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F O R E W O R D

We wish to take this opportunity to thank those who had a part in conducting the 23rd Texas Turfgrass Conference. This marked another year in which we had a record attendance.

The program was designed to include information for all phases of turf. Appreciation is extended to the speakers who prepared the talks and made the publication of these Proceedings possible.

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TIFDWARF MANAGEMENT TO INCLUDE INSECT CONTROL

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The history of Tifdwarf has been written several times but a recap of its origin should be given here for clarity of its management requirements. The first plug was taken in 1961 from a grass expanding in greens where Tifgreen was under stress or not doing well. Such a green was #12 at the Florence Country Club in Florence, South Carolina. A second area was in #2 green at Sea Island, Georgia on the Plantation Course. The green is very small and the Tifgreen would thin out each year in July and August but the Tifdwarf was expanding each year. A plug from this green was taken to Tifton by Marion McKendree, Superintendent at Sea Island Club, in the spring of 1962. A third plug came from #6 green at Glen Arven Country Club in Thomasville, Georgia in 1962 where the green was infested with a high population of nematodes. The private company that increased this plug felt the grass was nematode resistant and this is one reason Jimmy Jackson selected it for his company at that time.

It should be pointed out that Tifdwarf was first observed and was outstanding during stress periods of growth for Tifgreen.

Other selections in the Florence, South Carolina #12 green have been made but so far none have shown superiority to Tifdwarf.

Tifdwarf was under research with Tifgreen for 3 years before release could be made. All research was in comparison with Tifgreen which is a probable cause of confidence of its performance.

If you have Tifgreen on all greens and are satisfied with its performance, do not change to Tifdwarf as it is not a miracle grass; however, it has been equal or superior to Tifgreen in all comparisons of research conducted by Dr. Glenn Burton and his staff at the Georgia Coastal Experiment Station in Tifton.

Some feel that Tifdwarf was released too soon, and that it was not thoroughly researched but results before it was released show that it was equal or superior to Tifgreen in all required putting green characteristics. At the present time, more than 2,000 greens have been planted with Tifdwarf.

As with most grasses, there is some reluctance to use a new grass when some turf managers are having trouble with one that was released ten years ago. There is no number for Tifdwarf, but "Tif" is an abbreviation of Tifton and "dwarf" describes its small size.

The maintenance of Tifdwarf is often compared with Tifgreen. Tifdwarf will actually do better under Tifgreen maintenance than Tifgreen under Tifdwarf for the best putting surface program.

One problem with Tifdwarf was noticed very early and that was its affinity to sod webworms. No doubt the dark green color attracted the moths and they dropped eggs where they knew the life cycle would flourish, and do they flourish unless an insecticide is used for control.

The dark green color is an outstanding characteristic of Tifdwarf, but during cold weather, it turns a purplish color that some find unattractive. Although, it goes off color easily, it seems to be slightly more winter hardy than Tifgreen in tests conducted by Dr. A. A. Hanson and Dr. Felix Juska in the USDA turf plots at Beltsville, Maryland.

Observation this spring, has shown that Tifdwarf responds in a similar manner to Tifgreen under poor drainage conditions, cold weather, and heavy traffic. It begins to recover from winter dormancy about 10 to 11 days earlier than Tifgreen. It should be overseeded for putting green use if the location is subject to frost or has temperatures slightly above frost.

Greens should be properly constructed for best results regardless of the type of grass used and merely changing the grass species will not always solve the problem. If drainage is not adequate, it must be improved. Many times a local sandy loam will be satisfactory and can result in a big saving to the club. Tifdwarf reacts the same as Tifgreen in that proper construction is necessary for best results.

Planting rates vary greatly, from 4 to 15 bushels per 1,000 square feet. Since the component parts of the grass are so small, a square yard of sod will plant a much larger area than other bermudagrasses. For the first 3 weeks, Tifdwarf seems to compare with Tifgreen in its development; however, unless forced with high rates of nitrogen (3 to 4 pounds of N per 1,000 square feet per month), it soon slows down in its growth process.

A pH of 6.0 to 6.5 is desirable but the grass will tolerate a much wider range.

At first, 1 to 2 pounds of N per 1,000 square feet, along with adequate phosphorus and potassium was considered sufficient. Now some of the best playing surfaces are receiving more nitrogen, especially during the early developmental stages. Tifdwarf has responded to more constant and complete fertilization than Tifgreen and 4-1-2 ratio is most desirable. It can be a low maintenance grass in that a greener color can be kept with less fertilizer, but the most enthusiastic users of Tifdwarf suggest higher rates for best results.

The grass grows so close to the ground that minimum topdressing is required to true the surface, and do not topdress too heavily or overlap as you will retard growth. Soil free of weed seed should be used at all times. Do not overwater, using only enough irrigation to prevent wilting. A knowledgeable use of water can mean the difference in good turf, even with Tifdwarf.

Since the grass grows so close to the ground, Tifdwarf can be mowed at 3/16" all summer without turning off-color as Tifgreen often does. In some cases, it has been mowed at 2/16" and the better golfers like it at this height. However, the green surface must be perfectly smooth or scalping will surely result. Tifdwarf will provide putting surfaces second to none at 2/16" cut, but it must be mowed at least 5 to 6 times per week and the cup changed frequently if traffic is heavy. If the cup is not changed often, traffic causes off-colored areas and roughness that takes too long for recovery.

The high handicapper does not necessarily like the fast, 2/16" green as the ball can easily be putted right off the putting surface.

There will be about half as many clippings from Tifdwarf as from Tifgreen which is the main reason why so many clubs mow only 3 times per week. This saves much time and has a great advantage where week-end labor is a problem. More leaves are left on the grass than with Tifgreen which accounts for the more numerous roots when compared to Tifgreen under the same conditions.

The greens should be cut very lightly with a vertical mower once per week or this operation can be delayed if brushes or combs are used regularly on the greensmowers.

A strong vigorous grass is one of the best defenses in weed control, and Tifdwarf is no exception. Its response is very similar to that of Tifgreen in susceptibility to herbicides.

Overseeding is similar to other grasses. For best results the seeds need to be in contact with the soil before topdressing. Small seed, such as bluegrasses, bents, and creeping red fescue are satisfactory but ryegrass has not caused a real concern except for disease susceptibility. The new ryegrass selections are giving superior appearance to the common ryegrass so often used in the past.

Recent reports from California indicate that Tifdwarf is susceptible to smog, but it performs well there in open areas where smog is not a problem.

We can summarize in a brief statement when we say Tifdwarf after 3 years on golf courses is a worthy putting green grass with proper management.

THE ACTION OF A FUNGICIDE

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Introduction

The managers of turfgrasses today have available a large arsenal of materials to select from in controlling plant diseases. Fungicidal use is rapidly increasing. Sales of one of the largest fungicidal manufacturers doubled from 1954 to 1964. The number of ads for fungicides in the Golf Course Reporter more than doubled during this same period of time. Because of the increasing demand imposed on plant protection by the increasing acreages of turfgrasses, more intensive management and greater demand for quality turf have resulted in more concern with diseases. Because of these increased demands thousands of chemicals are screened annually for fungitoxic properties. It has recently been reported that there are approximately 400 chemicals marketed for use in plant disease control. These are available in approximately 800 formulations. Since turfgrasses are grown under highly artificial conditions this often predisposes the plant to fungal attack. No matter how well cultural practices are planned and executed to keep turf diseases to a minimum it is impossible to cover all eventualities of weather and soil conditions and plant responses to them. The combination of all of these factors makes it highly probable that the use of fungicides will become more and more essential for obtaining and maintaining good quality turf.

The fight with fungi has proceeded ever since man became husbandryman of the land. The ancient Israelites complained about bugs, blasts, and blights. Insects were among the first pests that man attempted to control. Micro-organisms did not come to occupy a space beside insects until about the mid-nineteenth century when Pasteur made his brilliant experiment on the bacterial cause of the Anthrax disease of livestock. DeBary, an early mycologist, three decades previous to Pasteur's work had recognized that fungi were the cause of plant diseases.

The first recorded mention of a chemical for plant protection was made by Homer, a Greek poet, in 1000 B.C. He mentioned the "pest averting sulfur with its properties of divine and purifying fumigation".

The study of turfgrass diseases began about 50 years ago with the testing of Bordeaux mixture for the control of brown patch. Fungicidal research has continued to be the major activity of pathologists working in this field.

Mode of Action of a Fungus

A fungus is a low form of plant life, thread-like and free of chlorophyll. Since fungal organisms do not contain chlorophyll they must depend on an organic source for their food and energy. Fungi are energy consumers like animals, not energy producers like the higher green plants. A fungus may obtain its food from a living plant, from a living animal, or from a telephone pole or a tent.

Not all fungi cause diseases; some live on dead and decaying organic matter, which they may dissolve and absorb for food. Most fungi produce spores. Spores of fungi are similar to seed produced by higher plants. Spores can be dispersed hundreds of miles by wind and water. Under proper conditions these spores can germinate, sending out germ tubes much like the higher plants send out roots, and infect plants. Fungi which attack plants causing disease are known as parasites and others which live on dead plants and animals are known as saprophytes. Some fungi can assume a dual role; when living tissue become scarce they can become saprophytes. Pythium, Fusarium, Rhizoctonia, and Helminthosporium are examples of a few of dual role fungi.

Infection by a fungal organism generally results in two processes: first, the penetration of the pathogen in the plant tissue, and secondly, the establishment of the pathogen on the host, or the infection stage. The waxy surface of certain leaves and fruits is a defense barrier which helps prevent the pathogen from penetrating the cuticle. Many fungal organisms possess the ability to produce enzymes which aid in breaking down the waxy material and other host material and allowing penetration to occur. In addition to the fungal organism penetrating directly through the host tissue they can also pass through the stomatal openings on the leaves.

Establishment of infection will follow successful penetration of the germ tube when the condition within the hosts are suitable. If infection fails after penetration the fungus dies. Failure of infection can be due to a number of factors and this is where the plant breeders, physiologists and biochemists have an interest in producing resistant varieties or introducing systemics that will prevent infection.

After infection has occurred the fungus, in order to survive, must produce certain enzymes to break down the proteins and carbohydrates of the host plant and utilize them for its own growth and reproduction.

What is a Fungicide

Since we are discussing the action of fungicides I think it is necessary at the outset to discuss what they are and some of their modes of action. Strictly speaking the word fungicide means "to kill a fungus."

Heat, acids, ultraviolet lights and other agents could thusly be fungicides. By common useage the term "fungicide" is usually confined to chemicals capable of preventing infection of living plants by plant pathogenic fungi. The term is also used to describe chemicals which may temporarily inhibit fungus spore germination without being lethal. In such cases the chemical is said to be a "fungistat."

Fungicides are merely one weapon in our arsenal of defense against disease-producing fungi.

A fungicide either prevents the penetration process by inactivating the enzymes secreted by the fungus or it inactivates other toxic chemicals produced by the fungus. This is the mode of action of the protectant type fungicides.

The presence of toxic materials which inactivate these enzymes will retard the development of the fungus. These toxic materials can be and in many cases are produced by the host plant and this is, in many cases the basis of resistant varieties. In other cases these toxic compounds may be introduced artificially and taken up by the plant in the form of systemic compounds. The systemic compounds may combine with other compounds of the host and produce a specifically new anti-enzymatic compound or they may remain unchanged within the plant.

How Fungicides Control Fungi

The control of fungi by fungicides comprises two basic principles, protection and therapy. To deal with the fungus before it attacks the host is protection. Protection is aimed at the healthy plant. To deal with the fungus after it has entered the host is therapy. Therapy is aimed at the diseased plant. If the potential invader is killed at the outpost before he storms the citadel, the principle is protection. If he must be ousted after he gets in, the principle is therapy or some workers prefer the term chemotherapy.

Most of the commonly used fungicides are "plant protectants," but other types have been referred to as systemic protectants and erradicants.

Deposition of a fungicide on a plant surface is not by itself sufficient to insure the utmost utilization if its capacity for controlling disease. It must be distributed so that the maximum number of potential locations of infection are protected.

The tenacity (adhering ability) of a fungicide plays an important role in the effectiveness of a fungicide. Many workers have shown that the tenacity of a fungicide increases with decreasing particle size. Tenacity is a quality of the material. Spreaders improve coverage but they reduce tenacity. They enable rain to wet the particles of spray material and wash it off. Small particles resist dislodgement better. On banana leaves workers found that 43% of a Bordeaux deposit was removed by the first one-fourth inch of rain. However, the next one-fourth inch removed only 4% and the suceeding treatments removed only about 1 to 2% per 0.5 inch of rain. Similar results were obtained with captan, maneb, and zineb on tomato foliage.

It is possible that the high initial losses experienced on weathering arise from a rapid and complete loss of large particles.

Successful foliage fungicides should have low water solubility. They have to be slightly soluble to be fungi toxic. Fungicides with solubility greater than 10 ppm have little residual properties.

A material added to a protectant to improve tenacity is called a sticker. With the improvements being made in fungicide formulations today it has been shown that spreader stickers do not materially improve deposition of the fungicide when high volume rates are used. However, the reverse is true when low volume rates are used.

The rearrangement of fungicide patterns on the plant leaf surface after initial deposit is referred to as "redistribution". Redistribution may either weaken or enhance protection. For example, if the fungicide is washed down by rain from the top of an evenly sprayed plant and redeposited onto lower leaves, redistribution may weaken the upper leaves. Conversely, if excess fungicide is moved from an oversprayed leaf, to an undersprayed leaf, protection is enhanced. Moisture is the most important agent of redistribution. Dew that forms a film of moisture on the leaf may greatly increase the effectiveness of fungicides by rearranging fungicide deposit and aiding in the release of the toxicants.

Another form of redistribution is the movement of vapors. Sulfur dusted on a leaf will give some protection to an undusted leaf immediately above the dusted leaf.

Fungicides may not only be moved along the leaf surfaces, but they may also move through leaves. The absorption and diffusion of fungicides through the leaf may be extremely important in enlarging the area protected by a single fungicide particle on the surface. This action helps to account in part for the practical protection obtained by obviously poor coverage. In addition it is a factor to be considered in the weathering of fungicides. The fungicide would remain in the leaf after the particle had been removed from the surface.

It has been demonstrated that the amount of fungicide on the surface immediately after runoff is less than the amount just prior to runoff. It is believed that when runoff occurs the droplets coalesce and liquid runs off the surface, carrying the fungicide with it.

WATER SOURCES FOR TURF IRRIGATION

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Planning any type of irrigation before determining the source of the supply of water along with the quantity and quality, might be compared to Simon Peter when he jumped over the side of his boat and walked on the water. He did fine as long as he was watching what he was doing and looking straight ahead, but when he began to look back at the other boys on the boat as if to say "Look what I'm doing," he bogged up to about his knees before old Peter looked back and got his mind on his business. If you don't keep your mind on your business when you begin an irrigation system, and determine the water source (even down to the last trickle) with the quantity and quality, you may find yourself way up past your knees.

Things happen when those greens begin to turn brown and the water is so low that you can see the top fins of those big bass, out of the water, while their bellies drag the silty bottom.

A sight to behold is to see a superintendent who just fertilized all of his fairways with ammonium sulfate and while on his way to the river to turn on the pumps, wonders why he is passing so many mud turtles heading across the course to a small pond. As you might suspect, some farmers up the creek had decided their alfalfa needed watering and their big pumps left the creek dry.

One last thought along this line is the anxious moment of the superintendent who was preparing for a major tournament when an automatic valve stopped working properly. This had happened on several occasions, but generally this could be remedied by removing a small fish or chicken feather, because he didn't feel an intake screen was necessary. The repairman was puzzled with his find during the repair and brought the substance to the superintendent. As it was being untangled, the few words that could be read were "Telvar" -- grass and weed killer. I'm sure the next few minutes were spent trying to think who were his enemies and was his water source really contaminated.

One thought not related to source, quantity or quality, is the superintendent who decided to dump two truck loads of small pea gravel around the intakes of his pumps to hold down the silt. The results were 100 percent -- all valves and sprinklers clogged, not to mention the permanent damage.

There are numerous sources of water and luckily for us, many are good. At the rate Texas is using water, it may not be too long before these sources become few and far between.

There are only 13.63 billion gallons of water on this earth and as the scientists know, if that's all there is, there can be no more. By the way, if some of you technical people don't believe the figures, just get a gallon bucket and start measuring. My point is this, so many of these gallons are good for irrigation purposes and so many are not, so use those good gallons wisely.

Although there are many sources, approximately 75 percent of our irrigation water comes from a river, creek, or stream. Let us take a look at these sources and mention a few of their hazards and some of their advantages.

Rivers:

In general, local river water is a good source. The quantities may be spasmotic in that there is a tendency for most rivers to flood during the rainy season and dry up during the summer. Some ways to obtain river water for use are to install the pump for the irrigation system in a deep hole of water, build a small dam across the stream and create a lake, or pump the water, when available, from the river to a storage lake on or near the turf area.

The small dam method is to locate a water hole in the stream, clean it out as much as practical, and construct a concrete dam (2 to 8 feet high) across the stream. The level of the dam should be determined by flood or high water conditions, so that the water will flow over the top without restriction.

Some courses use a portable or permanently mounted pump, generally of high volume, and when there is water in the stream or when it is flooding the water is pumped to storage lakes.

Equipment used on river type installations is varied. Where high water levels occur, the turbine type pump is generally used because of the vertical lift required. In most cases, if the lift is low, the centrifugal pump is used. Approximately 25 feet is the maximum that a centrifugal pump will efficiently lift water in this area. However, it may be best if the lift is not more than 12-15 feet.

Rivers normally will not silt in as badly as lakes because the water movement keeps much of the silt in suspension and washes it down stream. Even though silt does not build up as readily in rivers, the pump intake should be a minimum of 18 inches from the bottom. The intake will less likely be a trash collector if angled about 45 degrees in the water and faced in a down stream direction. Most likely the foot valve on the end of the suction will have a strainer. This strainer is adequate in most cases, but if a heavy leaf problem is present, it may be necessary to install a large basket type strainer around the intake. This should be a minimum of 3 feet square and constructed of hardware cloth with 1/4 to 1/2 inch openings.

There are several precautions that should be taken when using river water. If the stream is small, know the number of acres of watershed that will run down the stream. Check if any of the area is farming land or brush land that might have harmful chemicals being used for some purpose, or if there might be chemical plants or oil explorations up stream. Find out everything there is to know about the run-off area.

What if the water source were the Brazos River where the chances for contamination from industry are numerous and the minerals collected from the different soils in the watershed are enormous? Fortunately the quantity of water flowing down a river of this type is enormous, so the dilutions are varied.

One of the primary concerns of irrigation water is the salt content. For only a few dollars, a very simple quick-test kit can be purchased to determine the changes in quality, but there is only one way to determine if the source of water is suitable for irrigation purposes and that is to spend about $10 and have it tested.

Lakes:

Lake or pond water didn't just happen to be there, so do not be fooled by the idea that the clear lake water is always good water. Treat all irrigation water sources as contaminated until proven otherwise.

Lake water is generally easier on the irrigation equipment than is river water because its slower movement has given the sand and suspended soil particles time to settle.

It has been determined that an extremely sandy water will destroy a certain brand of sprinkler in approximately 150 operating hours, whereas a clear water will operate the same brand of sprinkler over 8,000 hours.

Lakes generally have clean water, but the cleaning process also has a filling process. It is not uncommon for a lake to fill with sand and silt as much as a foot or more per year. This creates several problems. The first is that the intake on the pump should be flexible to the extent that it can be raised as the silt level in the lake rises. The quantity decreases directly with the filling process. The expense for cleaning a silted lake is unbelievable, if it can be done at all.

The size of the lake or lakes required for an average 18 hole golf course varies with the type of system, the number of acres being irrigated, and the extent of application. Generally, a six to eight weeks supply is sufficient for this area, assuming that the supply can be refilled during this period. Suppose a course uses 800 GPM, 8 hours per day, seven days per week, for six weeks, a lake approximately 10 acres in size, averaging 6 feet deep, would be needed.

The pumping equipment to be used on lake sources is about the same as on river sources. More centrifugal type pumps than turbine type pumps are used on lakes. The reason is that the danger of flooding is less and the level is generally more static, resulting in closer placement of the pump to the water.

Springs and Seepage Areas:

These sources are variable, so use caution, both in the quantities and qualities. The quantity varies with the area from which the spring is derived. Many springs are just a run off occuring from a high area draining down to an impervious layer and coming out at some lower point. As long as excess water is draining from these high areas, the spring will function, but just when the hot weather occurs, the high land may get dry along with the spring or seepage source.

Many times the seepage area is large enough that the spring flow never stops. A spring of this type continually producing 50 GPM or maybe 150 GPM can be an extremely economical source. Some of the areas can be dredged or teased into increased production, but remember that the high areas hold just so much water. This amount may produce a continuous small stream, but a larger amount for only a short period.

The quality of spring water is varied. Local water for springs may be good, but under the term springs and seepage areas, we should consider underground rivers and artesian water. The water in underground sources may have traveled over hundreds of miles of rock and sand formations. The formations will release many of their minerals into the water, leaving it totally unusable for irrigation purposes.

Assuming that an underground river, pool, or water bearing formation is found and is good, the probability is that it will be a permanent source. Be careful, the quality can change, just as rivers and streams.

