1983 TURF CONFERENCE PROCEEDINGS

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The 28 talks included in these Proceedings are condensations from speakers before sections of the 1983 M.R.T.F. Conference. We appreciated the willingness of the speakers to participate and prepare materials for your reading. A copy of these Proceedings has been mailed to all those attending the 1983 Conference; one person of each member organization within the Midwest Regional Turf Foundation not in attendance at the Conference, and to a list of those in educational activities.

Proceedings of each annual Conference have been prepared since 1948. A limited number of 1975, 76, 77, 79, 80, 81, and 82 Proceedings are available at $2.00 each, as well as additional copies of these Proceedings. Order from:

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Seven Principles of Turf Management

Dr. D. B. White
University of Minnesota
St. Paul, Minnesota

It is often useful to take a nontraditional view of our turf situations. A new perspective often results in some new ideas. My objective is to apply ecological principles to turf management so that you may have some new insights into why things happen in a turfgrass community.

The first principle is really a definition. It is my definition of turf management.

1. Turfgrass management is the management of competition between desirable (turfgrasses, trees, etc.) and undesirable (weeds, etc.) vegetation.

This says we manage our turf to favor the plants we want, while penalizing the plants we don't want. Mowing, for instance, favors turfgrasses while penalizing young woody plants and other plants that can't tolerate decapitation.

The other six principles are not definitions and are described below.

2. All plants are different in response to the major growth factors and mowing.

It is the difference that allows us to manage the competition. Another example with mowing is that most turfgrasses respond to regular mowing in a way that increases the population of tillers. The turf becomes more dense crowing out or not allowing other plants to become established.

3. There is an optimum set of conditions when considering the major growth factors, under which any plant type will be most productive and competitive.

If we can discern the optimum level for light, water, nutrient, soil, mowing, etc., in the plants we desire,and maintain these conditions,then our turf will always be functioning at the best level of quality.

An important note here is that optimum us not meant to be maximum. A maximum condition can only be maintained briefly and then a recovery period is needed. It is something like running as fast as you can for as long as you can. While oprtimum means the best or most favorable condition for continued reproducible performance. The lesson for us is if we drive our turf as hard as it can go it will sooner or later fail, and the harder it has been driven the longer it will take to recover.

4. There are limits of tolerance related to conditions under which turf can grow.

For example, there is a minimum amount of light under which Baron Kentucky bluegrass can maintain normal growth. If the minimum is exceeded Baron will not be able to compete with, say, Glade which (is different) tolerates lower light levels. Another example is that elite type Kentucky bluegrasses tolerate a lower mowing height than common Kentucky bluegrass.

5. There are interactions between growth factors and we must realize that when we change one condition we change them all.

An example might be if we increase irrigation we increase leaching potential (interaction with nutrients) and decrease air in the soil (interaction with oxygen, etc.) and change pH, etc. We need to study to learn what these interactions are.

6. There is an accumulation associated with constant or regular treatment applications.

For instance, if we constantly mow elite Kentucky bluegrasses at the normal height for common Kentucky bleugrass, the effect will likely be to accumulate thatch. If we continually apply lime when it is not needed we will accumulate a higher pH. If we regularly mow a putting green at the lower limit of tolerance, the effect will likely be to accumulate a continuing reduction in not only top growth, but also root growth.

We can remember though that Nature is forgiving in many ways and grass often grows in spite of us. So, folded into this principle is the idea that usually a one-shot treatment does not accumulate an effect. This allows us, for example, to mow shorter than is desired occasionally, say at overseeding, without doing great harm.

7. When things are not going right an effective strategy is to identify the factor or condition furthest from the optimum and correct it first.

This is a very important principle because it adds incentive to learn the others and occasionally allows us to perform seemingly magical things. The reason is that all factors interact and when the furthest from the optimum is corrected, it usually interacts to shift responses to all the other factors closer to the optimum.

There are several more principles that are applicable to turf management situations, but time does not allow us to deal with them here. However, I hope these mentioned above will be useful to you in your programs and that you have a good year.

Roots - Maintain What You Have

Dr. D. B. White
University of Minnesota
St. Paul, Minnesota

One major key to success in turf management is maintenance of a deep, vigorous root system.

