Turfgrasses have a low-level, diffuse reflection that causes nominal glare and associated eye discomfort in contrast to relatively smooth surface such as snow, sand, and many types of hard surfaces on buildings, streets, and sidewalks.

Safety is enhanced by the higher cut turfs along roadsides which aid in safer emergency stoppage of vehicles. Similarly, turfs on recreational sports fields provide a cushion which reduces the shock and potential injury to players.

SPORTS - BEAUTY - HEALTH

Perennial grasses maintained under turf conditions provide low-cost, attractive surfaces for numerous outdoor leisure, recreational, and competetive sport activities such as baseball, croquet, field hockey, football, golf, lawn bowling, lacrosse, rugby, skiing, and soccer.

The quality of life is improved significantly through the beauty of turfs, particularly when grown is combination with flowers, shrubs, and tree plantings in a total landscape concept. A more favorable, harmonious environment and improved mental health are important benefits of turfs, particularly to people living in high density urban areas.

THE INDUSTRY

The monetary value of these turfgrass benefits to Texans would be difficult to assess. However, the annual cost for maintaining the 3.1 million acres of turf in Texas is estimated to be $640 million. Home lawns represent the major form of turfgrass usage, but the increase throughout the State is also associated with allied human activities on the grounds of businesses, industrial complexes, parks, public institutions, recreational areas, highways, schools, churches, cemeteries, golf courses, and military installations. Thus, turfs form an often unnoticed background for most of our day-to-day activities.

TURFGRASS RESEARCH NEEDS

Improved turfgrasses and cultural practices are a "must" for the future. Continued concentrations of people in urban areas with less mobility to outlying locations and increased leisure time result in greater use of the limited recreational and green-belt areas in and near urban centers. Researchers at the Texas Agricultural Experiment Station are involved in developing improved turfgrasses and cultural practices that will require minimal maintenance in terms of costs, water requirements, and energy demands, but at the same time will retain the valuable functional, recreational, and ornamental benefits.

Research at Texas A&M University is aimed at identifying specific characteristics that are reliable predictors of tolerance to environmental stress such as low temperature kill, drought and turfgrass wear. These characteristics can then be used as biological markers to speed up the selection processes in breeding programs. Cultural requirements of individual grass selections in terms of nitrogen fertility level, water use rate, and mowing frequency also are being studied.

Highly trafficked areas of sport fields, parks, and recreational areas require more sophisticated, intensive maintenance. Therefore, cultural systems that maximize tolerance to traffic, especially turfgrass wear, are being investigated, as is the identification of cultural procedures and turfgrass selections that will maximize the rate of recuperation on sites where turfgrass wear is very intense.

This step-by-step research moves us closer to the goals of effective turf at minimal cost for satisfying the functional, recreational, and aesthetic needs of Texans.

I. Environmental Stress Investigations:

1. Study the water use rates of turfgrasses - with initial emphasis on the influence of stomata and canopy structure on water loss from St. Augustinegrass.

2. Adaptation studies of St. Augustinegrass and tall fescue to three shade adpated environments as affected by mowing and nitrogen regimes.

3. Fatty acid composition in the mitochondria of C-4 perennial warm season grasses as related to low temperature stress - the ultimate objective being the identification of a quick method to screen for low temperature hardiness.

4. Determine the components contributing to drought resistance of grasses, with initial emphasis on rooting.

5. The identification of a biochemical marker for predicting wear tolerance which could be utilized in a turfgrass breeding program.

6. Elucidation of the causal mechanism involved in the spring root die-back phenomena of warm season turfgrasses.

II. Cultural Investigations:

1. Bermudagrass cultural study - nitrogen level x cutting height interactions for sports turfs and the effect on thatch formation.

2. St. Augustinegrass lawn fertilization study - nitrogen rate x timing x carrier interactions in relation to maximizing nitrogen efficiency.

3. Shade turf cultural study - species x cutting height x nitrogen systems assessment.

4. Effects of nitrogen nutrition on root growth of bermudagrass - including nitrogen level x root growth x carbohydrate reserve interactions.

5. Study implications of the spring root die-back phenomena on the major turfgrass cultural practices.

6. Establish cultural techniques to enhance sod transplant rooting.

7. Development of a prediction equation for the timing of fall winter overseeding on dormant bermudagrass.

III. Cultivar Characterization and Adaptive Studies:

1. Evaluate the comparative wear tolerance among and within turfgrass species - bermudagrass, zoysiagrass, St. Augustinegrass, tall fescue, and the winter overseeded cool season turfgrasses.

2. Conduct shade adaptation characterizations of the commercially available tall fescue and St. Augustinegrass cultivars.

3. Bermudagrass, zoysiagrass, and St. Augustinegrass cultivar characterization at four nitrogen levels, with emphasis on a low nitrogen requirement.

4. Evlauation of the commercially available winter overseeded cool season turfgrass cultivars in monostands and polystands.

5. Development of a technique for the identification of perennial ryegrass, bermudagrass, St. Augustinegrass, and zoysiagrass cultivars by disc gel electrophoresis of protein extracts.

IV. St. Augustinegrass Improvement:

Will utilize the collection of St. Augustinegrass selections planted at the TAMU Turfgrass Field Lab in:

1. Assessing the components of turfgrass quality - including shoot density, leaf texture, uniformity, and vertical shoot growth rate.

2. Screening the selections for low temperature hardiness using the recently developed cold stress simulation chamber and associated techniques.

3. Screening the selections for adaptability to establish, form a turf, and grow under tree shade stresses.