Wells:

It is hard to separate a well source from a spring or seepage source. About the only difference is that with a well source, an open hole must be drilled down to the water rather than the water running out to the surface.

Well sources are good and bad, just as other sources. There are advantages with wells in that as a well is drilled, samples may be taken at each water bearing level. At the time the casing is perforated, only good water formations need to be opened. Many wells have several water bearing formations that may be salty or polluted to the extent of a toxic quality. Generally each formation is separated by an impervious layer that keeps the good and bad water from mixing.

Some wells are large enough that a pump not only pulls the water from the well, but also pressurizes the water into the system. This is generally the most economical method of pumping. If the output of the well is small, it is generally pumped into a storage lake at a slow rate. The storage lake holds the volume necessary to operate the larger pumps on the distribution system. Many courses have several small wells connected together to produce the volume in order that the double pumping costs are eliminated as is required when the water is dumped into a storage lake.

It is sometimes debatable if these double pumping costs are really as large as might be suspected. The reason is that many wells produce large quantities of sand, which, as mentioned earlier, greatly reduces the life expectancy of the thousands of dollars worth of distribution equipment on the turf area. By pumping into a storage facility and giving the water time to calm, most of the sand drops out leaving relatively unabrasive water going through the system. Naturally, the pump impellers wear out fast, but this would be a minor cost as compared to the replacement of the entire workings of an irrigation system after each few hundred hours use.

Equipment needed for a well source will generally be a turbine pump. Some are placed in the well under water and push the water to the surface, while others have the motors on the surface with a shaft going down into the water driving the impellers and pushing the water to the surface.

Other Sources:

There are numerous sources of water for an irrigation system and only two or three have been discussed. The other sources are just combinations of these few primary sources.

For example, many courses use sewage effluent. This is a good source if the quality is satisfactory. Some type storage lake is recommended to hold the quantity necessary and give the water more time for aeration.

The quantity is normally consistent throughout the year, but a check with the plant operator can pin this down to exact monthly averages.

City water is another secondary source that is used by many courses. This can be fairly economical if the city pressure is adequate (which it rarely is). Otherwise a booster pump must be used. Another disadvantage is the chlorine or other materials added to purify the raw water. In many cases the quantities are so great that they become toxic to the turf.

The quantity can generally be furnished, but you can be sure that if a dry period occurs and rationing commences, the turf user will be one of the first to be rationed.

The water is pure and free from sand which has many advantages, but just because it is safe for human consumption doesn't necessarily mean it is safe for turf growth. Have it analyzed for turf use as irrigation water.

It is doubtful if there is a person in this area over 10 years old who, at one time or another, hasn't been involved with irrigation. We all know that if we are to irrigate, we must have a source of water. It must come from a faucet and go into a flower pot or onto the lawn. It must be sucked out of a lake, stream or well. It may even be flooded onto an area or it may be from a little boy standing behind a tree, but the things necessary are: where does it come from, how much is there, and how good will it be when applied to the turf.

IRRIGATION WATER SOURCE SURVEY

We all have just so much time allowed to talk to you concerning our topics. There are numerous slides that could have been shown with this talk, but rather than showing them, I have taken a survey within the last few weeks and would like to share the results with you.

As all of you have asked yourselves after a talk, (that's what he says, but I wonder what are the real facts). This survey reveals the facts of where more than 100 of the golf courses in Texas get their source of irrigation water. I talked with several men that were familiar with courses in Texas, and I just went down the list of courses with no particular selection and listed where they obtained their source of water.

The results are as follows:

Lake---------28.2%	May be refilled by some minor source, but the lake is primary.
River--------15.5%	Pumping directly from the river.
City--------- 8.4%	Direct city supply with and without booster pump.
Sewage------- 4.3%	Pumping primarily sewage effluent.
Well---------43.6%	Of this percentage, less than 10% pumps directly from the well into the system.

NEW DEVELOPMENTS IN AUTOMATIC IRRIGATION

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Emphasis placed on the development of equipment to permit automatic watering of turfgrass areas has resulted in marked progress in the past few years. Equipment presently available permits the controlled application of precise amounts of water. Further, systems incorporating such equipment are capable of delivering the water in accordance with the needs of the grass plants and in conformance with the ability of a given soil to take in (infiltration capacity) and store it (water-holding capacity). Most important, today's systems are economical and perform their functions in such a manner as to assure conservation of water and minimal operating cost.

Recent advances in controllers, valves and sprinkler heads have been substantial. These components, when used in accordance with a good design and when installed properly, perform very well. It is well to keep in mind, however, that any system, new or old, irrespective of how well it has been installed, used and maintained can be no better than the basic design with which you have started.

Good system design and hence good performance has to start with the specifications laid down by the owner or his representative--preferably the turfgrass manager. He must specify what he wants the system to do.

Basically any system design is a compromise between cost and performance. Thus, the owner-operator-turfgrass manager must make certain basic decisions, all of which revolve around obtaining the best performance for the first cost and operating cost they can afford to pay.

Design of a system starts with the operator or turfgrass manager answering questions such 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 a system design, are fixed and a change of mind at some later time will only result in dissatisfaction and headaches.

The area to be covered or watered must be determined precisely and is probably best specified by use of an accurate plot plan. There can be no question if this is laid out.

On large areas like golf courses and parks, the hours available or time allowable to apply a specified amount of water substantially affect the cost. As an example, watering 100 acres at a rate of 1 1/2 inches per week will require 4,070,000 gallons per week. This, divided by seven (days of week), equals 581,400 gallons per day. If the watering must be accomplished in a six (6) hour period, the flow required will be 96,900 gallons per hour or 1,615 gallons per minute. The pumps and mains will have to be big enough to deliver this volume of water! If 8 instead of 6 hours were available, the flow in gallons per minute would be reduced to 1,210 gallons per minute, and if 12 instead of 6 hours were available, the flow in gallons per minute would be 475. A substantial savings in material costs alone will result. The number of hours per day available for watering is a matter of judgment--a balancing of cost against convenience and players' requirements--but <u>it is a decision</u> that must be made before starting to design a water system. If the system is designed to permit watering during play, such cannot be changed arbitrarily at a later date.

So likewise with the amount of water to be applied. The water needs of the grass may be calculated from available climatic data--evapotranspiration. 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 <u>trouble</u> for all concerned.

<u>Type of system</u>

The rapidity with which golf courses have moved to automatic irrigation--both on new courses and the conversion of quick coupling systems on old courses--has been one of the more dramatic advancements of recent years. Some start with the conversion of tees and greens and do fairways later. The development of the valve-in-head and two speed sprinklers has made conversion a very fast and economical practicality. Cost of labor and lower operating costs are factors, but basically unavailability of labor (competent), the reliability of the system and marked improvement in turfgrass quality--both from use and aesthetic standpoints, and the fact that superintendents can control the watering operation are some of the major advantages that may be cited for automatic systems.

<u>Wind condition</u>

The importance of wind is an often overlooked factor when purchasing equipment or in design of a system. Performance of various pop-up heads varies only slightly. So, a standard spacing chart may be used as a guide.

Wind Velocity Miles Per Hour	Maximum Triangulator Spacing (Per cent of Diameter)
0 - 3	70
3 - 5	60
5 - 7	50
8 - 10	40

The number of heads required for effective watering goes up in inverse proportion to the square of spacing. Therefore, three times as many heads would be required in an 8 to 10 mile per hour wind as one required in a 0 to 3 mile per hour wind. Substantial savings may be affected simply by the operator scheduling watering periods to coincide with periods of day or night when wind is low.

These factors along with information on the maximum precipitation rate allowable, uniformity of precipitation and service life (durability) of the various component parts are all critical to proper design and must be specified by the future owner or his representative.

Once this information is available and turned over to a sprinkler system designer, a system to meet <u>your</u> specifications may be designed.

Do not fall into the trap of ignoring such specifications; and instead, relying on some well-meaning friend who tells you that you should use only X pipe, Y heads and Z controls and valves. All may be perfectly good, but they may not be compatible or what you need for your turfgrass area. Failure to specify the basic requirements for a given system has resulted in very poor and unsatisfactory performance of many systems, automatic and otherwise. One further advantage of specifying in this manner is that responsibility for performance is easily assignable--to the designer--rather than permitting the installer to blame the designer, or the manufacturer of pipe blaming the manufacturer of controllers or sprinklers--or, as is sometimes the case, all blaming each other and all leaving the superintendent to live with the problem. Specify the area, the hours, the amount of water, type of system, maximum wind and precipitation and service life. Such factors are not necessarily new developments in automatic irrigation; however, without careful attention to these details, results will not be favorable. The automatic system will perform as it is designed and installed. It cannot compensate for inherent error.

New developments in automatic irrigation would include:

1. Precise specifications.
    a. Recognition of importance from cost and operational standpoint.
    b. Handled by one organization and based on specific requirements set up by turfgrass manager.

2. Master - Satellite control.
    a. Master control - electric - located in superintendent's office or other convenient area.
        (1) Permits easy and rapid adjustment to suit weather conditions.
        (2) Controls total amount of water applied to course.
        (3) Economical - run wires from each Satellite controller to the master. Substantially reduces cost.

b. Satellite controls - located on site - visual control of area being watered.
    (1) One control position for each head.
    (2) Permits independent adjustment of each head. Running time will conform to requirements of soil - infiltration, water holding capacity - slope, the exposure (direction, wind velocity), water table, grass, thatch.
    (3) Permits use of hydraulic (or electric) valve; thus in case of hydraulic is more economical and short tubing run assures highly satisfactory performance.

4. Low precipitation rate - thru recycling or intermittent operation.
    a. Precipitation rate - inches of water per hour. Effective precipitation rate may be reduced when sprinkler heads with high precipitation rate - say 0.5 inch per hour - are run for only a short period, say 1/10 of each hour. Thus, recycling permits more effective use of water because such assures maximum infiltration.
    b. Such is possible only with automatic controls and when valve effectively shuts off all water - drainback or back drainage of low heads included.
        (1) Valve in head performs in this manner.
    c. Such is more effective in high wind - intermittent operation tends to average weather conditions, especially wind during operation.

5. Uniformity of coverage.
    a. Attainable with proper design - proper selection of heads, nozzles, pressure.
        (1) Wide selection of nozzles and ability to change easily highly desirable.
    b. Single row systems require special feature.
        (1) Two speed head assures uniform coverage.
    c. Recycling feature contributes.

6. Use of nonmetallic components - Delrin, cycolac, ABS, PVC, polyethylene.
    a. Noncorrosive.
    b. Economical.
    c. Readily available.

7. Equipment, especially heads, have a longer service life irrespective of use conditions such as sandy water.

Automatic systems:

1. When designed on basis of specific requirements.

2. When components - controllers, valves, heads and pipe - incorporate the latest technical advancements and are selected on the basis of performance and economy;

3. When installed according to specifications;

4. When programmed to deliver water in accordance with capability of the equipment and the design; and

5. When inspected and serviced routinely -

will:

Properly "water" turfgrass at the lowest cost - provide maximum use (minimum interference with use) - produce highly satisfactory playing conditions - permit precise control of moisture by the best qualified individual - the superintendent - and will keep you and your customer - the players - happy.

BROWNPATCH CONTROL

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Introduction

A few of the more common diseases found on southern turfgrasses are Helminthosporium leaf spot, gray leaf spot, Curvularia leaf spot and melting out, cottony blight, rust, mildew, algae, fairy rings, nematodes, and brownpatch. As far as which of these might be the worst, L. N. Wise in his lawn book states that the worst diseases is the one that is killing your lawn. In this particular geographical area, the most popular disease at the present, especially in St. Augustinegrass, is Brownpatch.

Characteristics and Symptoms

Brownpatch is caused by a fungal organism known as Rhizoctonia solani. This disease is most prevalent when the days are warm (73°-85°) and humid and the nights are cool and damp. The disease spreads by fungus threads, or mycelium. (Slide used.) The clide shows individual mycelia; however, when many of the mycelia are bunched together, they form a small cob-weby mat which is most noticeable in the early morning hours while dew is still on the grass. The disease frequently kills in a circular pattern, but it is not uncommon for it to gradually thin and eventually kill an area of turf. (Slide used.) This slide shows the circular pattern in grass having a moderate infestation of brownpatch. In this case only the leaves have been killed and new growth has begun in the center of the circle. (Slide used.) A close-up of the outer edge of this ring shows the freshly killed grass which is brownish-yellow in color. (Slide used.) Here we see a comparison between healthy St. Augustinegrass and diseased St. Augustine. Normally, a very characteristic symptom of brownpatch in St. Augustine is a rotting at the base of the leaf sheath so that the entire leaf may be pulled from the stem by an easy pull on the leaf blade.

Control Measures Management

Thus far, I have dwelled mainly on symptoms and characteristics of brownpatch in St. Augustine. Now for a look at control. First, let's look at management practices which might aid in control or prevention. Here is where the old adage "an ounce of prevention is worth a pound of cure" certainly applies. It is much more desirable to prevent disease damage than it is to cure a diseased area and wait several weeks for the grass to recover. A considerable amount of work has been done on nutrition and its effect on turf diseases. It has been shown that heavy amounts of nitrogen, when applied late in the growing season, will increase the infestation of brownpatch. This is not saying that fertilizer should not be applied in the Fall; it merely means that if fertilizer is applied, it should be a balanced one and not just nitrogen alone. The literature reviewed did show, however, that an underfertilized grass was more susceptible to brownpatch than an overfertilized one.

Another management practice that may help to prevent serious damage by brownpatch is proper watering. During the brownpatch season, watering should be completed early in the day in order to give the grass time to dry before night. Also, when possible, clippings should be removed to preclude a buildup of thatch which provides a perfect haven for disease organisms.

Chemical Control

Enough on managerial control, let's take a look at chemical control of brownpatch. The mercury containing fungicides were among the first to be used for brownpatch control and are still among the more effective chemicals in use. Fungicides containing mercury do present some hazard in that they may injure the grass if used when temperatures are above 80°F. Materials containing pentachloronitrobenzene (PCNB) are also very effective in both prevention and cure of brownpatch disease in St. Augustine. During the past several years, we, here at Texas A&M, have conducted fungicide experiments down in Houston, Texas, were we tested a broad spectrum of fungicides for their effectiveness in controlling brownpatch on St. Augustinegrass. This year we narrowed the number of fungicides down to those containing PCNB and concentrated more on rates and formulations. We have also looked into PCNB--fertilizer combinations and are studying the fertilizer effects on regrowth after the disease has been brought under control. As far as recommended dosages go, we feel that 1.0 lb. of PCNB per 1000 ft^2, if applied on a healthy turf as the brownpatch season approaches, will act as a preventative for approximately 4 weeks; a second application should carry the grass through the season. If the signs of brownpatch are already visible, than we suggest the use of PCNB at a rate of 2.0 lbs. a.c./1000 ft^2 be used as a curative.

Summary

In summary, I would like to re-emphasize the importance of recognizing the occurrence of a "brownpatch season" and preparing your grass accordingly.

1. Avoid excessive nitrogen fertilization.
2. Water early in the day.
3. Remove clippings if possible.
4. Get on a program of using fungicides as a preventative.
5. Use the proper fungicide at the first sign of disease.

BENT VARIETIES FOR TEXAS GREENS

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Bent varietal research has not been done to a great extent in Texas, except by country clubs growing bent through trial and error. Sometimes this method is hard to beat if enough time is allowed.

The selections being used most and doing the best are as follows:

Cohansey

Cohansey (C-7) originated in #4 green at Pine Valley Golf Course, Clementon, New Jersey and has been used as often as any of the selections. It was selected by your after dinner speaker, Mr. E. R. Steiniger. The pale yellow green color is objectionable to some people, but it has performed well enough to be popular. It is vigorous and aggressive and exhibits wide adaptation to climatic conditions according to Dr. Wayne Huffine in Oklahoma. Cohansey performs well in warm areas and is being used more in the southwest. It exhibits some tolerance to brown patch and melting out, but is susceptible to dollar spot, here in Texas and all across the south and is rather susceptible to Pythium. It competes well with Poa annua in addition to masking it. This past year was one of the worst years that we have had in many years for bent managers in the southeast.

Seaside

Seaside bent is perhaps the most widely used bentgrass in America. It is a creeping bent and most of the seed supply is harvested from stands on the coastal regions of Washington and Oregon. The quality is generally rated poorer than most selected varieties of creeping bent. It is below average in disease resistance which allows the stronger plants to survive and take over which often gives a very spotted or patchy effect. An old green which is mottled is a good example of the natural law characterized as "the survival of the fittest". The plants which are most suited to a particular environment will persist and those which are unsuited will die.

The heterogeneous and multiform nature of Seaside bent allows it to be used over a tremendous range of environmental conditions. There is always a strong possibility that within the population there will be some individuals which will be suited to the environment and will persist and form a turf.[1] It appears that with such a wide genetic variability, Seaside can give a good account of itself and has for many years. It develops individual strains that exhibit almost unlimited variation in texture, color, grain, and disease susceptibility.

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[1] Agricultural Handbook p. 170.

In Oklahoma, the pathologists find Seaside to be more susceptible to brown patch than Penncross, but Seaside has shown more resistance to dollar spot.

Seaside is usually seeded 1 to 2 pounds per 1,000 square feet and requires 10 to 12 weeks before playing on it. In most cases, 10 to 15 pounds of N per 1,000 square feet per year is used from two sources of nitrogen, natural and synthetic organics.

Penncross

The other seeded creeping bent is Penncross. It was selected at Pennsylvania Agricultural Experiment Station, University Park by Dr. H. Burton Musser and staff and was released in 1954. Penncross is the first generation seed produced from three vegetatively propogated clones of creeping bentgrass. The parent strain for seed production is identified under the station accession numbers 10(37)4 (Pennlu creeping bentgrass), 9(38)5, and 11(38)4. This is known as the polycross technique. Penncross is vigorous, relatively disease resistant, fine textured, and offers an attractive color. Despite the fact that the parent strains were selected in Pennsylvania, an area quite favorable to the growth of bentgrass, it has performed creditably in many parts of the United States.[2]

Penncross is more resistant to Pythium than either Cohansey or Seaside and has been more resistant to brown patch but is more susceptible to dollar spot than Seaside.

Other selections are being observed in Oklahoma by Dr. Wayne Huffine and one selection made at the Muskogee Country Club is looking very good.

During the summer of 1968 much bent was lost in the southeast. The variety in the putting green at East Lake Country Club, Atlanta, Georgia that came through the best was Old Orchard. It is rather surprising that this selection has not been used more in the southwest; however, it has to be planted by stolons which may be the main objection.

We can summarize by stating the bent selections we are using have done quite well, but we are in need of a better and wider selection.

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[2]USGA Green Section Record, September 1964, Ferguson, Marvin H.

CLASSIFICATION OF INSECTS THAT MAY ATTACK TURF AND ORNAMENTALS

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When George McBee first asked me to talk on this subject, my first question was, "How do you want them classified?" This subject covers many insects and many plants and actually there are several ways they could be classified. He suggested I do it anyway I wanted to. I finally decided to break it down into four groups by insects normally attacking plants below the soil, turf, flowers, shrubs and shade trees. Some insects attack all of these plants, but other are limited to only one group.

Soil Insects:

1. White Grubs - Larval stage of May or June beetles. Adults emerge from soil in April, May or June and feed on leaves of elms, pecan and other trees at night. In day time they lay eggs in the soil in sod areas preferably of high organic matter content. These eggs hatch in two to three weeks as white bodied brown headed grubs. They live in the soil one to four years, usually three, depending on the species, feeding on roots of grasses and other plants. In warm weather they stay one to three inches below the soil surface and in hot or cold weather four to eight inches deep; however, they have been found as deep as five feet in the soil. The grub changes to the pupal or resting stage in early summer and the adult in late summer or early fall, but stays in the soil usually until the following spring. Damage shows up as yellowed dying patches varying in size and shapes. When infestation is severe enough the turf may be lifted or rolled up, like a carpet, as few if any roots are left to anchor it.

2. Wineworms are tough bodied light to dark brown or yellowish in color. They are 1/2 to 1 1/2 inches long. They are the larval stage of click beetles, snapping beetles or skipjacks. Life cycle is very similar to white grubs staying in the soil two to six years depending on species. Damage is similar to white grub damage.

3. False wineworms for all practical purposes are the same as wineworms except legs and antennae are longer. They are the larval stage of darkling beetles.

4. Male crickets are light brown in color and about 1 1/2 inches long. Their forelegs are short and stout with shovel-like feet. They burrow through the soil, feeding on and cutting roots as they go.

5. Other insects occasionally cause root damage. This past year there were two instances of the burrowing bug damaging St. Augustine grass by sucking juices from the roots. The burrowing bug is about 1/10 inch long, black, and looks much like a stink bug.

Turf Insects:

1. Sod webworms live in the soil in silk lined tunnels during the day and feed on green leaves at night. This causes irregular yellow and brown areas to appear. To find the worms which are 1/2 to 1 inch long, break apart some of the sod or sprinkle 1 square yard of the suspected area with one gallon of water with one tablespoon of pyrethrum extract or oil of wintergreen in it. The worms will come to the surface. Night inspection with a good light will often reveal the worms feeding.