One dilemma turf managers face is that we can't see the root system and the symptoms of problems are usually expressed to us by the tops of the plants. Too many times we attack the symptom without identifying the cause(s), the real problem. If we can identify the real problem, we can then separate the factor(s) involved and correct those that are furthest from the optimum. An example might be that the symptom is wilting (water stress). If the real problem is lack of water then irrigating is the solution. If the real problem is that the environment is demanding water faster than the plant can take it up (too hot and windy), then the answer might be syringing. If, in fact, there is enough water in the soil, but the root system is too small to handle the amounts needed, then a totally different problem exists where more water may make the root system even smaller by decreasing the air supply. Indeed, the real problem might be lack of air in which case a totally different strategy is indicated - aerification, for instance, or a combination of modifying watering practices, aerification, syringing and the like.

Before continuing, it may be useful to share a few principles and rules of thumb:

1. If what you're doing is working, don't change. You may experiment on a small scale to improve, but test before you use something new, or change.

2. Another motto for successful turf managers is to "help the grass grow better when conditions are better for growth", remembering that success is the accumulation of many favorable responses.

3. We need to realize that the condition of the summer root system is for the most part determined by the condition the root system was in the previous fall. This means that your fall program can determine how the grass will respond to hot summer weather the next year.

4. Roots follow favorable nutrient, air, and water gradients in the soil. For instance, if your irrigation schedule applies only small amounts of water at a time, it is likely that the favorable water gradient will be shallow, and that is where the roots will be - shallow.

5. Photosynthesis is much less affected by temperatures in the 35-55^{o} range than respiration. More photosynthate and less respiration should equal more stored reserves.

6. Roots grow at temperatures down close to freezing.

When all the above are put together, it becomes obvious that the fall is a very good environment for turf growth, storage of reserves and root development. This being the case, it is important for you to adopt a late season fertilizer program. We have found 1 lb. of actual N/1000 sq.ft. two to three weeks before things freeze up works very well. This is especially true if it is preceeded by a normal fall fertilizer application three to five weeks earlier.

It is also important for you to maintain the best possible capacity for photosynthesis in the grass plants. This means that if you are mowing a green at 1/16" or close to the limit of tolerance that you need to raise the mower after Labor Day to take advantage of the season and build some reserves before winter by maintaining greater leaf area, and therefore greater photosynthetic capability.

In addition, other normal fall practices such as aerification, dethatching, snow mold treatments and the like all interact to help the grasses prosper and should not be neglected.

I would like to share some brief thoughts about professionalism in turf management. You are the professionals, therefore you are the experts,and as expert professionals I believe you have a responsibility to educate your clientele. If you are a golf course superintendent who is forced into having the fastest greens in the county you need to educate your greens committee that it may be tolerable as long as the grass has time and is managed to recover and build a reserve before winter. Let them know the consequences if they insist that you maintain turf at or beyond its limit of tolerance. Also let them know what some of the alternatives are and what cultural, quality, and dollar costs can be expected with each alternative. Talk about quality and what it can be if you are allowed to raise the height of cut in the fall, and do all the other things to prepare the turf for winter and the subsequent playing season.

If you are a lawn maintenance person the same things apply. Let your clientele know the benefits of late summer fertilization, let them know the benefits of dethatching and aerification, and let them know what the proper height of cut is for their turf situation. Share your knowledge so that your customers can have the best turf possible. It is in your best interests to do that.

And remember that if you want a deep, vigorous root system in the summer you must work at it the previous fall.

Have a good season!

An Irishman At Purdue

Edward B. Connaughton
Turf Major
Purdue University
West Lafayette, Indiana

My native home is Ardsallagh, Roscommon, Ireland. My first interest in turfgrass management, although I was unaware of it at the time, was because my father, Ned Connaughton, was the local greenskeeper at the nine hole golf course, and he introduced me to golf course work at the early age of thirteen.

His equipment consisted of one tractor, a three gang unit for cutting rough and fairways, one greensmower and a rotary mower. My job was cutting the fairways and the rough, and I was the envy of my friends because I got to drive the tractor.

The summer I was fifteen a part-time job at a local bar paid better than the golf course so I started to work there and forgot about the golf course, but it was that same summer I started to play golf and very soon I found myself spending every spare moment I had on the golf course trying to improve my skills at the complicated sport. While attending school for the next three years my summers were similar to the one mentioned, although my golf game was improving rapidly and I now held a handicap of 8.

I graduated from school in June, 1977, and like most of my fellow students, I did not know what I wated to do for a career. Turfgrass management was not even in my mind as I did not like what my father had to go through to maintain a good quality golf course.

While still working at the bar I saw an advertisement for a Trainee Greenskeeper at the Royal Dublin Golf Club. The only reason I applied for the job was because the position would be filled by having an interview with the club officials and management, and I needed job interview experience. I traveled to the capital, Dublin, in December 1977, and I had my interview with the club management and the head greenskeeper, Mr. Peter Murphy. After a forty minute interview with these people telling what the training included and the kind of work I would be doing, I knew it was the career I wanted to go into.

In January 1978 I got a letter of acceptance and worked until May 1979. The Royal Dublin golf course is a seaside golf couse, and we were managing it to promote the native fine fescues and seaside bent that grows naturally in the sandy soils of Bull Island in Dollymount, Dublin.

My training involved working with a recognized Head Greenkeeper of the Irish Greenskeepers Association to associate myself with all the skills necessary to the successful management of a golf course. I also had to complete a syllabus written by the City and Guilds of London examination board which involved learning soil science, chemistry, botany, and completion of a log book on the skills necessary to become a certified Greenkeeper.

It was also necessary to have training on a parkland course to familiarize the trainee with both aspects of golf course management in the British Isles. On the parkland courses we manicured the Poa annua in the rich poorly drained soils that favored the meadow grasses (bluegrass). The reason for manicuring the Poa annua is that our summer temperatures rarely reached the height where the Poa came under stress and died.

In May 79 I moved to the parkland course of Elm Park Golf and Sports Club to work with head greenkeeper, Jim Byrne. This left me being trained by the best greenkeepers in the indurstry to become familiar with the skills necessary to managing a golf course.

As I was the first person in Ireland to study to become a certified greenkeeper, I had to find someone to teach me the all-important concepts of soil science,chemistry and botany. As there was no official institution teaching these subjects specially for turf in Ireland, I was fortunate that Dr. Harry Spain was an active follower of the Irish Greenkeepers Association and a main driving force behind setting up, nationally, a trainee greenkeeper progem. Dr. Spain has a PhD in soil sciences, and he agreed to teach me the subjects necessary for the City and Guilds syllabus. From May 79 to May 81 when I sat for my exams I attended weekly sessions with Dr. Spain to become familiar with all the concepts that were necessary to pass the difficult City And Guilds of London exams.

During my training to become a certified greenkeeper my skill at the game of golf kept improving greatly, and in that time I had the opportunity to play and look at the majority of golf courses all over Ireland. I couldn't help but notice the inconsistency of maintenance and conditions of the courses from coast to coast. This sparked in me a desire to further my education in the area of turfgrass management, and consequently looking to the United States and possibly working there for a while to learn more about turfgrass management.

To achieve this aim I had to get myself a job on a golf course in America and the only way to do this was to attend the annual International Golf Course Superintendents Association conference. I started to save my money in August 1980, and with the help of being really lucky at a game of poker, I was able to pay my way to the GCSAA conference in Anaheim, California, in January 1981. My dream came ture here and I was offered an assistant superintendent's job at the Bedford Golf and Tennis Club in Bedford, New York, under superintendent Mr. Terry Boles.

I traveled to Ireland after the conference to finish my study and training and traveled to England in May of that year to sit for my exams. I passed my exams with distinction (A), and became the first certified greenkeeper in Ireland, thanks to the Irish Golf Greenkeepers Association and Dr. Harry Spain.

Now the time had come for me to make the big move to the United States to learn more about turfgrass management. I started my new job at the Bedford Golf & Tennis Club, New York, June 1981. The idea was tucked away in the back of my mind about going to University to further my education in turf. I attended local chapter meetings of GCSAA and some university field days, and everyone I talked to about a college degree in turf management encouraged me to go to school.

I had read The Turf Managers' Handbook by Drs. Daniel and Freeborg and it outlined a B.S. degree in turf management, and some superintendent recommended Dr. Daniel and Purdue University to me, so I wrote to Dr. Daniel and told him what I was interested in doing and he also encouraged me. With the encouragement and advice of Bedford's president, Mr. F. Sides, and superintendent, Mr. T. Boles, I made the decision to come to Purdue in January 82 .