2. Fall armyworms are green to brown in color and grow to 1 1/2 inches in length. Eggs are laid by dark grey mottled moths in large cluster on or near the food plants. They hatch in two to five days and eat ravenously and move as grass is destroyed. Life cycle takes one to two months depending on conditions and can have five to eight generations, in Texas. Wet seasons are favorable for development. Other Lepidopterous larvae such as cutworms and other armyworms are very similar in damage and life cycles.

3. Chinch bugs have caused much damage in Texas this past several years to St. Augustine lawns and Phil Hamman will discuss this part next.

4. Bermuda grass mite has spread to much of Texas and has done considerable damage in some areas. Damage is apparent when bermuda fails to begin normal growth in spring despite adequate water and fertilizer. Growth that does appear displays typical rosetting and tufting caused by shortening of internodes and apparent stimulation of abnormal excessive leaf growth. Mites are extremely small and are found in the leaf sheaths. Heavy infestations cause grass to turn brown and die allowing weeds to emerge in thinned areas. This pest likes hot, dry conditions, with damage usually appearing first on dry ridges and along margins of the lawn. Summer blight fungus is nearly always present where bermuda mites are found and may be responsible for much of the damage.

5. Rhodes grass scale attacks Bermuda and St. Augustine. The adult is about 1/8 inch in diameter, globular, dark purplish-brown and covered with a white cottony secretion. Nymphs or crawlers move about considerably at first, then settle down, attach themselves to the plant and secrete the wax that covers them. Usually they attach themselves to the stem in the axil of the leaf. There can be as many as five generations per year.

6. Grasshoppers, ants, termites, leafhoppers, slugs, springtails and snails sometimes damage turf areas.

7. Miscellaneous pests that don't necessarily damage the grass as such, but annoy man by being there, are chiggers, fleas and ticks.

Flower and Shrub Insects:

There are so many insects that damage flowers and shrubs that it is impossible to go into detail on all of them in the time allotted this morning. To simplify things, I will show some typical insects and damage caused by insects with chewing, piercing and sucking and rasping and sucking mouthparts. You are no doubt already familiar with many of the chewing insects such as May beetles, rose chafers, cucumber beetles, bagworms, leaf rollers and grasshoppers. Piercing and sucking insects involved include many kinds of aphids, spider mites, plant bugs, lacewing bugs, whiteflies and scales. Thrips belong to the rasping and sucking groups and damage plants by rupturing the cell walls until the sap comes outs, then sucks the juice up.

Shade Tree Insects:

Many of the shrub insects also damage trees, but will not go over those again. I will group them again by chewing or sucking mouthparts. The chewing group includes webworms, of several kinds, worms feeding in open, of several kinds, asps or puss caterpillars and borers. Sucking insects include aphids, spider mites, scales, plant bugs and gall insects.

I will not go into detail on control of the insects just discussed, but will give general recommendations. Chewing insects can usually be controlled with DDT, chlordane, dieldrin, heptachlor or serin. Sucking or rasping insects with malathion, diazinon, trithion, ethion or systemics such as disyston or thimet. Borers are controlled best by prevention by keeping the trees healthy, spraying trunks and larger limbs in July, August and September, with dieldrin or DDT or fumigate by putting carbon disulphide in the borer tunnels and plugging with clay or non-absorbent cotton. For detailed information on control of specific insects, see your county agent for various publications available through his office.

It has been a pleasure and an honor to have the opportunity of being a part of your program.

THE IMPORTANCE OF PROPER PUMPS AND CONTROLS IN IRRIGATION SYSTEMS

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Acting as sales agent for several manufacturers of liquids control products, we have the opportunity to see these products applied to irrigation systems.

We do not engage in engineering and expect users to be technically qualified or to have professional help from consulting engineers.

In irrigation systems we are primarily interested in moving liquids to a place they are needed, in the amount and in the time required.

Liquids are generally transported by:

A. Vessel or tank
B. Gravity flow open system
C. Closed system pipeline
D. Combinations of each

The closed system, utilizing piping, remains under an induced head until it is released to atmosphere and dispersed over an area. It is this particular type system that we wish to discuss further.

Many of the static and dynamic considerations of liquids are present in the application of pumps and controls to irrigation using closed or limited free discharge piping.

Liquids in motion in closed systems are often compared to a moving freight train and with just cause. Although water is a nearly incompressible fluid, it produces interesting phenomena when its velocity is radically altered. Anyone present can testify to this that has witnessed a pipeline buck or rupture due to water hammer or surge.

There is a lot of misinformation associated with the water hammer. For the sake of simplicity let's compare it to what happens to a freight train when an immovable object is placed in front of a moving train or the caboose is stopped while the train is moving. Depending on how fast the train is going, resulting damage occurs.

Fortunately, water piping systems are a little more flexible than train couplings so little notice is given to the small "thunk" you sometimes hear when turning off a garden hose too rapidly.

There is velocity of water similar to the speed of the train where the inherent flexibility of the piping can not withstand the resultant surges that can be created by a quick closing valve at the end of the line or by stopping too many pumps at once.

For example, a normal flowing system pressure of 150 PSI can produce a short duration shock pressure of 750 PSI by radically altering a velocity of 15 feet per second. Piping can be sized adequate to provide volume needed at a more safe velocity than the example.

In the past, certain high strength cast iron and steel piping could contain shock pressures approaching this magnitude, but with the advent of PVC and transite pipe, the manufacturers maximum pressure recommendations must be adhered to.

Pumping station pumps, controls and control valves have therefore become the object of more attention for the pressure is induced at this point on the system and total flow is governed at the pumping station.

Some of the most interesting closed systems for irrigation I have seen were designed for modular construction. Meaning that which can be easily modified or added to.

In design, consideration was given to:

Upsteam conditions to provide proper suction pressure, low friction losses to prevent pump cavitation, valving to isolate pumps and provisions for future increases in pumping capacity.

Proper sizing of the pumps to provide adequate present volume requirements at the flowing pressures determined.

Downstream conditions to provide proper discharge manifolding and piping sized for velocity considerations.

Pipeline conditions to release entrained air and provide vacuum relief for severe changes in pipeline elevations.

Selection of basic controls for pumps to provide for both continuous and intermittant volume demand.

Safety controls to provide for power failure, excess velocity, starting and stopping surges, pipeline breaks, pump time delay and safety interlocks in electrical circuits for phase failure, phase reversal of incoming power to pump motors.

Cross connection of irrigation and domestic use piping to avoid contamination of drinking water.

In summation, from observation, I have the following suggestions for your consideration in planning pumping and controls for irrigation systems:

Design for the present with an eye to the future. Provide for the unforeseen modification, for the error in calculation.

Keep your pumping system manifolding modular and spacious so that additional pumps can be added.

Provide extra coupling, pressure taps, blowoff line or blind flange.

Equip your system with a bypass and provide adequate isolating valves.

Provide for a standby source of water. Could you connect to a nearby fire hydrant?

Provide safety controls now, not after loosing a 100 HP pump or motor.

Carefully examine a system requirement before deciding on a fully automatic control system. Know your system requirements intimately.

Don't build a monument to yourself by providing an extravagant control system. No one will appreciate it but you and definitely not the operator.

Keep your operator in mind when considering an automatic system. You may have the horse, but not the jockey.

Provide an adequate wiring diagram for the electrician to follow and record any changes.

When utilizing wiring conduits, pull several spare wire pairs for for future additions as well as for troubleshooting.

When utilizing more than one supplier of control components, have an understanding beforehand on startup, unit responsibility and warranty. Don't expect things to work out for themselves.

When in doubt on applications of automatic controls, start with semi-automatic feature and provide space in control panels for more complete equipment.

Remember, automatic controls are basically modular. Use the building block system. Keep it simple, keep it flexible. Keep your mind open.

Providing proper pumps and controls for irrigation systems is a jack be nimble job.

Thank you.

The story goesabout the hostess that had every important person in town coming for dinner that evening. She decided her best efforts would go to preparing a mushroom dish from mushrooms grown in her own darkhouse.

To assure they were not the poisonous type, the maid first fed some to the dog. Everything appeared alright. That evening dinner was served. Just as dinner was finished, the maid entered exclaiming "The dog is dead."

Of course, the hostess had all the guests removed to the hospital to have their stomachs pumped.

Weeks later, as the hostess and maid were visiting in the kitchen, the maid remarked "You know, that truck sure made a mess of the dog."

When you assume, it can be both costly and embarrassing.

LATEST DEVELOPMENTS IN WEED CONTROL

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By the most generalized classification, herbicides or weed killers are selective or non-selective. Either category may be further sub-divided into pre-emergent or post-emergent classes depending upon whether the herbicidal effect is observed in weed seeds, seedlings or established plants. Recently emphasis has been placed upon the development of herbicides providing selective pre-emergent control of annual grasses, such as crabgrass, goosegrass, annual bluegrass. These more selective herbicides include the carbamates and toluidines. These herbicides may be applied as sprays or as dry granular formulations, but must be applied before annual grass seeds germinate. Selective pre-emergent grass killers affect growth of the primary root of germinating grass seeds. The chemical may be absorbed through the seed coat or by the primary root as it emerges from the seed. Once absorbed, the weed killer prevents cell division within the primary root tip. The entire annual grass plant dies because the root system cannot develop to absorb water and nutrient elements from the soil. These pre-emergent weed killers are selective primarily because of low solubility in water, but yet each is readily absorbed by seeds or root tips. These rather insoluble weed killers remain near the soil surface and are absorbed by annual grass seeds or seedlings during germination. To insure complete control of annual grasses, adequate coverage of each turf-grass area is essential, since the grass weed killer must be in close contact with each germinating seed.

Most turf-grasses are deeply-rooted perennials and their roots are not greatly exposed to the surface layer of weed killer. Therefore turf-grasses do not readily absorb the weed killer and are not injured or retarded due to herbicide treatment. Turf-grasses cannot be re-seeded for several months after application of most pre-emergent grass weed killers. Also, overseeded grasses, such as ryegrass may be killed or retarded by these herbicides for several months after the application. These chemicals are not physiologically selective as to type of grass seed and most will inhibit root growth of all grass seeds or seedlings.

A new development in the field of selective pre-emergent annual grass control is the concept of fall application for the control of annual bluegrass (Poa annua) plus control of brabgrass and goosegrass the following season. Three of the currently available pre-emergent herbicides appear to persist over winter in effective concentrations for residual control of these three annual grasses. Bensulide (Betasan, PreSan), DCPA (Dacthal), and tricalcium arsenate applied during late summer to early fall have controlled annual bluegrass as it germinated throughout the cooler months. The persistence of the herbicides in soils has been adequate for residual control of crabgrass and goosegrass the following season. Several other herbicides could be mentioned which will very effectively control all three grasses provided the late summer or early fall application is followed by a mid to late winter application.

The new approach of fall application for residual control of the major annual weedy grasses presents few problems on bentgrass greens and fairways or lawns which are not overseeded. Pre-emergence control of annual bluegrass in bermudagrass that is to be overseeded presents a special problem, in that the residual herbicide can inhibit germination of all seeds. Current research indicates proper seedbed preparation plus liberal top-dressing of greens that received late summer or early fall application of persistent herbicides may allow successful overseeding. Another technique of incorporating activated charcoal in soil to which pre-emergent herbicides were recently applied is also being studied. The activated charcoal appears to inactivate any residual herbicide still in the soil, and permit high percentage germination of desirable turf seeds applied any time after the charcoal application. Another approach being studied, which is possibly more practical, is the late summer application of less persistent pre-emergent herbicides which may be leached or degraded away before a late fall overseeding. This could allow establishment of seeded cool-season grasses, and another application of pre-emergent herbicide some weeks after the over-seeding or first mowing might prevent subsequent annual bluegrass germination during the winter months. These approaches to annual grass control in overseeded turf areas might prove to be practical provided the mixture to be overseeded is free of annual bluegrass contaminant. In some manner, annual bluegrass seeds must be eliminated during the overseeding process since the germination requirements for annual bluegrass seeds and most cool-season grasses used in overseedings correspond very closely.

For eradication or total clean-up of annual bluegrass plus broadleaf weeds established in dormant bermudagrass fairways or lawn areas during late winter, paraquat will do the job. With proper timing the non-selective contact action of paraquat will eradicate all cool-season annual weeds leaving turf areas weed-free until warm season weeds begin to germinate during spring months. This use is still in the experimental stage and no label recommendations are yet available.

Some new developments have occurred in total vegetation control. Sodium arsenite has been the accepted soil sterilant for many years, but newer herbicides may offer some advantages. Some types of pre-emergent herbicides also provide some post-emergent weed control. The symmetrical triazines, substituted ureas and uracils have such dual herbicidal activity. These weed killers are generally very insoluble in water, but are readily absorbed by roots of shallow-rooted vegetation. By increasing the selective rate of application of these pre- plus post-emergent herbicides 5 to 10 fold, temporary to long-term sterilization of soil may be obtained. At these elevated rates, many of these herbicides may maintain soil sterility longer than sodium arsenite. Rapid kill of all vegetation may be obtained by adding a contact weed killer to the pre- plus post-emergent herbicide. Such contact herbicides include TCA, PCP, lightweight oils and paraquat. Total vegetation control with a soil sterilant may be desired along fence lines or rights-of-way, for edging sidewalks or planter beds, or marking base lines at the ballpark. The major requirements for a satisfactory soil sterilant include persistence in the upper few inches of soil for a prolonged period, a minimum of lateral movement, ease of application, and broad spectrum control of all weeds. Herbicide combinations which have provided maximum soil sterility and minimum movement in soils include: diuron (Karmex) plus paraquat, isocil (Sinbar) plus PCP, bromacil (Hyvar) plus paraquat or PCP, and Tandex plus PCP. Much improvement has been made in controlling resistant species by using such mixtures of herbicides. Further advancements needed for improved total vegetation control include increased effect on resistant herbaceous and woody perennials, but maintaining minimum effect on desirable plants which have their roots in the treated areas, and reduced lateral downslope movement of herbicides from the treated areas.

COMMON DISEASES OF BERMUDAGRASS AND BENTGRASS AND THEIR CONTROL

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Several diseases are common to both bermudagrass and bentgrass. Following is a summary of the common diseases.

Disease	Causal Agency	Bermudagrass	Bentgrass
	Patches killed		
Brown patch	*Rhizoctonia solani*	+	+
Dollar spot	*Sclerotinia homeocarpa*	+	+
Pythium blight	*Pythium ultimum* & *P. aphanidermatum*	+	+
Spring dead spot	Unknown	+	-
	Leaf spots and melting-out		
Gray leaf spot	*Piricularia grisea*	+	-
Zonate eye spot	*Helminthosporium giganteum*	+	-
Leaf blotch	*Helminthosporium cynodontis*	+	-
Leaf spot	*Helminthosporium sorokinianum*	-	+
Red leaf spot	*Helminthosporium erythrospilum*	-	+
	Powdery or rusty leaf surfaces		
Powdery mildew	*Erysiphe graminis*	+	+
Rust	*Puccinia graminis*	+	+
Rust	*Puccinia cynodontis*	+	-
	Others		
Slime molds	Several species	+	+
Fairy ring	Several species	+	+

Brown Patch

Symptoms: Somwehat circular brown patches varying from several inches to several feet in diameter appear. On closely-clipped bentgrass a dark, grayish-black ring of wilting grass borders the diseased area. This ring is noticeable in the morning but disappears when the grass dries.

Cause: Brown patch is caused by a fungus that resides in the soil or old dead grass. The fungus produces small, hard, black bodies (sclerotia) which survive adverse conditions. Elements grow from these black bodies which can enter and parasitize the blades, leaf sheath, crowns and even the roots. It grows freely from blade to blade under conditions of 100% relative humidity and temperatures between 70-95^{o}F.

Control: Avoid overwatering and frequent late afternoon or evening sprinkling. Water early in the day so that the grass leaves will be dry before evening. Avoid overfeeding during summer months with a quickly available, high-nitrogen fertilizer. Less brown patch occurs when the available nitrogen supply in the soil is low and phosphorus and potassium levels are high. Prune dense trees and shrubs to let in sunlight, increase air circulation and promote faster drying. If possible, remove the clippings. Where this disease has a known history of occurrance, spray weekly in hot, humid weather, using a mercury fungicide, Dyrene, Daconil 2787, Difoltan, Fore, or Terrachlor.

Dollar Spot

Symptoms: This disease appears as round, brown or bleached spots, the size of a silver dollar, or somewhat larger. If left unchecked, the spots may merge forming large, irregular, straw-colored, sunken areas. When dollar spot is active a white, cobwebby growth can be seen on the grass leaves when dew is still present.

Cause: The white, cobwebby growth on the grass foliage is the dollar spot fungus. Dollar spot may occur regardless of management of soil fertility, but damage is usually most severe if there is a deficiency or great excess of nitrogen. Dollar spot is most active during moist periods of warm (60-86^{o}F) days and cool nights. Bentgrasses, especially certain strains of creeping bent, are most susceptible.

Control: Follow the same cultural practices as for Brown Patch. Spray during the spring months and again in late summer and fall using Cadmium containing fungicides, inorganic or organic mercury fungicides, Daconil 2787 or Dyrene. Follow manufacturers directions. Where the disease is a persistent problem a preventative spray schedule should be conducted. Where it occurs only occasional, start applications when disease is first evident.

Pythium Blight

Symptoms: The turf becomes spotted with irregularly shaped, small blighted areas ranging from 1/2 to 4 inches in diameter. In the early stages, the grass blades have a water soaked greasy appearance. This is followed by shrivelling of the leaves and the patches fade from green to light brown.

The initial spots look like Dollar Spot disease, but are pinkish in color, with cottony mycelium visible in the spots. As the disease progresses, the patches meld together, causing large areas to be killed.

Cause: The pythium fungus is capable of living as a soil saprophyte. However, in a previously diseased turf, the organism may overwinter in a dormant condition in infected plants.

The pythium fungus is most active at 85°-95° F. temperatures. It is a warm wet-weather disease problem. The fungi spread primarily from plant to plant by means of bridging fungal elements. Under favorable conditions for their development, this type of spread can be very rapid resulting in losses of large areas of turf. Distribution of the disease over distances is usually accompanied by movement of contaminated surface water and transporting diseased plant parts on maintenance equipment.

Control: Calcium nutrition greatly influences disease development. Plants grown under conditions deficient in calcium are more susceptible. Alkaline conditions also favor the disease. Maintain a balanced fertility program keeping the calcium level up. Keep the soil pH in the acid range. Irrigate with short enough intervals to hold the soil close to field capacity.

On the whole, fungicides have not provided adequate control of the disease. The product Dexon is an exception and has shown excellent promise.

Bermuda Spring Dead Spot

Symptoms: Areas of various size are dead when the bermudagrass begins to green-up in the spring.

Cause: Unknown

Control: No satisfactory control has been found. The application of the insecticide dieldrin has tended to reduce the severity of this disease.

The Leaf Spots, Blotches and Melting-Out

The leaf spots and blotches all have similar symptoms and life cycles. These diseases are difficult to tell apart by symptom expression and frequently it is necessary to make a microscopic examination for positive identification. This group of diseases cause gray to brown spots and/or blotches on the blades and sheaths. In some cases, the tissues bordering the diseased and healthy may be a darker brown or even purplish. Numerous spots or blotches cause death of the blades. Heavy infection of the foliage causes a brown to reddish-brown cast to the turf and as the disease progresses the turf appears to melt away hence the common descriptive term "melting-out" can be used in general for all of these types of diseases.

The fungi causing Gray Leaf Spot, Zonate Eye Spot and Red Leaf Spot usually parasitize the foliage, i.e., leaf blades and sheaths. The disease Leaf Spot and Leaf Blotch are capable of entering the crown and roots causing crown and root rot diseases as well as spotting and blotching.

Cause: See table above which summarizes the diseases of bermuda and bent grasses.

The fungi causing the leaf spot and blotch diseases all have similar types of life cycles. These organisms can live on the dead foliage as well as living tissues. They commonly bridge from one season to the next in the dead grass litter. From here, spores are produced which are carried to the foliage by wind or splashing rain. It is necessary to have 100% relative humidity and moderate temperatures for a prolonged period (8-10 hours) for spore germination and infection to become established. Following is a summary of the environmental needs for development of these diseases.

Disease	Host	Preferred Temperatures	Relative Humidity
Gray Leaf Spot	Bermuda	70-80° F	100%
Zonate Eye Spot	Bermuda	75-90° F	100%
Leaf Blotch	Bermuda	60-70° F	100%
Leaf Spot	Bent	70-85° F	100%
Red Leaf Spot	Bent	75-95° F	100%

The appearance of these diseases is related to their temperature preferences. Thus, some are early spring diseases such as Leaf Blotch and Leaf Spot and some are summer diseases such as Zonate Eye Spot and Red Leaf Spot.

Following initial lesion development, more spores are produced which cause further infection. This process continues on so long as the environment is favorable.

Control: High nitrogen levels through application of quick-release nitrogenous fertilizers have been reported as making grass more susceptible to these diseases. In turn, however, such a fertilizer causes rapid development of new growth quickly replacing that lost from leaf spot disease. Also, there have been reports that higher mowing levels tend to reduce the leaf spot incidence.

Because long dew periods favor leaf spot and leaf blotch diseases, any management practice that will cause the grass surfaces to dry more quickly will reduce the disease intensity. Areas which are notorious for these diseases should have a preventative spray program. Maneb, zineb, Daconil 2787, Dyrene, Tersan or Calocure applied at a rate suggested by the manufacturer and at 2-week intervals before the disease gets started will prevent it from becoming established. In the case where this disease is only a springtime problem, it would not be necessary to carry the spray program into the summer. The spray program, however, needs to be adjusted for prevention of probable summer diseases such as Pythium blight.

It is very difficult to control the crown and root rot phase of leaf spot and leaf blotch diseases. This phase commonly occurs when the plant is undergoing considerable environmental stress. The best means of minimizing crown and root rot is to maintain the best possible growing conditions. In midsummer, see that the grass does not undergo undue droughth stress. Syringe it properly so that there will be a cooling effect. In the winter, do not allow excessive winter drying. Chemicals have been quite mediocre for control of the crown and root rot phase. The only ones which have given some control has been the mercury fungicides used as a soil drench. It is necessary to get the fungicide down into the soil where the disease organism is residing.

Powdery Mildew

Symptoms: The surface of the leaf blades have a powdery white substance. The turf sometimes looks as though it had been sprayed with milk.

Cause: The powdery mildew fungus lives on the surface of the leaf and obtains its nourishment by penetrating the surface cells and producing an organ that absorbs its nutrient requirements from the cell. On the surface of the leaf, the fungus produces long chains of spores causing the powdery appearance. The spores are carried about by air currents and when on the surface of a leaf they can germinate and establish a new colony. Interestingly, the germination of these spores are not influenced particularly by humidity but primarily by temperature. They prefer temperatures of 60-70^{o} F. for germination, but can germinate at considerably lower temperatures. Therefore, the disease is one that is present during cool periods.

Control: Mildew is easily controlled by applying dusting sulfur, wettable sulfur, karathane or acti-dione.

Rust

Symptoms: The turf becomes rusty in appearance. A close look reveals the blades have numerous round rusty spots. The rust readily rubs off onto one's fingers when the blade is rubbed. A rusty dust collects on one's shoes and other wearing apparel when walking across the turf.

Cause: The rust fungi has a unique life cycle in that they have several different forms and have alternate hosts. The red form is the only stage that is of concern as a turf disease. The red material is innumerable spores (fungus) which are distributed by air currents. Some land on uninfected grass blades where, in the presence of moisture, they germinate and cause infection.

Warm days followed by cool nights with long dew periods favor infection and reproduction of the rust fungus. Rust is more apt to become a problem in the late summer or fall because of favorable environment for infection and the growth rate of the grass blades may be reduced allowing for adequate time for pustule development before being clipped off.

Control: The carbamates, zineb and maneb, and cycloheximide give excellent control; sulfur will also give control.

Slime Molds

Symptoms: Small, white, gray or yellow slimy masses grow over the grass in round or irregular patches smothering or shading otherwise healthy surfaces. The masses dry to form bluish-gray, gray, black or white powdery structures. When crushed between the fingers, they disintegrate into a powdery mass that easily rubs free from the grass blade.

Cause: Slime molds are not parasites. They are soil inhabiting organisms which feed on decaying organic material in the soil. In humid weather a slime mold grows out of the soil onto whatever is available for support and produces its spore masses. A well watered, well fertilized lawn provides an ideal environment.

Control: If left alone, the slime mold disappears. However, since it is unsightly a home owner may wish to remove it. This can be done by a forceful spray from a garden hose or with a garden rake. Fungicides applied to control melting-out, Brown patch or other diseases should keep slime molds in check.

Fairy Ring

Symptoms: The Fairy Ring disease causes a circular ring of fast-growing, dark green grass often surrounding a ring of thin or dead grass. Sometimes the ring is not complete and gives the appearance of an arc or horseshoe. The rings vary in size from a few inches in diameter to many feet. The strip of thin or dead grass varies from three to six inches in width. After rains or watering many mushrooms or toadstools may appear in the area of dark green grass.

Cause: Fairy ring is caused by several soil-inhabiting mushroom types of fungi. Growth starts at a central point and filaments of the fungus grow outward equally in all directions. Outward spread may occur at the rate of a few inches to two feet or more per year. The part of the fungus on the inner side of the circle dies off as the fungus grows outward. The darker green grass is caused by microorganisms in the soil breaking down organic matter, subsequently resulting in greater nitrogen availability.

Control: Fairy ring is difficult to control because the soil in the area in which the fungus is present becomes impervious to movement of water. The fungus can be killed by the use of mercury fungicides, but the main problem is getting the fungicide in contact with the organism. Control will not be satisfactory unless this is done. Perforating the soil with holes 1/2 to 1 inch in diameter, 4 to 5 inches apart and 6 to 8 inches deep from the point of stimulated grass to about 6 inches outside the ring and filling the holes with a mercurial fungicide may give control. A wetting agent added to the fungicide solution may assist in better penetration and killing of the Fairy Ring fungus.

General Principles of Disease Control

1. Follow good maintenance practices.
2. Know your turf diseases and how to control them.
3. Follow a strong preventative fungicide program.
4. Use the proper fungicides correctly and timely.

PREDICTING THE WEATHER FOR TURF

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Introduction

Predicting the weather for turf requires knowledge of the influences of the weather elements on turfgrass as well as the ability to identify and to forecast the movement of large scale weather features. Another essential ingredient is a fundamental understanding of micrometeorology, because each golf course has its own microscale weather. For example, during a rain-shower, one portion of a golf course may receive one-half inch of rain while another section receives no rainfall.

The weather elements which are of particular interest are wind, temperature, precipitation, humidity, and evaporation. These parameters are related closely with changes in the large weather systems; however, the local climate normally changes very little from year to year. Consequently, if local weather records are kept, you eventually accumulate enough information to determine your local climate. One advantage gained by keeping long term weather records is that they help you decide when to plant new grass, when to expect the most golfers, and how grass growth is affected by the local climate.

Microclimate

The following discussion condenses the fundamental concepts of the behavior of the weather elements over small areas. Where possible, the ecological role played by each weather element is considered briefly. Also, the discussion will be concerned primarily with warm season grasses; however, where appropriate, occasional reference will be made to cool season grasses.

Air and soil temperatures are important because they directly effect germination, growth, and decay of all plant life. As is readily known, Kentucky bluegrass will grow when soil temperatures are above 36° F and when the average air temperature is about 40° F or greater. This cool season grass also has an optimum response when the average air temperature ranges between 68 and 75° F; but, becomes dormant when the air temperature exceeds 90° F or the average air temperature is greater than 75° F. On the other hand, bermudagrass doesn't become active until the air temperature exceeds 50° F. This warm season grass has its optimum response when the average air temperature is between 75 and 80° F and the grass survives to air temperatures slightly above 100° F.

According to W. H. Daniel, after a cold spell, Zoysia grass needs three nights of minimum air temperatures in excess of 50^{o} F before active growth will continue. Generally, Zoysia grass will go off-color with a hard frost, and new leaves usually do not reappear until about mid-May in the Ohio River valley region.

The diurnal variations in soil and air temperatures near the ground have been described by many authors. Figs. 1 and 2 show that these variations are greatest in the upper six inches of the ground. Notice, in Figs. 1 and 2, that the amplitudes of the diurnal air temperature profiles are greater than those in the soil. Also notice that the strongest temperature gradients will occur in the summer so that the grass must be tolerant of large temperature fluctuations during the warm portion of the year. In general, the greatest changes in temperature occur near the ground and can occur quite rapidly, while changes in the soil temperature are gradual.

The temperature of plant organs tends to follow closely that of the immediate environment. This is especially true of root temperatures, which are almost identical to soil temperatures. Shoot temperatures may differ by several degrees from air temperatures, depending on the absorption of solar radiation. Sunlight increases the temperature of plant tissue; however, the degree of evaporation can cool tissues below the air temperature.

The rate of temperature change is often fully as important as the degree of change. Sudden temperature changes tend to be more deleterious to plants than slow changes of the same magnitude, apparently because the plant requires a certain amount of time to adjust to new temperature levels. It is the rate of cooling, rather than the absolute minimum, which determines whether or not the plant is injured by the formation of intercellular ice or the development of stem lesions. Time also has an important bearing upon the degree of injury sustained at extreme temperatures. A plant may withstand an extreme temperature of a given intensity for a short time, whereas the same temperature maintained for a long time may prove fatal.

Many golf courses are located in or near major metropolitan centers. It is known that a large city tends to create an island of heat, resulting from local space heating. Fig. 3 illustrates this effect for Houston, Texas, during a clear, calm night on 27 December 1967. Notice that the analysis of the distribution of temperature at about 9 p.m. shows that the temperature is about 8^{o} F colder over the surrounding countryside than over the central business district. This study revealed that the maximum difference in temperature between downtown Houston and open country apparently occurs between 7 p.m. and midnight. No temperature measurements were made in any of the parks in the city.

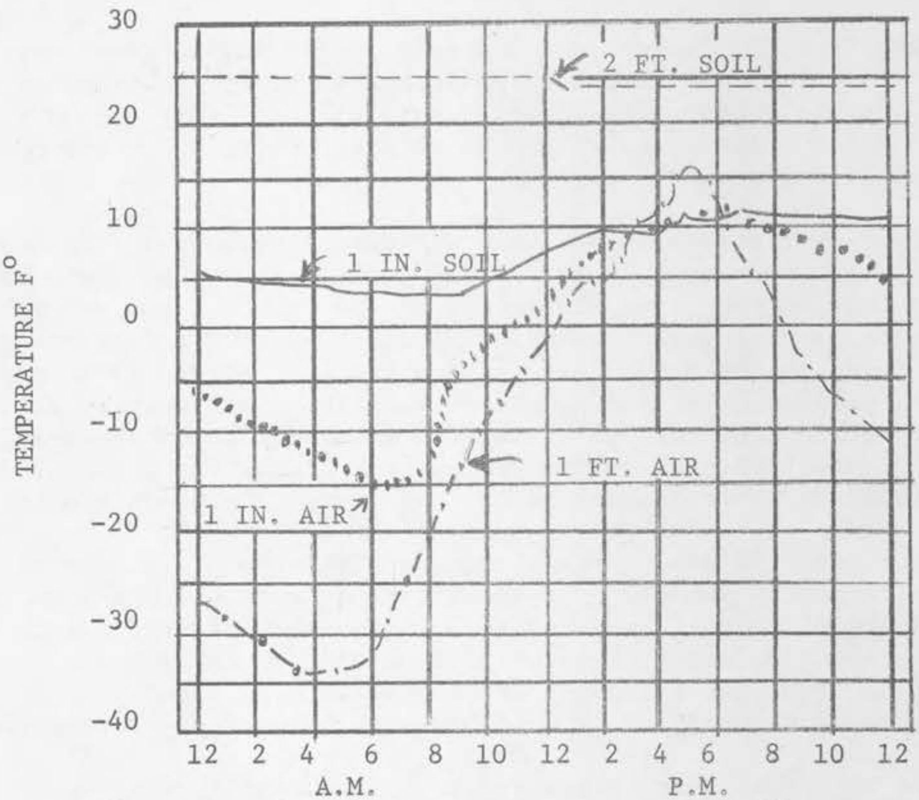

Fig. 1. Air and soil temperatures at a microclinate station on a clear, cold day, January 19, 1963 (After Shaw).

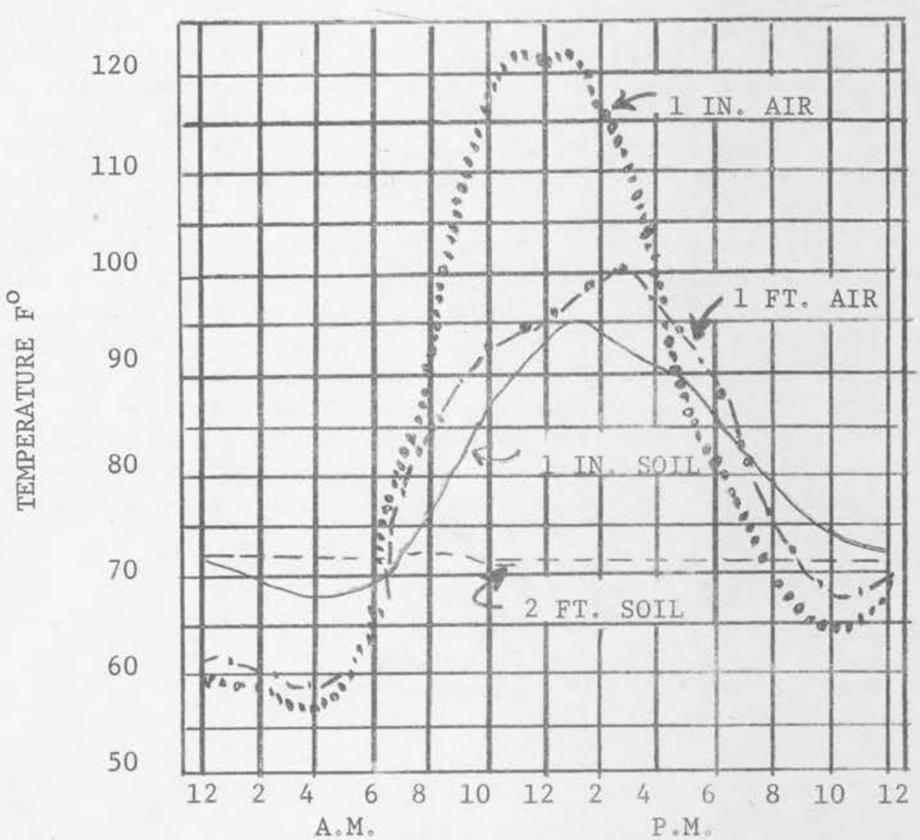

Fig. 2. Air and soil temperatures at a microclimate station on a clear, hot day, August 9, 1964 (After Shaw).

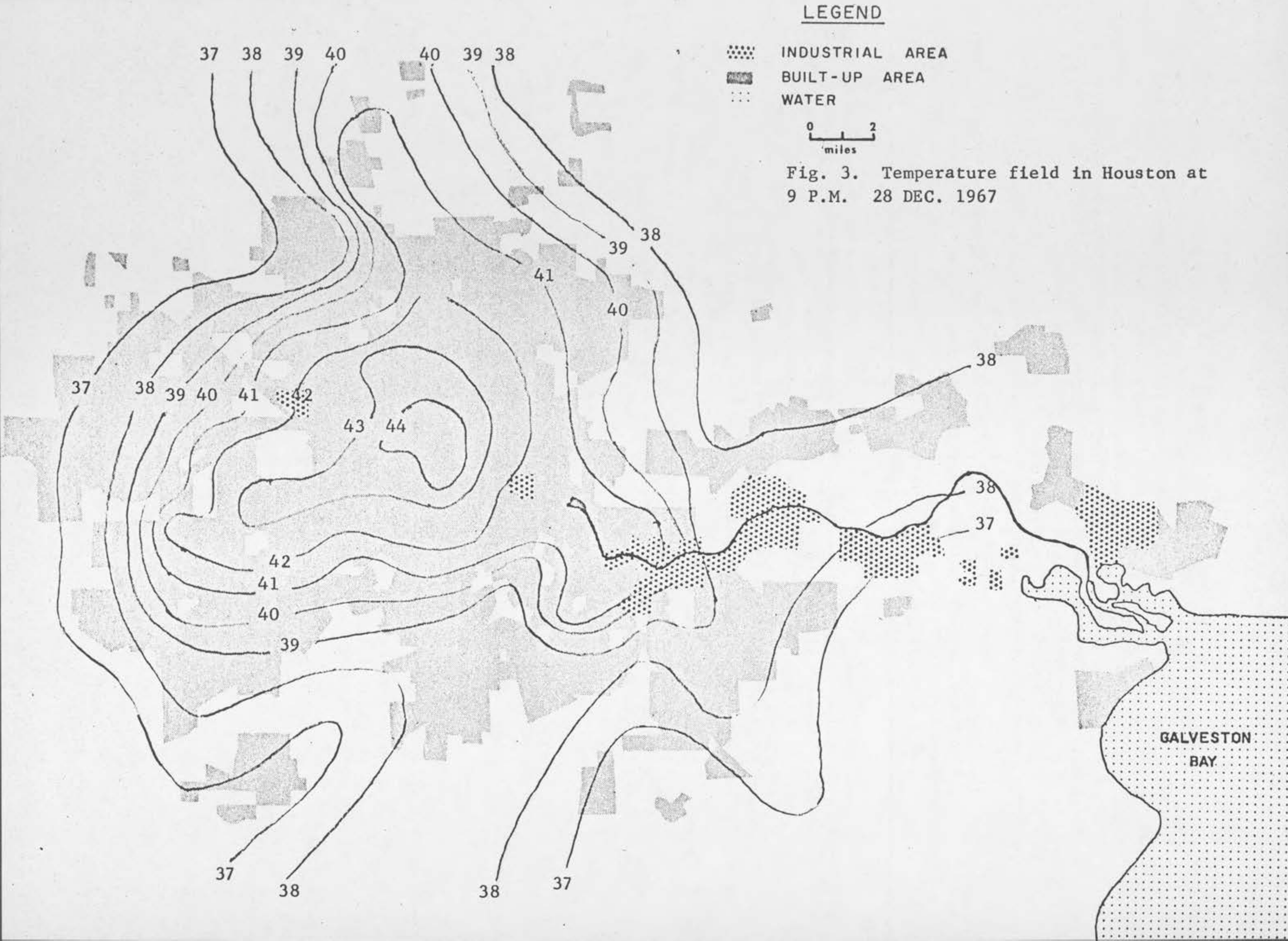

Fig. 3. Temperature field in Houston at 9 P.M. 28 DEC. 1967

Wind speed is important primarily because of its influence on local evaporation and on the modification of the temperature field. Strong winds tend to increase the rate of evaporation of water from the ground. Conversely, light and variable winds permit air to remain over a given region long enough to begin to acquire the same characteristics of temperature and moisture as those of the ground. Provided these conditions are maintained for an extended period of time, there will be little or no exchange of heat and moisture between the ground and the atmosphere.

Near the ground the effect of frictional drag causes the wind speed to be rather small so that, in general, very slow wind speeds occur within several inches of the ground. Above a height of about one foot, the wind speed usually increases at a logrithmetic rate. This effect is illustrated by Fig. 4 and it occurs primarily in the afternoon.

On the average, the fastest wind speeds occur in the afternoon while minimum wind speeds are usually observed between 10 p.m. and 5 a.m., depending on the season and on the geographical location.

Knowledge of the wind speed at a given location is helpful in making several important decisions. For example, should you plan to water turf today or tomorrow? Or, at what time of day should we spray with insecticides? You probably wouldn't want to spray or water when the wind is strong and gusty, because the insecticide would be blown away and could possibly damage nearby vegetation and, similarly, water from your sprinkler system would also be blown away. With strong winds, evaporation from the ground would occur at a rapid rate so that only a small amount of water would infiltrate your soil. If you must water on a windy day, keep the stream of water from the sprinkling system as close to the ground as possible.

Water used by plants is a function of temperature. For example, Kentucky Bluegrass requires maximum water when the range of the air temperature is between 70 to 80° F. Bermudagrass needs maximum water when the air temperature is about 90° F. If dormancy occurs, water use decreases rapidly.

The word "evaporation" has been used loosely to represent the amount of water vapor evaporated from a given surface. Unavoidably, this definition implies that transporation from plants is involved also. Thus "evapotransporation" should be used as the more precise definition of the loss of water vapor by plants.

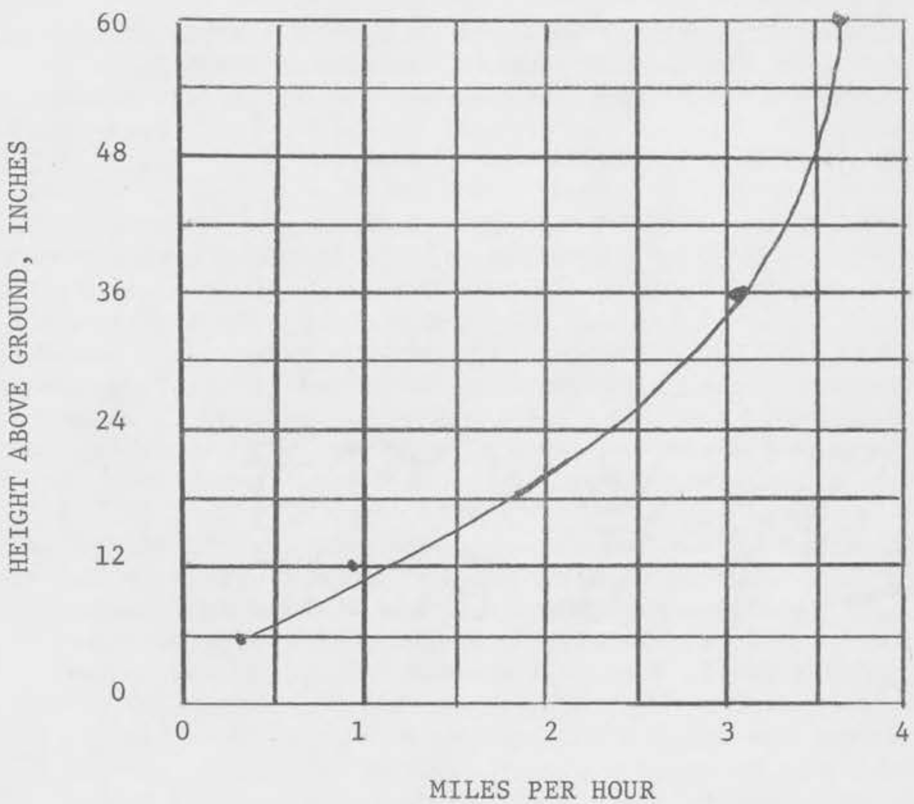

Fig. 4. Profile of the variation of wind speed versus height near the ground.

Evapotransporation is affected by such factors as temperature, wind speed, moisture content of the air, and available soil moisture. As mentioned previously, an increase in the movement of air causes a corresponding increase in evapotransporation. Transporation is increased rapidly with an increase in wind speed up to about 5 mph, and then more gradually up to 15 mph. Wind speeds of more than 15 mph usually decrease transporation by lowering the temperature of the plant and causing closure of the stomates. Transporation through the stomates is responsible for 85 to 95 percent of the water vapor that diffuses from plants to the air.

Transporation appears to be influenced principally by a combination of leaf characteristics and solar radiation which determines the leaf temperature. Leaf temperature, in turn, affects the water vapor pressure in the stomatal cavities. The higher the leaf temperature, the higher the water vapor pressure. Now the difference between the water vapor pressure of the air and the vapor pressure of the leaf is called the vapor pressure gradient. The greater this gradient, the greater the rate of transporation. High transporation rates generally occur during atmospheric conditions of moderate temperature (low relative humidity) and intense sunshine.

Obviously, from the discussion above, we realize the importance of knowing more about local weather conditions and how they influence and affect plant growth and development. By keeping long term weather records we can discover how the weather elements at a given site vary throughout the year. Annual trends can be seen easily when the data are finally analyzed and graphed on a daily basis for an entire year. Thereby, local climatic variations are immediately available for your personal use to give you a physical basis for making such decisions as when to plant, what species of grass to plant, and whether or not to water the grass.

Instruments and Observations

Professional weather forecasts are made for large regions, not for small areas such as a golf course. Thus, if each golf course was appropriately equipped with a small weather station, the professional weather forecast could be adapted successfully for local use.

Before you decide to build a weather station, you must determine the amount of money you will be permitted to invest and what instruments you can purchase with the available funds. Many types of instruments are available for measuring the weather elements; however, only a few specific instruments are necessary. Your weather station should contain equipment for measuring the air and soil temperature, soil moisture content, precipitation, evaporation, and relative humidity. Of these instruments, the first three are most important because they will help you in evaluating the health of your grass.

A single U-shaped thermometer can be utilized to determine the daily maximum and minimum temperatures. The average temperature for the day can be determined from the average of these two measurements. Prices for reliable thermometers of this type range from about $10 to around $30. Continuously recording equipment costs a great deal more. As mentioned earlier, soil temperature is seldom the same as the air temperature. By knowing the soil temperature you are provided with important information concerning germination, growth, and fertilization. Single removable soil thermometers costing less than $5 can be used to measure the current soil temperature. This type thermometer should be read at the same time (times) each day so that any diurnal fluctuations will be removed. More elaborate equipment is available at higher cost.

Daily measurements of precipitation, by means of a rain gauge, will give you helpful information concerning the available moisture supply; especially, when these data are related to the soil moisture content. A rain gauge should be exposed in an open area, free of any nearby obstructions such as buildings or trees. A clear, plastic rain gauge can be purchased for about $15.

Evaporation measurements can be very useful for helping you to estimate the soil moisture content, drying rate of the soil, and to evaluate the effectiveness of precipitation. A simple atnometer system can be purchased for around $15. Equipment for determining the soil moisture content, a tensiometer, is available in the price range $20 to over $200.

Unfortunately, wind equipment is expensive, particularly for a recording system. The simplest indicating types of wind equipment range from about $75 to over $300. Remember that by knowing the variation of the wind speed throughout the day, you will be able to pick the most favorable time of day to water and spray. When mounting the sensing element of a wind instrument, remember that it must be located in a region free of obstructions.

Once you have decided on which instruments to purchase, one other very important task remains; namely, where to place your instruments and, in what type shelter. The instrument shelter must permit air to circulate through it freely and it should be painted white to reflect solar radiation. Free air movement is essential to obtain the true air temperature; therefore, the shelter should have louvered sides and bottom as well as a 2-inch air space between a double roof and the outside surface. Most shelters are located about 5 1/2 feet above the ground and are situated in an open field. The shelter should be constructed to prevent precipitation from wetting the instruments.

Data Presentation and Uses

To obtain a good climatological record it is important that your observations of the weather elements be made in a consistent manner and tabulated on a standardized form such as the one presented in Fig. 5. In this figure $\overline{T}$ represents the average daily temperature, "Evap." evaporation, and a special column is provided for any comments that may be appropriate.

When analyzing the data remember that the maximum air temperature usually occurs between 2 and 4 p.m. while the minimum temperature often occurs at about sunrise. However, on cloudy days and nights or during periods when weather fronts pass, the temperature extremes can occur at any time of the day.

Relative humidity minimums usually occur during the afternoon and it is generally greatest when the daily temperature reaches its lowest value. Thereby, transporation from plants is usually greatest in the afternoon.

Grass covered soil is cooler than bare soil during the summer months. Soil moisture losses proceed from the top-soil downward.

The presentation of the data must depend on the specific problem being investigated, but it is generally insufficient to present the data only as average values. The best approach is to use some method of relating values of the parameter to the frequency of their occurrence. For example, what is the percentage occurrence of temperatures above 100^{o} F, or, what is the probability of 2 inches of rain in January? These values can be determined from an accumulation of climatic data. At least 5 years of data should be collected before placing any statistical significance on your numbers.

After collecting your meteorological data you should compare, for instance, your average daily temperature and the average monthly soil temperatures with those obtained by the local Weather Bureau station. Such a comparison will tell you how much your local climate varies from that of the Weather Bureau. You can then begin to use this infromation to supplement the professional forecasts.

By plotting monthly precipitation against monthly evaporation you can determine whether or not a water balance exists. Such a tabulation will help you determine those parts of the year you should water your grass most often.

Date	Time	Max. T.	Min. T.	Soil T.	Rainfall	Wind (Dir./Speed)	Evap.	R.H.	$\overline{T}$	Comments

Fig. 5. A proposed table to be used to tabulate and maintain climatic data.

These examples represent only a few of the possible applications of your climatic data. For help in analyzing your data contact the local Weather Bureau station, the state climatologist of any academic center with a department of Meteorology.

References

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Acknowledgement

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LIGHTING PARKS AND GOLF COURSES

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Introduction

For the next few minutes you will be devoting your efforts to outdoor lighting. Before we get into discussions of the how's and the why's of lighting, let us take a brief tour of our factory in Hendersonville, North Carolina. Located on a plateau between the Smokies and the Blue Ridge Mountains, Outdoor Lighting Department, General Electric Company, is the largest single manufacturing facilities for lighting equipment in the world.

Built in the late 1950's from sculptured aluminum, glass and brick, at night time Outdoor Lighting Department takes full advantages of the products which it manufactures.

Since that time, Outdoor Lighting Department has undergone several major expansions including two new warehouses, one shown here in the upper right picture and another located further to the right outside the picture. In the background is the internationally famous "Crossroads of Light", where we are able to demonstrate any type of roadway lighting system currently used. The "Crossroads of Light" consist of a major boulevard, equivalent to the modern day expressways with both asphalt and concrete surfaces; a major collector street; and a residential street. Over 5,000 visitors come to Hendersonville each year to see this demonstration in order to evaluate their lighting systems.

Most of the luminaire manufacturing is done on high speed, automated assembly lines. Here we see the manufacture of the Power Bracket and 101 SA's, commonly known as barnyard lights. In the background you see the overhead lines carrying the General Electric Roadway Luminaire. Hendersonville currently has four such high speed lines for Roadway Luminaire production only, turning out as many as 800 fixtures per day.

These two lines are designed to handle production of our Industrial Luminaires,500 and 1500 watt quartzflood luminaires, seen on the left, and Powerflood mercury luminaires. In the foreground you can see the optical assembly for the General Electric Filterglow Luminaire. The charcoal filter is currently being used in our Roadway, Industrial and portions of our lighting product offerings. It has proven that it can reduce the maintenance required on a given fixture by as much as 25%!

There are two major components required in any outdoor lighting system: a lamp, and a luminaire. First, let's take a look at the current lamps most popularly used in lighting. The three most common light sources are filament, fluorescent, and the high intensity discharge sources. Here we see some of the various shapes and sizes of mercury lamps in both clear and phosphur coated varieties. These are the most common today in lighting systems and offer relatively small envelope size, long life, and high lumen per watt output.

As you can see here the standard life rating on an ordinary filament lamp is approximately 1,000 hours. In comparison, the mercury lamp offers us better than 24,000 hours life, 16,000 hours of life maintained.

On a relative scale you can see that mercury has a life of approximately 48 months whereas filament would last approximately 10 months, fluorescent approximately 24 months and Lucalox approximately 20 months. In a given lighting system that would be operated over 1,000 hours per year, mercury has obvious economic benefits resulting from the savings in labour and lamp cost.

Lucalox, the latest introduction in light sources is the most efficient light source known today, producing 110 lumens per watt. Mercury, as you can see, gives us approximately 55 lumens per watt. Consequently, a 400 watt Lucalox lamp produces 44,000 lumens versus a 1,000 watt mercury producing 55,000 lumens. This results in a tremendous savings in power consumption.

The second part of the system is of course the luminaire. Here is the General Electric Roadway Luminaire called the M-400A Power Door. As you can see, it utilizes a prismatic glass reflector and a built-in photocontrol on top. This unit is commonly sold to the state highway departments and utilities, however, it is often used in area and industrial lighting in major parking lots.

The most popular floodlight designed to utilize the mercury light source is the General Electric P400 and P1000 Powerflood. As you can see here it utilizes a die cast aluminum external housing with an internal Alzac reflector and an integral ballast. The trunnion is of galvanized steel. Notice this unit can also be individually photo control.

The most popular area lighting fixture offered by General Electric is the A4000 Powerglow. This fixture uses 4 - 1000 watt mercury lamps, is 4 feet tall and 6 feet in diameter. The optics of this luminaire are designed to give low glow, a diffused light, and to cover an area of 1 acre to 2 footcandles.

Now that we have seen what comprises a lighting system, it is necessary that we have a basic understanding of the terminology of lighting. Let's compare it with a water hose squirting water into a barrel. Water comes through the hose under a certain pressure. In a lighting fixture, by changing the optics of the luminaire we can concentrate the pattern of light and change the "pressure" of the light. This pressure we call candlepower. In our water hose the water that comes out of the nozzle is measured in gallons. The light that comes from the luminaire is measured in lumens. From our water hose, most of the water will fall into the barrel at which we are aiming. This water is utilized water. In lighting the amount of light that falls on the area is called utilized light. Finally, the amount of water that falls in the bottom of the barrel is called density. In lighting, the amount of light that falls on the given area is called lumen density or footcandles.

Basically, a footcandle is the amount of light produced by one candle and falling on an area one foot square on a sphere located one foot away from the source.

Industrial, Commercial and Parks

In the past few years, lighting has grown at an increasingly fast rate. There are many reasons for this fast growth rate, among them the growth in crime, increased vandalism, and on the plus side, advertising. Commercial and industrial facilities have become increasingly aware of the fact that facade lighting of their buildings and plants is one of the cheapest forms of advertising they can buy. And, with the many architectural features that we have to work with today, good lighting is becoming as much an art as a science. Take, for instance, the Kirby Building in Houston shown here. By placing the floodlights in banks and aimed upward at a steep angle we have created shadows from the ledges at each floor and caused a striped effect. This gives the building an unusual appearance at night and presents itself to the public for miles around.

One of the most famous landmarks in our country, Independence Hall in Philadelphia is lighted with Lucalox to 20 footcandles and certainly has an outstanding appearance. The golden color of the Lucalox lamp combined with the architecture of the building itself have made Independence Hall as much a show place at night as in the daytime.

This is Florida Power & Light Company in Miami, Florida. I think you will certainly have to agree that this is one of the most outstanding commercial buildings that you have ever seen. Lighted with a group of Par lamps and 500 watt Quartz, and using red, blue, yellow and green diachroic filters, the building takes on a unique color scheme. And, each of the floodlights is sequenced and programmed by a computer so that different sections of the building change colors over a period of time creating a motion effect. The diachroic filters used on this building are experimental and must be changed approximately once a year.

In any type of facade lighting, whether on commercial or industrial buildings we would always recommend that the floodlights be hidden from view as best possible. Here you can see 2 - 1500 watt Quartzfloods hidden behind shrubbery. This adds nice landscaping to the building in the daytime and hides the source of the illumination at night.

This is another rather unusual lighting job in an industrial facility. This photograph was taken with a fish eye lens looking down the length of the building. Each of the luminaires that you see is a 400 watt mercury floodlight. In case you are interested this is the vehicle assembly building at Cape Kennedy, Florida.

Looking at the building with the doors open you can see part of the first stage of a rocket being assembled in the building and a portion of the banks of floodlights mounted on each side.

I mentioned earlier one of the prime reasons that industrial facilities are interested in good lighting is for security lighting against vandalism. Here you see a row of Powerbrackets mounted on the side of the building spaced every 75 feet apart. These units are 400 watt mercuries, and light the side of the building as well as the ground well out past the sidewalk. Anyone within 50 feet of the building can easily be seen.

On the face of this building you see 400 watt mercury floodlights serving a dual function. Not only do they give excellent security lighting at night, but also provide illumination for night time loading and unloading.

As major industrial complexes become more and more aware of their outward appearance to the public, they are now beginning to present their facilities to the public in a pleasing manner. At the entrance to this industrial complex we have used A4000 Powerglows spaced every 150 feet down the median of the boulevard. At night these luminaires serve to light the street and to give a decorative appearance to the overall complex.

Industrials are now lighting their parking areas so that the night shifts will feel safe and in order to reduce accidents. This lot is lighted with two 1000 watt Roadway luminaires per pole. Notice that the system follows the basic design criteria of good parking lot lighting, that is the spacing of the luminaires should be approximately 4 times the mounting height. In other words, if the luminaires are mounted 40 feet in the air then the poles should be spaced approximately 160 feet apart. This spacing can be stretched to as much as 6:1 ratio, however, uniformity begins to become unacceptable at this spacing.

This shopping center has lighted its entire parking area with only 3 - 4000 watt Powerglows, spaced 200 feet apart and mounted on 40 ft. standards. This is a 5:1 ratio and you will notice that the uniformity is still excellent.

Going indoors for just a second we see Valley Manufacturing Company in Valmont, Nebraska. This is a pole manufacturing company, and is lighted to 75 footcandles with twin 400 watt mercury luminaires. Here we have accomplished the three most important things in industrial lighting: Good high level illumination, low glare from the luminaires, and excellent contrast on the ceiling. Notice as you look up toward the ceiling that there is good illumination on the ceiling itself. It is not like looking into the headlights of an oncoming car at night.

Here is a different type of commercial application - the stockyards in Abilene. The stockyards are lighted with 2 - 1000 watt floodlights mounted at each pole to give an average illumination of 5 footcandles. Lighting the stockyards for night time use has increased their operation by better than 50%.

This is Stone Mountain National Park in Atlanta, Georgia. There are many, many different areas in parks that need to be lighted, one of them being the roadways through the park. And, usually a park lends itself to a decorative type unit rather than the standard roadway luminaire.

Here you see the use of 400 watt post top luminaires mounted at 20 feet and spaced every 100 feet through the park. As I said, these luminaires function as street lights at night, but give a very pleasing appearance and enhance the beauty of the park in the daytime.

This rather unusual mall is in Knoxville, Tennesee. Here the architect has used 175 watt roadway luminaires mounted 4 to a pole and mounted at 25 feet to give excellent lighting in the mall area and at the same time still gives what we feel to be a very pleasing appearance.

Landscape lighting is truly an art, blending the right wattage with the right color in the right location. Here you see excellent usage of low wattage mercury hidden behind bushes lighting pine trees. Because of the deep green color of the trees the landscape architect has used clear mercury lamps to bring out the strong blues and green in the trees. If this were an area of hardwood trees and in the fall, he could easily change these lamps to the new phosphur coated lamps or to incandescent to pick up the reds and yellows in the leaves and add to their beauty.

Indirect lighting from 500 watt quartz floods hidden on either side of this bridge highlight the bridge, give it texture and emphasize its architectual beauty at night. Notice in particular that the colors of the incandescent lamp source helps to emphasize the color of the bridge and the hardwood trees above.

Again, you see how the landscape architect has managed to create a mystical wonderland in this forest that would appear completely different if viewed in the daytime. Here the architect has used low wattage clear mercury lamps hidden down in the trees and aimed straight up to highlight the color and the texture of the evergreen trees. At the extreme right you see that he has used incandescent lamps to highlight yellows and orange in the hardwood trees.

Parks offer probably the greatest possibility for good lighting combined with imagination and creativity. In every park we find roadways, playgrounds, parking lots, buildings and landscape, all of which can be highlighted with good lighting as well as making them functional for additional hours of use each day. There are many good ways to light a given park and recreational facility, and General Electric's Outdoor Lighting Department is ready to help you with your particular application at any time. Please feel free to call on us at your convenience.

Golf Course Lighting

One of the most popular sports today is golf. And, as you know, lighting is beginning to play a major role here too. But before we look at the how's of golf course lighting let us take a brief look at the why's. In 1958, there were 3.9 million golfers. But, in 1966 there were 8.5 million.

Now let's look at the growth in golf courses during this same period of time. In 1958, there were 5,745 golf courses. In 1966, there were 8,772 courses.

It is easy to see then, that golf courses have grown at the rate of 5.5% whereas the number of golfers have increased at the rate of 10.8%, almost twice the rate of golf courses!

Obviously something will have to be done. We have two choices: First, we can either build new golf courses or, second, we can light our existing courses. As you can see here it is estimated that a nine hole golf course in a suburban area would cost approximately $200,000.

However, if we were to light that same golf course it would take approximately 132 floodlights. Totaling the cost of the luminaires, poles, lamps installation, etc. we can see that it would cost us approximately $66,000 to light an existing course.

On an annual basis, taking into consideration the cost of the electric power, the replacement lamps and the cost of cleaning and relamping, it would cost approximately $2,630 to maintain this lighting system.

Now let's take a look at the annual income gained from lighting this course for night use. If we assumed that the lighting system will give us three additional hours of operation per night, and that there are twenty starts per hour at $1.50 each green fees, then we will have an added income per night of $90.00. If the course operates 200 nights per year this means an annual income of $18,000.

Now, if it cost us $66,000 to install this system and $2,630 per year to operate it over a period of 4 years this is a total of $76,520. Having an income of $18,000 per year for 4 years is $72,000 return over the same period of time. Consequently, we will have a total write off in less than 5 years!

We are certain that this study is very conservative for 5 reasons:

1. Many courses are shorter than 3,300 yards.
2. Lighting should add more than 60 rounds per night.
3. Green fees are often higher than $1.50.
4. This study ignores other income sources.
5. There are often more than 200 golfing nights per year, as we have in Texas.

Now let's take a look at some how's of golf course lighting. Obviously, golf has changed a lot since Tommy Burke hit the first golf ball on the first lighted golf course many, many years ago, as you can tell from this very stylish picture.

Now let's go out to San Francisco, California and play a round of golf on the Tall Pines Country Club golf course, which is the first regulation 18 hole golf course that was completely lighted for night time use. This system was installed in 1967 and our reports are that the system will have completely paid for itself within approximately 3 1/2 years. Throughout the entire golf course we maintain a constant mounting height of 40 ft. On the tees our pole is placed 50 ft. back and has two luminaires mounted on it. Aimed at the tee area we use a 1000 watt phosphur coated mercury lamp in order to produce the good color rendition required when our golfers are spending any time at one location. Notice from the shadows that the light is mounted directly behind the tee so that the shadow will go straight forward and will not fall over the ball regardless of whether we have a left or right handed golfer. The second luminaire is a 1000 watt clear mercury and aimed at a distance of approximately 100 ft. down the fairway. You can see where the center of the beam hit just on the crest of the hill out past the golfers. This 100 ft. distance is 2.5 times the mounting height and at no time should we exceed that distance. The tee area is lighted to an average of 5 footcandles maintained.

Here is another tee with a little different set of circumstances. Notice that the shadows are coming back behind the golfer. At any point on the golf course we should try to utilize as few poles as possible, and locate as many fixtures on a single pole as we can. In this instance, on the left side there was a fairway pole and on the right side there was a pole lighting the green. Since both these poles were very close to this tee, we mounted high floodlights on these existing poles. The clear mercury lamp used for lighting the fairway in front of the tee is mounted on the pole at the left. Consequently, we have eliminated the pole behind the tee, have put three floodlights on the pole to the left and two floodlights on the pole to the right. Extreme caution should be taken, here, however, to prevent the lights from being too far out ahead of the golfer and blinding him.

Now we are out on the fairway. The fairways of the golf course should be lighted to 3 footcandles average maintained and our poles are still 40 ft. tall. In all cases we use uni-directional lighting, that is, the lights are aimed in one direction down the fairway. We still maintain the maximum 100 ft. aiming distance and use points so as to overlap the beam spreads as much as possible to create a uniform lighting system as you see here.

Looking back now in the fairway, you can see how the floodlights are aimed toward us, as exemplified by the shadow of the man standing on the front edge of the green. All the lights you see in this picture are not used on this particular fairway. The shorter poles are on another fairway up to the right of the one we are playing on.

Let's talk a minute about spacing. In all cases on the fairway we use the clear mercury lamp because color rendition is not as important to us here, and because we can get the longer throw and more concentrated beam pattern with it. Notice here that we have concealed the poles as much as possible and in some cases we have mounted the floodlights in the trees. This is very acceptable, since it eliminates the need for a pole. However, make certain that all branches around the floodlight are trimmed up so as not to hinder the light output of the luminaire. If our fairway is 50 yds. or less in width then our poles should be spaced approximately 35 yds. apart, staggered. If the fairway is 65 yds. wide the poles are spaced 25 yds. staggered. If the fairway is 85 yds. wide the poles are 20 yds staggered and a 100 yds. wide would require a spacing of 35 yds. opposite. The fairway that we are looking at is in the 50 yds. wide class and the poles are staggered from right to left down the fairway. In no case should we exceed 4 times the mounting height of the pole, or 160 ft.

Well, here we are at the green and as usual I am in the sand trap. Notice my partner on the right is getting somewhat disgusted since I have already taken 7 shots to get out.

Well, finally I made it out, but don't get your hopes up. I topped the ball and skimmed it over the green and had to come back. Notice in particular the good color rendition and the reasonably high level of illumination on the sand trap and the green area.

On the greens we calculate for an average level of 5 footcandles maintained just as we do on the tees. Several things should be mentioned about lighting a green. The lighting should be bi-directional, that is coming from each side so as to eliminate as much shadow as possible and to get as excellent uniform light across the entire surface area. The poles should be located within 50 ft. of the center of the green, and should use one 1000 watt phosphur coated lamp per pole. Again this is for the good color rendition since our players will be spending some time on the green. If our poles have to be located more than 50 ft. away from the edge of the green, then one of the luminaires should use a clear mercury lamp in order to get the necessary punch to bring the level of illumination up to required standards. Of course the quantity of floodlights required to produce the suggested footcandle level will depend largely on the size or area of the green. Two floodlights are sufficient for anything up to approximately 6,000 ft. As we increase the area then obviously we should increase the quantities of floodlights, for instance, if you double the size of the green, that is now we have an area of 12,000 ft. then we should use four 1000 watt phosphur coated fixtures in order to get adequate coverage of the playing area. One other important point about lighting the greens. Obviously the poles cannot be placed behind the green since the floodlights would be looking into the players as they approach. In order to properly place the poles we would draw a line perpendicular to the fairway and through the center of the green. The best pole location of course would be on this line and within 50 ft. of the center. However, it is acceptable for us to inscribe an arc from the center of the green and come down not more than 30 degrees from the perpendicular. Our poles can then be placed anywhere within this 30 degree arc.

Well now that we have finished our game with an outstanding score of 133, we decided we had better go to the driving range and hit some practice balls. Let's assume that our driving range is 150 ft. wide and 900 ft. long. Our poles should be spaced 50 ft. apart, giving us three pole locations, and 30 ft. high. The reason for the somewhat close spacing is to insure adequate uniformity on the tee area. Our calculations should produce at least 10 footcandles on the tees and 5 vertical footcandles at a distance of approximately 200 yds. This can be accomplished by using one phosphur coated luminaire per pole to light the tee area, giving us three units total. Then, just as in regular golf course lighting we would aim one luminaire per pole with a clear mercury lamp at a distance of approximately 100 ft. This is to reduce the contrast of going from an extremely light area into a relatively dark area and also helps those of us who have very short shots to find the balls. Finally, we can produce our 5 vertical footcandles by aiming 4 floodlights per pole, a total of 12 in this case, at a distance of approximately 600 ft. These 12 luminaires will adequately give us the 5 footcandles that we require.

WHAT'S IN A BAG OF FERTILIZER

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"What's in a bag of Fertilizer?" Before answering this question, it will be necessary to examine some of the materials used in manufacturing a lawn or turf fertilizer.

The first material we should consider is nitrogen and the forms in which it is available for a fast reaction from nitrogen fertilizer we would want to include a nitrate nitrogen source. This could be either nitrate of soda or ammonium nitrate. Intermediate growth response could be obtained from nitrogen with an ammonium source such as ammonium nitrate or ammonium sulphate. Most of the nitrogen taken up by the grass-type plant is in the nitrate form, however, some nitrogen may be taken up in the ammonium form.

There is another form of nitrogen used under some conditions as a slow release form of nitrogen. Urea is a combination of two parts of ammonia with one part carbon monoxide. Little if any urea is used by the plant in this form. Urea first is hydrolized by enzymatic action to the ammonium form and then oxidized by microbial action to the nitrite form and then to the nitrate form. This oxidation will take place with proper conditions of temperature and moisture. To insure that a minimum amount of nitrogen from urea is lost to the atmosphere, urea must be used in either cool weather or immediately watered when applied during warm weather.

To overcome this possible loss, TVA has been conducting work on coating urea particles to reduce the rate of microbial action and to reduce this loss as a nitrogen gas. Some very slow release nitrogen fertilizers with sulfur coated ureas have been developed. These sulfur coated ureas will be about 35% nitrogen with 15 - 20% of the nitrogen available in the first two or three days and then a very slow release of 1 or 2% of nitrogen available daily for an extended period of time.

The second source of materials we should consider in manufacturing a lawn or turf fertilizer would be the forms of phosphorus available. There are three phosphorus sources generally used by most manufacturers of lawn and turf fertilizer. The first diammonium phosphate--either 21-53-0 or 18-46-0 --which is 90-95% water soluble. Either 21-53-0 or 18-46-0 will give the same chemical and agronomic response. 21-53-0 is a pure crystal form of diammonium phosphate whereas 18-46-0 contains some of the impurities of the west process acid. Two other forms are monocalcium phosphate, or 0-20-0 which is 80-85% water soluble and 0-46-0, or triple super phosphate that is 85-90% water soluble.

The other source material to include in this discussion of lawn and turf fertilizer would be potash. The most prevalent form would be muriate of potash or potassium choloride which is about 60% K_2O. This form is the one used by a large majority of the manufacturers. A very few speciality type fertilizer have used potassium nitrate or potassium sulfate.

Dr. McBee and I agreed that a typical lawn fertilizer should have 16% nitrogen, 6% P_2O_5, and 12% K_2O.

A bulk blend grade with no filler could be made by using 1,325 pounds of ammonium sulfate, 275 pounds 18-46-0, and 400 pounds of potassium chloride. A tone of material would analyze 16-6-12 with no filler. Assuming some cost for these materials on the market today, this blended grade would cost the manufacturer approximately $40.13/ton.

Some people in the lawn and garden trade are catering to customers that prefer a 16-6-12 with an organic base. To include an organic base in the previous bulk blended grade it will be necessary to use higher analysis of some of the base materials such as ammonium nitrate to replace the ammonium sulphate. This would permit the inclusion of an organic base to the 16-6-12.

In another blended 16-6-12 grade we would have 956 pounds of ammonium nitrate, 600 pounds of 0-20-0, and 400 pounds of potash. Only a limited amount of an organic base material or 44 pounds/ton would be added. Using an organic material at about $10/ton, this blended grade could be made for approximately $38.84/ton.

Another formulation to make a 16-6-12, bulk blended grade with a higher amount of organic base, would require the use of a high percent nitrogen product. With 712 pounds of urea, 261 pounds of triple superphosphate, 400 pounds of potash and 627 pounds of organic base may be included per ton. The cost of this grade is approximately $39.94/ton.

A third method of making a 16-6-12 is by using an ammoniator granulator. In this process, the end product would not be a bulk blended grade as previously described, but would be a homogenous grade. It may be made by using 591 pounds of ammonium sulphate, 447 pounds of 44% ammoniated solution, 111 pounds of 0-20-0, 218 pounds of 0-46-0, 400 pounds of 6% potash and 280 pounds of 93% sulfuric acid. Heat will develop when the sulfuric acid reacts with the 44% nitrogen solution. This heat is needed to granulate this material. This finished product will have approximately 1% moisture and a cost of $42.12. The ammoniation granulation grade costs a little more. However, the grades have some properties not present in the bulk blended grades previously discussed. In a bulk blended grade, previously discussed. In a bulk blended grade, separation or segregation of the organic base from the granular fertilizers is possible due to the too large differences in particle size. The difference in particle size is the factor that gives the greatest change in distribution patterns among fertilizer grades. With a homogenous grade the material is quite uniform in size with no separation or segregation as we would present in a bulk blended grade. The ammoniated grade requires a larger capital investment to manufacture than the bulk blended grade, however, there is more flexability in use of raw materials that may be used.

These are the different ways we could make the same grade of fertilizer. In each case the grade would be a 16-6-12. You could make it with no filler, with a small amount of organic filler, a large amount of organic filler or with the ammoniation granulation method with no filler at all. I hope this has given us some insight as to the different ways the same fertilizer could be made. The quality of the product would depend upon the raw materials used and the job you would want the grade to perform such as a fast acting fertilizer, one with an intermediate action, or delayed action.

REDUCING COSTS IN TURFGRASS MANAGEMENT

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The cost of maintaining turfgrass areas has been increasing year after year. Unfortunately, operating budgets have not been increased rapidly enough to meet these ever-increasing costs. Club officials must recognize this and, unless they are satisfied with a sub-standard course, they must take a hard look at their operation and supply the funds to provide people with what they want. It appears to me as I visit clubs around the country, that bar stools have more chrome, carpets are thicker, walls are expensively paneled and draped, and the golf courses are going to pot.

I would like to go on record by saying that the superintendent is not to blame for this situation. By and large the average superintendent is doing an amazing job with the funds and facilities he has to work with. He is making every effort to learn more to develop new techniques that will save the club money. He attends turfgrass conferences and monthly meetings. He freely trades information with fellow superintendents.

But, in my opinion, this is not enough. He needs to get through to the club officials and get them to recognize where the problems are.

The basic problem is simply this: "You must spend money to save money."

O. J. Noer had a classic statement of his own that said it in a different way. He was heard saying, many times: "A golf course is not a place to save money - or to waste it."

These statements pave the way to our discussion: "Cutting costs in turfgrass management". When we begin an analysis of any operation to bring down costs, the first things we look for are those areas where most of the money is being spent. The sum total of savings on little things is insignificant. It is in the big spending areas where the greatest savings can be made.

Where is the largest expenditure in turfgrass maintenance?

Labor of course. This is where most of the money is spent. Labor budgets today average about 70% of the total budget.

I wonder how many people realize that in 1939 - 30 years ago - the labor budget averaged 70%. It is obvious that little or no change has taken place. This is obviously not true in other industries.

Coupled with the fact that labor usage is high is the fact that labor is also scarce. Competition for manpower - that is getting higher wages and more benefits in other industries - is slowly driving turfgrass management into a corner.

What can be done? Well, it's better to start too late than never. And the way to start is with a plan. A plan that covers all aspects of the problem. You can make up your own, or use the following as a general guide. Remember, don't cloud your plan with a lot of unrelated problems. Stick to one concept, and that concept is doing the job that the membership wants done with a minimum of labor and cost. Don't compromise. Cheap labor and improvised equipment waste money. Your club is not looking for something cheap. They want top quality at a reasonable cost.

Plan 1:

Areas to explore:

1. Your over-all system of operation
2. Operations that lend themselves to mechanization
3. Preventive equipment maintenance program
4. Parts inventory and control
5. Reconstruction to reduce maintenance
6. Redesign of fairways and roughs
7. Comprehensive study of sand traps
8. Labor and labor relations

Let's elaborate on each one of these points:

1. Overall system of operations:

When you take a cold, hard look at the average system of operations on many golf courses, your find that the sequence of operations and the methods employed were not developed from the standpoint of efficiency, but rather were developed through trial and error.

In many cases we find not a planned operation, but an inherited system. This does not mean that the whole system of operations is bad, but it does mean that there is plenty of room for improvement.

It is my feeling that the whole system must be re-evaluated. A scientific and practical approach must be developed to meet the challenge of the sixties with its rising economy, high prices, and labor shortages.

In evaluating a system of operations, one must start with cost and time studies. This is something that is seldom, if ever, mentioned in any turfgrass publications.

The first thing you need to get into cost and time studies is a stop watch. This little instrument will give you a lot of information. For example - how long does it take to mow a green? If you determine the time that the reel is actually cutting grass, you will find the total time is only 10 to 11 minutes for an average 6000 sq. ft. green. The rest of the consumed time is used up getting to the green, preparing the mower, emptying the basket, hand-spitting, etc.

In industry, we are guided by a rule known as "Parkinson's Law". His law states: "Work expands to fill the available time." (It might be a good idea to type Parkinson's Law on a piece of paper and glue it to the back of your stop watch.) It means that, if you have an hour's time to get dressed, you consume the time doing so. If you have only ten minutes to get dressed, you accomplish the same job in that amount of time. Therefore, if it is the custom at your club to allot three hours to a man to mow his greens, then he will use this time to complete his task.

<u>If you change the procedure, you must also change the time consumed</u>, and this is directly related to cost.

What we are really attempting to do is not to force a man to work <u>harder and faster</u>, but we are developing a system which will make him more <u>efficient</u> and therefore do more at less cost.

The Formula I use is 10 minutes a day represents a saving of $100.00 a year, because you must add to the hourly rate vacation and all benefits the employee receives.

Projecting this formula, if we have a crew of ten (10) men, at a savings of $100.00 a year each, we wind up with $1,000.00 saved.

Assuming that I am correct in my observations, and taking the low figure of one hour per day saved, this represents a saving of at least $600.00 per year times ten (10) men is $6,000.00. This represents a nice chunk of your labor budget.

What I have pointed out here, however, does not mean that you can proudly tell your club officials that they should deduct this money from your budget. Every cent that you save is going to be needed for the inevitable increases in wages, including your own salary, supplies, etc.

Let us now explore operations that lend themselves to mechanization. Here is another area where a great deal can be done.

Far too many golf courses are still back in the horse and buggy days. Antiquated equipment, or worse yet, total lack of equipment, means that the job to be done must be bulled through with expensive hand labor. In this day and age, we cannot afford to dig ditches by hand. We are wasting money when we mow an area with an eighteen-inch hand-pushed rotary mower when the job can be done with a riding triplex. We should use machines that require one man rather than a crew. Many operations can be mechanized today with modern equipment. Some of these operations include aerification, top dressing, dragging, mowing, watering and even supervision.

Two-way radio systems increase efficiency tremendously, making possible immediate contact with workmen on any part of the golf course.

We should initiate and enforce a preventive equipment maintenance program. Much has been said on this subject, but not much has been done about it.

Ford Motor Company has published these figures. Failure to replace a damaged $10.00 dry type air filter on a tractor can cause more than $150.00 engine damage. Replacing a $2.50 hydraulic fluid filter may save $25.00 to $50.00 in parts and labor later on. A cracked hose between the air filter and carburetor costs just one dollar to replace, but can cause $100.00 or more engine damage. In less than a half hour, $1.00 or $2.00 worth of labor, you can clean, service, and fill a battery that might save a new $20.00 battery. Just a few minutes spent each week inflating tires correctly can save $10.00 or $20.00 or more in yearly excess wear to tires. We could go on and on. With a good preventive program of equipment maintenance, we not only pick up impressive savings, but equally important is the equal savings in down time while repairs are being made.

Parts inventory and control is another area that saves money in wasted down time. Many supply distributors have spoiled you with their efforts to keep you supplied with parts on a minute's notice. It takes more than a minute to get you the part; and both you and your supplier are losing money and patience.

It does not take much time to sit down with your supplier and determine those parts on each machine that are going to wear. Order them and stock them in your own parts inventory. Ask your supplier to replenish your parts stock in an orderly fashion as you use the parts. When a good parts inventory system is installed, you will find that you will not have to run all over hell to get things moving again.

Reconstruction of the golf course layout is a big area to explore to reduce costs. You must learn that you have to spend money to make money. Many golf courses were designed when labor was cheap.

Tees are usually the prime target in reconstruction. Many tees and tee areas cannot be maintained efficiently with modern equipment. Reconstruction will eliminate a lot of headaches along with saving a great deal of money. Reconstruction of bridges, hard-to-maintain-creeks and banks all fit into these areas of exploration for cost savings.

Redesign of fairways and roughs can easily knock off fifteen to twenty-five acres of intensive care turf.

Many golf course fairways have become bowling alleys and greens have become saucers.

Constant mowing in straight lines has destroyed the free flowing design of the architect. Fairways have become wider than they need to be. Stake out each fairway to make it look like its original design and you will find that you will pick up quite a few acres that do not need the intensive care you are now giving them. When this is done, it will be reflected in savings in mowing time, fertilizer, water, and wear and tear of equipment.

A comprehensive study of your sand traps may reveal a substantial area for cost reduction.

I believe that I am correct in stating that the maintenance of sand traps is the second largest item in your budget.

Anything you can do to eliminate traps or re-construct them for easier maintenance is going to reflect substantial savings each year.

Labor and labor relations is seldom considered as a cost-saving area, since we usually relate it to higher wages, more benefits and more manpower. Yet, if we look at it logically, we find that labor and labor relations have a profound effect on costs. I am talking about efficiency in performance. I am talking about attitude. A well-adjusted worker that likes his work, communicates well with you and enjoys working at your club, is an asset to your organization and can be directly related to cost of operation. The first thing you must offer is a decent living wage with all the expected benefits. But it doesn't stop there. A good man wants to become part of the act. He is willing to share your problems if he can share in the praise.

Recently, a golf course superintendent told me that, while he was having lunch in the club house, a member came by and praised him for the fine condition of the course. He said it made him feel good all over, and the raise he had been thinking about, didn't seem as important. I asked him if he had gone right out and told his men the same thing. Unquestionably, they would have felt as good as he did about it.

There is virtually nothing that motivates people more than pride. I feel certain that many of us work for less than we could get somewhere else, or in another line of work, because we are willing to trade dollars for satisfaction. All of us would rather work for less dollars and be happy, than to make a lot of money and be miserable. I believe this is especially true of workmen who choose golf course work for a living.

In many ways, it is a hell of a way to make a living. Rain and mud, stinking hot and freezing cold, bitching members, and flying golf balls, tiring work, and no one appreciates the work that he has done. The disadvantages of the job must be offset with enough good things to make him want to stay on. Becoming a part of the team is a strong motivating force that will keep him on the job day in and day out.

Building the team is your responsibility. Learn to communicate with your men. Bring them into the act. Hold meetings with them. Explain in detail what you are trying to accomplish. Involve them in your short and long-range plans. You will find that it will pay big dividends. When you sense that a man will not become part of the team, get rid of him. If you can't replace him, you may be surprised to find that your team will take up the slack. Get rid of dead-heads. Take the money you were paying them, and give it to your good men. Analyze it this way. If you have ten men and two are fouling up the works, get rid of them. For round figures, let's say they were making \$2.00 per hour. That's \$4.00 an hour you have picked up. If you divide the \$4.00 among the eight remaining men you can increase their wages \$.50 per hour. You can get a lot of mileage with this kind of money. Bring your men into the act. Let them know that you have just so much money to spend on labor to get the job done. Every additional man you hire is robbing their paycheck. Make them conscious of this. The less men to do the job, the more they make. Efficiency will sky-rocket. Your men will give you more ideas than you ever dreamed of to cut costs.

Summarizing the points that I have outlined, I would say that I have lightly skimmed over some of the important areas that you can study for cost savings. If you apply yourself, I am sure that you can come up with some surprising answers. When you do come up with answers, go over them with your officials. If you can sell them your ideas, you will find that they will help you achieve your goals.

Remember - As superintendent of turfgrass maintenance, you must concern yourself with only three primary areas of activity. These three areas are covered by the Three F's:

1. Finances
2. Future planning
3. Fouled-up details

DEW IS NOT DEW

Tom Mascaro
West Point Products Corporation
West Point, Pennsylvania

Dew on turfgrass areas is not dew. Most of the commonly called "dew" is in reality exudated water or guttated fluid exuded from the open stomata of the grass blades or from the clipped ends. Very little research has been done on the origin, composition or effects of exudated water, yet there is much evidence that it has a profound effect upon turfgrasses. Many theories have been presented but few have been documented by resource research. It is my hope that this discussion will stimulate research people and others to delve into this fascinating and important subject, and that the turf man who studies the following presentation will better understand some of its mysteries and how to cope with its effects through cultural practices.

The effects of exudated water apparently first received recognition when the United States Golf Association over twenty years ago conducted a survey among member clubs relating to the incidence of disease on putting greens. One conclusion that was drawn from the survey was that the golf courses that practiced early morning watering had less disease than those that did not. No one understood why but this practice worked and through the years has been adopted by many superintendents. The practice of early morning watering must, in some way, be related to exudated water, but its function is not too well understood.

Although we have made great progress in the science of turfgrass culture, a great deal of mystery still surrounds some of the problems we encounter.

These words indicated a mysterious set of circumstances of which no one is quite certain.

I suspect that many times we blame disease for loss of turf for lack of a better answer. We have special names for these problems; like, "melting out", "wilt", "spring dead spot", and even "summer dead".

Turfgrasses seem to die out overnight. Diseases strike and become uncontrollable. It seems to me that there must be an answer to why we lose control and turf is severely injured or lost.

Great progress has been made in the development of fungicides. They are of trememdous help to carry us through critical periods. Yet they fail us under certain conditions. Note these three words: Under Certain Conditions.

Another great mystery to me is why more basic research is not being done on why these problems occur in the first place.

Aspirin is great, but it seems to me that it is mighty important to know why we have a headache.

Therefore, in this discussion, I will discuss more the why rather than the cure.

During my many years in this great turfgrass industry I have seen and photographed many problems. I have been particularly fascinated with the mysteries of the effects of turfgrass loss.

I have been deeply disturbed when men who were good turfgrass managers lost their jobs because they failed to keep their grass alive under certain conditions. Feeling that there must be an answer, I listened to many theories and studied the research literature for any clues that could be pieced together.

The evidence I have accumulated seems to indicate that there are many factors that can be related to this problem. One of these factors, however, apparently has a pronounced affect as to why turf diseases occur and is the least understood. This factor is exudated water.

Exudated water is surrounded by mystery. It is not even called by the same name by different people. Some call it exudated water. It is referred to as exudate water. Others will call it guttated water, water of guttation, or guttation fluid. Still others say it is water of condensation. Children call it "Fairy Rain" but most of us call it "dew".

Many people have talked about dew, much has been written about it, not much is known about it, and what is known many times is full of misconception.

I would like to quote from the following article that was published nationally a few years ago:

"What Causes The Dew To Fall?"

Have you ever wondered why there is dew some nights and not others, Why nights but not days, why on some parts of the lawn but never on others, or what dew is?

Poets have called dew "Nature's water jewels". Children see it as "Fairy Rain". The meteorologist says, "The air got too cold to hold all the moisture-the excess fell to earth".

Three requisites are essential for dew to form--moist air, a cold surface, and a clear sky. If clouds gather, dew ceases to fall. If tree foliage overhangs the lawn, effect is like a cloud and dew does not collect.

But when the day has been brightly sunny and the night turns real cool, conditions are right for a copious fall of dew.

Next morning you will discover that the very smallest grass blade has not been neglected. It will be dew-laden and an object of beauty.

Frequently a leaf will have a single large dewdrop, clear as a diamond, deposited at the very tip of the blade. Sometimes two or even three large drops will be held suspended, while upon the extreme sharp edge of one or both sides of the blade there will be a collection of small, bead-like drops in orderly, precise fashion.

When the large dewdrop perched upon the tip of the grass blade starts to fall, it descends rather slowly at first, following the extreme edge of the blade as it slides down and joins up with the other dewdrops it encounters strung along the edge of the leaf. Eventually the combined drop becomes heavy and falls to the soil.

Dew can provide a valuable addition of moisture for your lawn.

Much of this article is misleading, yet it says what most people think about dew.

The so-called "dew" we see on turfgrasses is largely exudated water. It doesn't fall, it rises, Most of it is water exuded or "pumped" out of the plant.

Light and temperature affect this process. During the night with lower temperatures and lower evaporation rates the exuded water accumulates. Apparently through the process of osmosis root pressures build up to force water out of the hydathodes. During daylight hours with higher temperatures and more rapid evaporation the reverse takes place. A few investigations have shown that the plant system is under tension and water can be taken in by the leaf. If the evaporation rate is low during the day, however, exuded water will remain and sometimes continue to form.

Perhaps the reason so called "dew" does not form under trees is that the soil is drier and water is not present to be exudated. We know that there is a definite relationship to the amount of exudate and the available soil water.

Close observation will show that the orderly, precise arrangement of the droplets is due to the location of the hydathodes and that the single large droplet at the tip of the blade is much larger than normal if the blade has been cut.

These are facts and have been documented by a few research scientists.

Here is what these men had to say about turfgrass disease and exudated water . . . . .

J. K. Wilson

1923

"Exudate contains both organic and inorganic materials."

The organic materials suggest exudate water may have a similar composition to that of the plant sap.

Hydrogen ion concentration is almost the same as the sap. As plants become older the exudate becomes more acid.

A substance (sugar enzymes peroxidase, reductase, or a combination of them) suggests that nitrates which are taken up by the plant are in part reduced to nitrites as they pass up through the plant tissues, and that this reduction may continue for some time after the water has been exuded.

The organic material that is present in exudate water seems to be easily utilized by bacteria.

Turfgrasses exudate water at different rates depending on the species. This is easily seen on turfgrass areas of mixed grasses. The exudated water is much heavier on some than on others.

The bentgrasses, bermudagrasses, and poa annua are prolific pumpers, bluegrasses are medium pumpers, and the fescues and zoysiagrasses are the driest or pump the least.

G. M. Hoffer

1949

Hoffer's Theory:

When turf is well fertilized with a quickly available nitrogen, the guttated water contains a high concentration of nitrates.

The nitrate salts cause a chemical burn on the grass leaf. The destroyed cells are than decomposed by bacteria to available organic matter.

The fungal spores germinate and sustained by the organic matter. If a great deal of thatch exists, some of the guttated water is obsorbed and held. When optimum temperature and moisture exists, fungus growth starts in the thatch and quickly spreads to the grass blades at the surface.

If the soil is compacted, this will restrict the infiltration of guttation fluid and a dangerour concentration of nitrates are held at the soil surface. This concentration of nitrate salts will cause a chemical burn of the plant stems and pave the way for fungus growth.

If a turfgrass area is well fertilized with a quickly available nitrogen and the exudated water is collected and poured in one spot, a severe chemical burn will result.

Engle

1955

"Very acid soil conditions favor most of the turf diseases."

"Tender succulent grass, which has received an excess of water and nitrogen, is susceptible to most diseases."

"While high humidity contributes to the softness of grass, it also may aid growth of the fungi."

"Air movement has a great influence on humidity as well as temperature at the turf level."

Large Brownpatch	77 - 86° F
Pythium	93°
Copperspot	81 - 86°
Dollarspot	68 - 86°
Pink Patch	65 - 73°

Early morning watering rather than evening has been found to keep turf more free of disease.

Lime to maintain pH above 6.0.

R. M. Endo

1967

Guttated water is the fluid exuded from the fixed, open stomata located at the tips of the grass blades.

When drops of guttation fluid are placed on the leaves of seaside bentgrass and threads of dollar spot fungus are added to the droplets, the threads grew sparingly to well and caused a variable amount of infection.

When water was used the fungal threads grew very sparingly and failed to cause any infection.

When bentgrass seedlings were sprayed with spores of Helminthosporium sorokinanum suspended in guttated water, the plants developed very severe symptoms on 99% of them in 2-4 days. Nearly all the seedlings were dead after 6 days.

Plants inoculated with spore - tap water suspensions developed water soaking, yellowing and necrosis on 10% of the plants in 6-7 days - all plants survived after 14 days.

Guttation water increased infection and disease. It induced acceleration and increase in spore germination.

One can readily see, from the research work done by these scientists, that exudated water and disease occurrence are interrelated.

Many golf course superintendents have contributed much to the practical aspects of this problem. Although most were not trained scientists, they did possess a green thumb and an intuitive sense that enabled them to do the right thing at the right time. To mention a few, Carl Bretzlaff, Golf Course Superintendent, who was at Meridian Hills Country Club in Indianapolis, would use a drying apparatus on his greens when disease weather was upon him. The rig consisted of several layers of burlap fastened to an axle mounted on wheels and hand pushed over the "dew" laden greens. He always kept his greens dry and along with the use of fungicides never had any trouble.

Joe Valetine, Golf Course Superintendent of the famous Merion Golf Club in Ardmore, Pensylvania, relied on the use of hydrated lime "to change the pH and dry the greens" is the way he put it. He would use 5 to 10 lbs. of hydrated lime per 1,000 sq. ft. at three or four week intervals during "brownpatch and dollarspot weather".

Jimmy Comito, Golf Course Superintendent at Huntingdon Valley, Pennsylvania, relied on severe dragging of the greens during periods of heavy "dew" and disease weather. "Dragging the greens breaks up all that mold, he would say, as soon as the mold starts up again, drag it some more - keep the greens dry too."

Marshall Farnham, Golf Course Superintendent, Philadelphia Country Club, firmly believed in early morning watering during the many years that I knew him. I cannot recall his experiencing any difficulty holding grass on his greens. Trained in Plant Breeding and having graduated from Cornell University, he was well versed in the science of turfgrass culture. I always felt that he related exudated water with the incidence of disease and although neither of us had a pat answer, we agreed that dilution of exudated water with early morning watering was a good practice.

Oscar Bowman, Golf Course Superintendent at Worham Country Club, St. Louis, Missouri, when he was superintendent at Algonquin would say, "Top dressing does more to prevent and control disease than anything else". A firm believer in top dressing, he has always relied on this important cultural practice and its value is reflected in his superb greens.

Other golf course superintendents, too numerous to mention, had, I have found, a number of things in common with these men. First, they all had a "green thumb", that is the natural ability to get plants to grow. Second, they all practiced good cultural methods, making sure that everything was in balance, and third, especially during critical disease periods, they used methods that more or less kept the turf dry. Without knowing about exudated water, they sensed that there was a definite relationship between heavy "dew" and disease.

Another factor which should be brought out in this discussion of exudated water is the strong possibility that turfgrasses are also injured and perhaps killed by accumulated salts carried in the exudated water.

Marloth in Egypt in 1887 found salts on the leaves of Tamarix as the result of exudated water residue. Lepeschkin in 1906 found glucose and basic oxalic acid. Klein in 1913 found that on some plants nitrate salts were deposited on the leaves as residue from exudated water.

Marloth reported the following after collecting the salts from the leaves and stems. The dry salts consisted of:

51.9% $CaCo_5$ - Calcium Carbonate

12 % $MgSO_4H_2O$ - Magnesium Sulpahte

4.7% $MgCl_2$ - Magnesium Clorate

3.2% $MgHPO_4$

5.5% NaCl - Sodium Chloride

17.2% $NaNO_3$

3.8% Na_2CO_3

We know that plant injury will occur when a high concentration of salts is present in the soil solution. Seeds are also affected. It has also been shown that injury will result by all soluble salts whether they contain plant nutrients or not.

If we look at some of the fertilizing materials used on turfgrasses, we find that many have a high salt index:

Material	Salt Index
Nitrate of Soda	100.0
Calcium Nitrate	72.8
Ammonium Sulphate	53.7
Nitrate of Soda Potash	51.2
Ammonium Nitrate	49.3
Muriate of Potash	31.9
Urea	26.7
Potassium Nitrate	20.1
Sulphate of Potash	14.1
Ammonia, Anhydrous	9.4
Diammonium Phosphate	7.5
Superphosphate, 20%	6.4

The salt index of a fertilizer indicates its relative tendency to cause seedling injury or drop burn.

Marloth's work seems to support the theory that exudated water containing a high concentration of various salts can cause injury in one of three ways or in combination.

One, as the exudate forms and the water evaporates, the salts accumulate on the leaf. When these salts reach optimum concentration, they cause a leaf burn.

Secondly, if the exudate falls and is obsorbed by the thatch and held there, plant stems can be injured or burned when the salt concentration reaches a toxic level.

Thirdly, if the exudate is washed into the soil root zone and high concentration of salts is formed in the soil solution, then root burn and injury can occur.

Summing up all of this foregoing information, we can form a theory which should be carefully investigated.

THEORY

Turfgrasses can be injured or killed from the effects of exudated water under certain conditions.

Exudated water is the result of the natural biological function of grass plants. It is the result of normal transpiration and is a continuous function of normal healthy plants. If normal exudation is stopped or retarded in any way, the grass plants may suffer.

Exudate water is formed on the leaf at the open stomata along the sides of the blade and at the tip. If the grass blade is cut and open cells are exposed, exudation will be profuse in this injured area.

Exudated water evaporates as it forms during periods of low humidity. It accumulates during periods of high humidity. Humidity levels are always much higher in the micro zone where grass grows. (The micro zone can be considered to exist from ground level to the level of the grass mowing height.) Exudated water has the same pH as the plant sap and soil water. It contains all of the nutrients available to the plant. If tests of exudated water are made for the determination of N P K and other elements, the results will show only the nutrients the plant is picking up. Low or excess nutrients will be present in the exudated water.

When exudated water evaporates, the solid portion contains salts and other substances.

If the exudated droplets remain undisturbed and evaporate while on the leaf, the remaining salt, etc., will accumulate.

If the pure exudated water droplets contain a high concentration of nitrates and fall to rest on the flat surfaces of lower leaves, burning of the live tissue may result. The exudate will be absorbed by the thatch. Research has shown that thatch can and does absorb and contain toxic substances that causes severe injury to turf.

Exudated water when diluted with irrigation water becomes harmless provided the diluted exudate is washed into the soil water. If the soil beneath the turf is open and porous, this process is facilitated. If the soil is hard and compacted, the salts from the exudated water will be held at the soil surface. When the concentration of salts reaches toxic levels, burning of the stems may occur.

If the soil surface is compacted and relatively impermeable to water, the exudated water that falls may with irrigation be carried along the soil surface and concentrate in pockets and small depressions causing injury of an uneven nature. This same process may occur in thatch. Concentrated salts from exudated water may be washed out of the thatch into low lying areas or pockets causing damage there.

Exudated water contains the proper nutrients to support bacterial activity.

Turfgrass diseases thrive on the nutritive content of exudated water. Dr. Endo has shown that the mycelium of the fungi penetrates the droplet for nourishment. Mycelial growth is greatly accelerated when exudated water is available.

Accumulated exudated water held in the thatch and the soil surface is a perfect nutritive medium to support fungal growth.

Exudated water, according to Dr. Endo, will increase infection and disease. It will also accelerate an increase in spore germination.

Exudated water is produced at different rates and this seems to be determined by a number of factors.

1. Grasses of different species apparently because of their biological structure have the ability to exudate water, each at a given rate.

Among the popular turfgrasses, their exudating rate can be shown as follows:

Bentgrasses - High

Bermudagrasses - High

Poa Annua - Medium High

Bluegrasses - Medium

Fescuegrasses - Low

Zoysiagrasses - Low

The rates at which these grasses exudate water can be directly related to the incidence of disease.

The bentgrasses and the bermudagrasses are highly susceptible to many diseases. The bluegrasses are moderately susceptible. The fescuegrasses and zoysiagrasses are the least susceptible and, of course, are the driest of the grasses.

Soil water, which is available to the grass plant, also is a determining factor as to the amount of exudated water.

Temperature and rate of growth, depth of root system, and frequency of cut, all play an important part relative to the amount of exudated water.

Wetting agents that apparently stop the formation of "dew" in reality only reduce the surface tension of the droplets. They cannot adhere to the grass blade and run off as they form. This may have some beneficial effect although accumulation of salts could still occur in thatch and at the soil surface.

Some of the foregoing statements are fact, some theory. Needless to say, there is enough evidence on the relationship of exudated water and turfgrass problems that this whole subject should be thoroughly and scientifically investigated. Until we can get the answers to some of these aspects of exudated water, we must continue to grow turf as best we can. Following is a suggested approach by H. B. Musser.

<u>H. B. Musser</u>

<u>Turf Management</u>

Conditions favoring fungus diseases:

1. Moisture

2. Temperature

3. Soil acidity

4. Soil fertility

5. Matted turf

Cultural practices:

1. Provision for adequate surface and subsurface water drainage.

2. Good air circulation over greens.

3. Correction of surface compaction with suitable aerating tools.

4. Modification of heavy soils b a program of aerating and top dressing to build a porous layer.

5. Adjustment of soil reaction to pH 6.0 or higher.

6. Use of the more slowly available nitrogenous fertilizers in quantities that will produce normal growth without over-stimulating.

7. Provision for a constant supply of available phosphate, potash, and trace elements.

8. Adjustment of watering practices to provide as long intervals between applications as practicable. Continuously saturated turf must be avoided.

9. Elimination of matted or spongy turf.

What to do during periods of stress:

1. Practice early morning watering. (This dilutes the exudated water and dries green before mowing.)

2. Use sufficient water to wash exudate into the soil. (Possibility of salt accumulation is minimized.)

3. Use high pressure and direct stream directly into turf. (The fungi mycelium can be mechanically destroyed at least temporarily by the force of the water.)

4. If a disease attack seems uncontrollable, drag mat the green in two or three directions, then mow. (This will mechanically destroy the mycelium of the fungi at or near the surface of the turf.)

5. If severe thatch is present and fungicide will not control the spread of the disease, try light vertical mowing. (Verti-cutting will mechanically destroy the fungi mycelium)

6. Top dress lightly. (Top dressing does something to the turf for which no substitute can be found. It will mildly stimulate the turf, dry it somewhat to help retard fungal growth.)

7. Lime
(If disease is rampant, dust with 5-10 lbs. of hydrated lime for 1000 sq. ft. at 3-4 week intervals. Although this amount of hydrated lime is small, care should be exercised when applying it. Grass must be dry or a burn will result. Apply after exudated water has evaporated. The hydrated lime should not be watered in, but left to remain on the turf until the next watering.)

In closing, I hope that I have stirred your imagination. There is too much evidence to ignore the possible effects of exudated water on turfgrass problems. On the other hand, we lack documented evidence about the cause and effects of so called "dew".

Research is not the exclusive domain of the scientist, it is also a part of the pratical man's job to be inquisitive, to study, and to experiment with cultural practices, to help supply some of the answers.

Even if we cannot prevent some of these problems from occurring, it would be comforting to know why the grass died.

PERSONNEL MANAGEMENT [1]

Dr. Gene C. Nutter
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Jacksonville, Florida

INTRODUCTION

Great opportunities lie ahead for the Turf-Grass Industry - in every facet and every location. For the turf-grass manager, the greatest challenge during this era of growth and development will be manpower, administration and technology (in that order).

Today when salaries and wages make up 60-75% of the operating budget for turf facilities, and when wage scales are between $1.50 and $4.50 per hour - and still climbing - and still you can't find help, its time we paid more attention to the subject of personnel management.

In addition to the shortage of labor, three other factors further complicate our manpower situation. Factor No. 2: Technology has advanced so rapidly that the kind of man who suited our needs ten years ago can't do the job today (unless we retrain him). We need more skilled technicians to operate our machines, apply our chemicals and understand our complicated irrigation systems. Factor No. 3: (the use factor) The Turf Industry is demanding higher standards of grooming and imposing greater use pressure. This means more exacting maintenance - in a shorter period of time. Factor No. 4: Disinterested employees. Unreliability and unconcern of employees (age of affluence) - high rate of turnover - absenteeism, etc.

So, with this situation facing us, we can no longer leave personnel management to chance - results are to haphazardous, dangerous and expensive. The answer is greater emphasis on personnel management.

Personnel management involves four major functions, as follows:

A. Recruiting (finding) Good Help

B. Training Good Help

C. Supervising Good Help

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[1] A paper presented at the 23rd Annual Texas Turf-Grass Management Conference, Texas A&M University, College Station, Texas. December 3, 1968.

D. Keeping Good Help

A. <u>Recruiting</u> (finding the right man) WHO - WHERE - HOW
<u>Why - are we so short of good help?</u>

1. The Manpower Shortage - Reason for Shortage

   a. <u>Shortage of available workers</u>. The National unemployment rate is low. All industries face manpower shortages and particularly of trained workers.

   b. <u>Higher wages and salaries elsewhere</u>. Minimum wage laws will affect all industries - whether or not directly covered by the law. Turf Industry salaries and wages are already far below other industries for comparable skills. They will <u>fall further behind</u> as <u>minimum wage</u> and <u>union demands rise in the Industry</u>.

   For example, a recent news release from the U. S. Department of Labor advises that the average Union Building Trades scale reached $4.85 per hr. during the second quarter of 1967. This release is based on a survey of union wages for seven unions in one hundred cities as of July, 1967. Unless quickly changed, this situation will result in more depressed manpower situations in turf operations.

   c. <u>Training limitations</u>. Our Industry <u>has not begun</u> to answer or even adequately consider the problem of training its future workers. The small number of college graduates (either two or four years) in our field is one of our Industry's greatest failings.

   d. <u>Keener competition for good help</u>. Even within our own Turf-Grass Industry, the competition for the few trained men will be vigorous. Dr. Duich recently told me that he has three applications for <u>every one</u> of his <u>two-year school graduates</u> at <u>Penn State</u>. This is just <u>within golf operations.</u> <u>Now</u>, add the <u>competition</u> with <u>sod</u>, <u>parks</u>, <u>cemeteries</u>, <u>retail business opportunities</u> and <u>commerce</u> - and we quickly see the seriousness of our turf manpower problem.

e. Greater fringe benefit requirements. This is a standard practice in most industries today, but our industry is slow to accept this modern principle. Today, workers look for these benefits.

f. Undesirable working hours and conditions. Seven-day weeks and long hours, coupled with low pay and poor working conditions (the barn or shack - often no toilet and crew quarters) - drive workers away from turf. They can have little pride in the work under such conditions. Certainly, we cannot draw better prospects from the youth of today.

2. Who

When you look into the mirror to shave for this evening's meeting - take an extra look. In 95% of the cases you will be looking at your chief manpower recruiter. Some help from employment agencies, college placement services and associations - but perhaps only a drop in the bucket. You will be your labor recruiter. (also trainer and industry relations chairman) What are your qualifications?
Mainly two -

a. You are the boss

b. You need help (anyone not may leave now)

3. How

Basic tools of recruiting. (Armed with these, you are ready to recruit.)

a. The job?

Write out job description, including:

-Table of Organization

-Line of Command

-Duties and Responsibilities of Position

-Hours and Days

-Reporting Information (office-operations center)

-Organization History

-Job Aids (office, transporatation, etc.)

-Salary or Wages

-Benefit Programs (vacation, insurance, retirement, etc.)

Write out job qualifications, including:

-Training (college, on-the-job, etc.)

-Experience

-Age

-Marital requirements

-Any special requirements (travel, etc.)

b. Job application form. (How many people do you know who just talk to a guy - never give him an application to fill out?) Include all pertinent information required and necessary i.e.: -Personal data (name, address, family status, names and ages of children, property ownership, how long, where born, where previously lived, etc.)
-Personal references and habits, religious affiliation, hobbies and organization affiliation, civic activities (school-clubs), does he drink, smoke or has he ever been arrested (for what, when and where).
-Training and background data
Schooling (where-when)
College (where-when)
Night school, special training course (armed forces, company schools, etc.), conferences and short courses attended, trade and professional organizations membership, his considered specialty.
-Business or professional experience
List of last five positions, employer, period of employment, description of work, reason for leaving, business reference (name of immediate supervisor, address and phone).

c. Job testing (selection techniques reduce turnover-better selection)
1) Written tests (I.Q., aptitude, job knowledge)

2) Oral tests (I.Q., aptitude, job knowledge)

3) Performance tests (skills)

4) Physical tests (strength, stamina, coordination)

5) Medical test (physical)

6) Psyciatric test (emotional stability)

7) Character investigation

8) Probationary period (success on the job)

d. Interview

Personal and private (after all above preliminaries, if interested)

e. Hiring

4. Where

a. Recruiting sources

1) From within organization if possible. Advancement very important

2) From outside organization

a) piracy within industry (experienced, hopefully!)

b) outside industry

c) employment pools
-college placement services
-employment agencies, private or government
-associations (FT-GA, GCSAA, etc.)

3) Temporary help
-Students
-Manpower agencies, etc.

B. Training

1. Orientation

a. Complete his installation (employment form, payroll information, etc., review organization, go over the physical plant, meet the people.

b. What is expected of him. Review job description and qualification form. Let him know what he is <u>here</u> for - explain his job, invite questions, etc.

2. Training

a. How to do job.

1) <u>Demonstration</u> - show him <u>how</u> in <u>detail</u> - don't assume he <u>knows</u> from elsewhere - show him <u>your</u> way. Let him know what you expect.

2) <u>Communications</u> - Don't take him for granted. Don't assume he knows (easy for supervisor to assume everything he forgot long ago), even simple lower eschelon jobs (like raking a sand trap) sound simple - but must be done right. <u>And</u> it may be a <u>big</u> thing for the new man in his viewpoint.

3) Practice - Give him <u>time to learn</u>. If he makes mistakes don't crucify him, discuss and demonstrate again.

3. Job Review and Evaluation

a. Review his progress. Don't just turn him loose after demonstration - come back. Check up on his progress - the more complicated the work, the longer the training. <u>Here is real efficiency leak</u> (job analysis and evaluation).

b. Evaluate work. Evaluate his progress periodically. Score him - then discuss with him - review <u>attitude</u> and <u>ability</u>.

c. Adjust training methods. Extend training or cut short - depending on his progress.

C. <u>SUPERVISION</u> (supervising functions)

1. Administration (the Mgr., Supt., Supervisor, etc.)

-records

-hiring, assignments and pay

-policies

-job classification

-evaluation

-the organization structure (table of organization and job description for manager, assistant manager, foreman, crew operations, etc.)

2. Supervision (in the field-the Ass't. Foreman)

   a. The organization work plan (laying out or organizing the total work load)

      1) Routine operation (day-to-day)

      2) Occasional (seasonal-periodic)

      3) Emergency

      4) Key elements of every job

         a) <u>Accountability</u>

            Everyone accountable for his performance (cannot be delegated or assigned)

         b) <u>Responsibility</u>

            Duties (can be delegated)

         c) <u>Authority</u>

            Authority to act within given lines without permission

         d) <u>Key relationships</u>

            The worker
            The boss
            The secretary
            The visitors
            The community
            The members

            (<u>must get along</u>)

   b. The job plan (individual operation - mowing greens, aerating, equipment maintenance)

c. Basics of supervision

1) Proper line of authority (superintendent, assistant, foreman, individual)

2) Supervisor knowledge, experience, respect (attitude)

a) Know job requirements

b) Proper knowlege of authority and responsibility

c) Knows his personnel

3) Proper job assignments

a) Re job descriptions and hiring

b) Assign work only in line with ability and experience

4) Work Control

Effective job direction (the foreman) - directs only as many workers as can be handled efficiently - "The Rule of Five"

5) Effective communications

6) <u>Job inspection</u>

-Analysis and evaluation

-Job elimination (change in function - eliminate old habits - obsolete)

-Job combination

-Change of sequence (get best flow of work)

-Job simplification (is there a better method)

-Motion analysis (manual vs. mechanical)

7) Upgrading job skills

-Initial training

-Refresher training

-Training for new methods

-Every new equipment item
-Every new chemical
-Every new <u>practice</u>

8) Reporting

-Staff meetings

-Daily progress

9) Planning

-The daily work plan

-The job plan

-The weekly work plan

-The seasonal plan

-The yearly plan

D. <u>KEEPING GOOD HELP</u> (The human factor)

1. Workers attitude factors

a. The organization image (company name-reputation)

b. The management (top to bottom-company policies)

c. The immediate supervisor (assistant, foreman)

d. The job itself (is it challenging, rewarding? Does it have a good image?)

e. Built-in job limitations (low budget, old equipment, 7-day week, etc.)

f. Compensation - salary, wages, fringe benefits. (Greater competition from government and big industry where there are broad benefit programs.)

g. Working conditions (the morale factor), the physical plant, working hours, uniforms, cooperation, proper equipment, employer attitude factors.

h. Fellow employees - compatibility, cooperation, respect, equality.

i. Employee (psychology) gaps

-The hostile worker

-The dependent worker

-The independent worker

2. Employer attitude factors - The 3 A's for building a good team (building morale)

a. Appreciation

-Let him know he's important-needed-appreciated-try to understand him.

b. Achievement

-Learning his job-extending his skills-gaining professional status-earning security.

c. Advancement

-Position-responsibility-pay.

EMPLOYEE MORALE is a by-product of sound management, according to the business publication "How Successful Executives Handle People", which concludes its chapter entitled "Factors Influencing Employee Morale" with the following summarization : "High employee morale is a by-product of sound organization. It is not a result that can be achieved by and for itself; above all, it is not a result of "being nice to people" or plying them with favors. Nor is high morale some thing to be achieved at the expense of good operating results. The same policies, attitudes and practices which are best calculated to produce good operating results over the long run are precisely the policies, attitudes and practices which produce high levels of employee morale.

Good morale and good results are not mutually exclusive. They are two aspects of the same thing: <u>sound</u> <u>organization</u> and <u>capable</u> <u>leadership</u> or <u>good</u> <u>personnel</u> <u>management</u>.

DEVELOPMENTS IN CHINCH BUG CONTROL

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Introduction

In recent years, the lawn chinch bug, Blissus insularis Barber, has become one of the most economically important insect pests of St. Augustine turfgrass. Possibly this insect accounts for the greatest amount of time, money and effort being expended in control of turfgrass insects. Yet, too many turfgrass managers, although armed with an impressive arsenal of effective insecticides, consistantly report irratic results when employing chemical controls. This points out that successful insect control depends upon recognizing the pest and understanding its habits so that recommended and timely control measures can be initiated before extensive damage has been done. Often it has been incorrectly assumed that insects, particularly chinch bugs, cause all of the troubles with St. Augustinegrass. But there are other causes such as disease, nutritional unbalance and drought which result in unsightly areas of grass. It is extremely important that in order to prevent damage an early effective detection method be coupled with a thorough knowledge of the chinch bug life history and habits and the insecticides available.

Description

Adult chinch bugs are 1/6 to 1/5 inch long, have a black body, reddish-yellow legs and fully developed wings which lie flat against the back. Each front wing is mostly white, but has an irregular black patch at the middle of the outer margins. The newly hatched nymphs (young) are bright red with a whitish band across the back. With each successive molt, the young darken and more nearly resemble adults, but have no wings.

Life History

Chinch bugs overwinter as adults in many sheltered areas near or in lawns. In the spring, adults emerge and lay eggs, which hatch in a few days into tiny nymphs. The nymphal stage lasts about 30 days and the life cycle is completed within 6 to 8 weeks.

Distribution

Known southern chinch bug distribution in Texas now includes those counties south and east of a line from Denton to Ft. Worth, to Stephenville and on through San Antonio. Populations and damage reports also exist in the southern most areas of the state including Corpus Christi and the Lower Rio Grande Valley.

Damage

Chinch bugs have piercing-sucking mouthparts and feed by sucking plant fluids. In the northern most areas of distribution, feeding ceases during the late fall, winter and early spring months. However, in the southern range, possibly there is scattered or limited feeding by adults. Damage first appears as small, wilted areas which soon become yellow or brown. These areas increase in size as the insect population increases and as chinch bugs move from damaged or dead plants to healthy ones. Early symptoms of infestation may be confused with several lawn diseases and other problems. Chinch bug infestations can be diagnosed accurately only if the insects are observed. Damage is most common on St. Augustine lawns; common Bermudagrass is seldom attacked. Other reported hosts include centipede grass, zoysiagrass, bahiagrass and torpedograss.

When damage is severe and chinch bugs are plentiful they usually can be found by spreading the grass, carefully observing the soil surface. To prevent extensive damage and lower the cost of reestablishing killed out areas of grass, accurate, early detection is necessary. A large metal can, such as a three-pound shortening can, a large coffee can or a gallon can with both ends removed can be used to determine the presence of chinch bugs. One end of the can should be pressed 2 or 3 inches into the soil, particularly at the edge of any yellowing areas. The can should be filled with water and kept full for approximately 10 minutes. The number of chinch bugs observed during this 10 minute period should be recorded. This process should be repeated in several different locations with careful observation to observe all nymphal forms.

Control

Because of increasing populations of the southern chinch bug, in 1964, 65 and 66, tests were conducted in Brazos County in 1967 with the following two objectives: (1) to determine if two scheduled applications would be adequate to prevent lawn damage and (2) to determine if emulsifiable concentrate and granular formulations perform equally as well if used at the same rate. An evaluation of six insecticides, shown in Table 1 as emulsifiable concentrate and/or granular formulations, indicated very little difference in performance when used at the same rate of technical material per 1,000 square feet. Only the diazinon emulsifiable concentrate failed to perform as well as the granular formulation. The treatment schedule, the first in mid-April and the second in early June, proved to be effective in preventing an increase in southern chinch bug populations and noticeable damage. However, it was ascertained that where late summer and early fall population buildups and migration becomes a problem, a third application in mid- to late September would possibly be needed on the basis of southern chinch bug control tests conducted in Brazos County in 1967 and work in other states, all materials used, except Akton, will be recommended for use in Texas in the 1968. Dursban (emulsifiable concentrate) only has label clearance for use by professional pest control operators. Akton does not have label clearance for use in controlling the southern chinch bug.

TABLE 1. Southern chinch bug population data reflecting the performance of the materials used in controlling this lawn pest, Brazos County, 1967.

Insecticide and Formulation[1]	Rate (lbs. actual/ 1000 sq. ft.)	Pre-Treatment Counts[2]	Post-Treatment Infestation Counts[3] (avg. no. chinch bug/sq. ft.) Weeks After Treatment									
			4	5	6	7	8	9	10	11	12	13+
Dursban- 1% G	0.0287	3	0	-	-	-	2	-	-	-	1	retreated
			2	-	4	14	retreated					
			0	-	-	2	-	-	4	-	-	6
Diazinon- 4 lb./gal. EC	0.2	8	0	-	2	-	4	-	12	-	45	retreated
			1	-	4	-	7	-	14	-	32	
Diazinon- 14.3% G	0.2	8	0	-	-	1	-	2	-	-	0	retreated
			0	-	2	-	4	-	10	22	83	
Carbopheno- 5% G thion (Trithion)	0.2	2	0	-	1	-	0	-	2	0	retreated	
			0	-	0	-	1	-	1	0	0	2
Ethion- 4 lb./gal. EC	0.2	9	1	-	-	0	-	-	1	-	2	
			0	-	-	1	-	-	2	-	2	
Ethion- 5% G	0.2	24	0	-	-	1	-	-	2	-	2	retreated
			0	-	-	2	-	-	1	-	0	4
Carbopheno- 2 lb./gal. EC thion (Trithion)	0.2	15	0	-	-	1	-	-	2	retreated		
			0	-	-	2	-	-	4	-	-	3
(Aspon+DDT- 3.2% + 4.4% G	0.2 (Aspon)	27	0	1	-	-	1	-	2	0	0	0
Akton - 1% G	0.04	45	0	1	-	-	1	-	-	2	-	-
Aspon+DDT - 3.2% + 4.4% G	0.2 (Aspon)	183	1	2	-	-	2	-	-	4	-	-

1/ G = granular formulation
EC = emulsifiable concentrate
2/ Population counts made just prior to initial application as average number of chinch bugs per square foot
3/ Damage is generally observed soon after populations reach an average of 10 per square foot.

VARIETIES AND MIXTURES FOR OVERSEEDING

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We are now on the threshold of exciting discoveries in both warm and cool season grasses. The timing is right to introduce these innovations. We now have the improved equipment necessary for proper utilization of more specialized grasses, and the technology of management has been advancing rapidly to allow us to meet the demands of the public. In addition, the press of costs as well as performance provides reason for casting around for improvements. Public awareness requiring a more pleasant world in which to live is becoming of greater importance.

The use of improved grasses for overseeding purposes will aid in providing higher quality winter turf. The possibilities for establishment, as well as better performance during the life of the stand is increasing. Because of the critical demands placed on the performance of golf course grasses, much of the effort has been expended to develop or find better grasses or combination of grasses for this particular use. However, there is an increasing awareness and pent-up demand for grasses which will perform better on general turf areas.

Let's take a look at some of the northern grasses which have possibilities for winter overseeding purposes.

Only a few years ago we could name all of the varieties of bluegrass on our fingers and have fingers left over. Now, the situation has changed. Within the last three years, four new varieties of blugrass have been introduced and many more are to come. These varieties are Prato, Windsor, Fylking and Sodco. Perhaps one or more will be proved out for overseeding use. In addition, many other experimental bluegrasses are being tested. Undoubtedly, varieties will be found which more nearly meet the needs of the south.

The same situation exists with the reygrasses. Only a few years ago we talked about Annual Ryegrass and Perennial Ryegrass and nothing more. No longer is this true. Recently, four Perennial Ryegrass varieties have been released. Various attributes make them distinctively different from the old Oregon Rerennial Ryegrass. These are NK100, Norlea, Manhattan and Pelo. Also, three Annual-type Ryegrasses are now on the market, plus a formula incorporating a new innovation. This innovation is the doubling of the chromosomes to provide a sturdier plant. The new varieties are Aster, Gulf and Magnolia. The Tetraploid form is presently on the market in a formula known as Tetrablend 333 Brand.

We can go on to the fine fescues and we will find a similar situation. New varieties are becoming available and undoubtedly one or more can be found which are superior for overseeding purposes. I also expect we will find new tall fescue varieties which meet this need. Other grasses such as Poa trivialis, Redtop and grass species not now generally known may prove just to be what we need for at least some of the overseeding uses.

I feel fortunate to be able to have a part in this development era. While a majority of my time has been spent in the north, during the past several years, a portion of my assignment has been to identify and develop grasses which will better meet the needs for overseeding golf courses and other turf areas in the southeast. It is an extremely interesting challenge. Our experience with grasses in the north has been extremely useful. However, in judging the cool season grasses for northern use, we are most concerned with the mature sod. Usually when evaluating grasses in the seedling stage or the immature stages, we are doing so as the days are lengthening and the temperature warming. In nearly all instances, we are working with a reasonable good seed bed. Not so when overseeding Bermuda or Bahia or St. Augustine turf. Fortunately, equipment is now available to produce a reasonably good seed bed. However, we cannot control the weather. At this time of the year, temperatures are tending downward and the days are getting shorter. Conditions are definitely abnormal for the establishment of turfgrasses and altogether different from the conditions we experience up north. There is no good reason why grasses should react the same when they are brought down here. Often they do not and this situation leads to a considerable number of our problems.

Not all cool season grasses even within a single specie react the same. There are different degrees in their relative growth rates, colors, competitiveness and ability to withstand traffic during the fall, winter and spring months. Some require more fertility, less fertility, different water levels, are effected differently by cold temperatures, are easier or harder to mow, and vary in their ability to withstand diseases. Each turf area and turf manager has certain requirements and the best grasses will be those which give satisfactory turf all throughout the months they are needed and then expire, allowing a gentle transition back to the summer grasses.

Because grasses differ, it should be possible to combine certain grasses in a manner whereby the weaknesses of one variety can be masked and the overall performance of the turf strengthened. In the past considerable effort was expended and experience gained in testing combinations of grasses which were then on the market. There were few experimental grasses at the time, and probably even less interest on the part of those developing cool season grasses in their potential use for southern overseeding. Undoubtedly, varieties were discarded which might well have been extremely useful in the south simply because they failed to perform satisfactorily up north. It has been a real lesson to me to observe the different demands placed on turf grasses down here.

New grass varieties and perhaps species will undoubtedly be found which perform in a superior way. Men like Dr. McBee have an intense interest in identifying these grasses so that they can be produced and seed made available for this rather specialized, and to a northerner, exotic market. With proper management and environment, single varieties can and do provide top quality turf. However, if something goes wrong with the variety, the entire turf area is in trouble. In part, the answer can be found through the use of formulas, including several specialty grasses.

One or two examples will illustrate my point. During the past several years, we have been evaluating the turf-type Perennial Ryegrass varieties NK100 and Pelo, as well as several others. We have narrowed our search to the two varieties. NK100 and Pelo because of their performance. Both are finer textured than the ryegrasses with which you are familiar. They are darker green, less rapid growing, and, therefore, require less mowing. They withstand cold and traffic to a greater degree than the older ryegrasses. Our results with both have been very satisfactory, we have found NK100 tends to produce a better turf on golf course greens during the forepart of the winter. Pelo, however, definitely forms a more attractive turf during the latter part of the winter. Both mow well, but I am told that NK100 holds the ball slightly better than Pelo. Pelo, however, has more eye appeal during the latter part of the season and is preferred by golfers for these reasons. There is some difference in disease resistance although both seem to be superior to Common Ryegrass. Because both varieties have many good characteristics, we feel there is a place for both of them. Because both perform somewhat differently than the other, we have also been evaluating them in mixtures. We have about concluded the most uniform performance fall through spring can be provided through formulas including these ryegrasses, and we are presently testing one under the name "Overcoat." We hope to have this formula on the market within the not too distant future. We are also looking at formulas including these ryegrasses along with other species. Perhaps we can provide the texture which Poa trivialis offers during the forepart of the winter and bentgrass provides during the latter part of the season, yet increase the traffic resistance through the inclusion of these finer textured ryegrasses. This is our hope.

As mentioned earlier, we have also been looking at formulas including the Tetraploid Ryegrasses. Because the Tetraploids tend to have broader leaves and darker green color than the normal Diploid varieties, they are more easily seen from a distance. While the darker green color is welcome, the broader leaves are very unsatisfactory on golf greens where the texture is extremely important. Nevertheless, for a general turf area such as around a commercial building or in a park, this particular type of ryegrass seems to meet a need. The leaves are more upright than is ture of the ordinary Diploid Ryegrasses and this aids in giving the appearance of a green lawn area. It is presently being sold for forage purposes. Perhaps it will also find a place where establishment vigor is important, winter hardiness a factor and appearance from a distance more important than close-up appearance such as when addressing a golf ball.

In considering grasses for overseeding purposes, the use must be designated. Is wear damage likely to be severe? If so, tough grasses, like the ryegrasses probably should be considered. If wear is not severe, then beauty and quick cover may be more important, and Poa trivialis is a good bet. Kentucky bluegrasses provide a good color to the turf and aid in the overall texture and density. Bentgrasses are slow developing, but produce high quality turf late in the winter and into the spring.

Combinations can be of value for both golf course and general overseeding purposes. Many of you are familiar with the "Milwaukee" formulas. Many of you were using this formula or some variant derived from it. There has been a shift away from Annual Ryegrass to the finer textured grasses. Based on what I have seen so far, I have felt that a formula consisting of 35% Poa trivialis, 30% Kentucky Bluegrass, 25% Creeping Red Fescue and 10% Bentgrass seeded at 12 pounds per thousand square feet can be of good service throughout this area. Varieties of these various grasses can also make a difference, but I am not prepared to discuss varieties at the moment. Perhaps following this winter season I will feel a little braver. Of course, there are many other combinations, and a number of you have your own reasons for feeling a formula consisting of different grasses and different percentages might serve your purposes better. Dr. McBee has extensive trials as do other research workers across the southeast. We in the seed industry are cooperating with the specialists, and I feel optimistic that improved grasses and improved recommendations for overseeding will soon be available for both those of you on golf courses and responsible for other turf areas.