I have one year completed and I now know I made the right decision on a career in December 1977. I hope to get my B.S. degree in Turfgrass Management in May 1985. My plan is to return to Ireland and become a turfgrass consultant and hopefully be able to improve the turfgrass industry. I have a long way to go yet to reach my ambition in the turfgrass world, but I'm pointing in the right direction.

Technology and Seed Production

Dr. Leah A. Brilman, Research Director
Jacklin Seed Company
Post Falls, Idaho

Jacklin Seed Company is located at the Washington-Idaho border on the banks of the Spokane River. It is the largest proprietary bluegrass producer in the world, and has a reputation for quality. In addition, we produce and market many other turfgrass and reclamation species. Innovation and research have always been important aspects of Jacklin Seed Company, from the early years when they were a dry bean and pea seed company experimenting with growing grass seed in Eastern Washington and Northern Idaho, to their experiments in producing a new bluegrass called Merion, to their present extensive research effort.

The primary emphasis of our initial evaluation of any new variety is determining the seed yield potential. Many varieties have excellent turf qualities, but due to low seed yields they cannot remain competitive in today's markets. Our first step in testing yields is to plant meter row yield trials replicated three times, with controls included to allow compensation for the more ideal conditions of no competition from weeds or other grass, warmer soil conditions because of dark open ground, no shattering losses, etc. By examining the data of individual plots and averages and comparing this to controls, an initial idea of whether a variety can produce adequate to excellent yields is obtained. In addition, these plots allow an evaluation of other characteristics of a variety that may influence its potential as a variety such as the incidence of powdery mildew and rust, seedling vigor, growth type, maturity date and ergot incidence.

If a variety looks promising in the yield trials, we then evaluate its yield potential in mini fields we call production rows. The production rows consist of four rows planted using standard farm equipment and procedures and maintained as our fields are maintained. These are swathed and combined, using field procedures. Although these yields are sometimes a little high, they are usually comparable to the yields obtained in a well established and properly maintained field.

The final stage in evaluating a variety for production capabilities and qualities comes when we establish spaced plant breeder blocks. Each plant in these blocks starts as a single seed, planted and grown in a greenhouse and transplanted into a field. In these blocks, each plant can be evaluated for uniformity to type. In the case of bluegrass, the percentage of apomixis can be determined to establish if the variety is sufficiently uniform to meet varietal specifications. Yield data and morphological information are also obtained from these blocks. These blocks are hand harvested so very high quality breeders seed is obtained. If we decide a new experimental has a market potential, this seed is used to establish foundation seed fields.

In addition, we establish turf plots, usually at the same time as the initial yield trials are established. From these we can obtain information on density, color, quality and some diseases in turf under our conditions. It is necessary , however, before a variety is placed into production that its suitability to many

different areas of the country and various markets is tested. This requires the cooperation of many different researchers at universities and in industry. It may be that a variety is susceptible to a disease strain only found in a particular area or is well adapted to certain management situations. These things can only be determined by wide scale testing, which usually continues as long as a variety is being produced.

As a new part of our testing program, we have just established low maintenance trials to evaluate species and varieties for what we believe will be a significant part of many markets in the future. Low maintenance means different things depending on your audience and their needs. It may mean a reduction in water use, reduced fertilizer and other chemical needs, or reduced mowing. Also, what would be a lower level of maintenance for many professionals, such as golf course managers, may be considered a high level of maintenance to a homeowner.

We cannot test all the low maintenance variables in this initial test, but we will be using low fertilizer levels, reduced water applications, and three different mowing schedules to test the suitability of different grass species and varieties for this type of use. Many of the species and varieties we are testing are from our reclamation department, and have been excellent in plantings on coal mine spoils, forest fire sites, etc., where very poor conditions exist. Superior varieties under these conditions include Reubens Canada bluegrass, which has a naturally low growth habit, Canbar Canby bluegrass, Durar hard fescue and Covar sheeps fescue. The latter three were developed by the Soil Conservation Service and Plant Material Centers for reclamation and forage.

Many of the different species we are marketing for reclamation and low maintenenace areas we are also producing or evaluating for possible production. In many of these species we have discovered a lack of basic production information, such as safe herbicides to use, optimum harvest time and harvest procedures. This has necessitated extensive research into many of these areas. In some cases, this is because these species have previously only been hand collected from native stands. Other species have not previously been grown without extensive field cultivation, by tractor or by hand. We have extensive herbicide trials on both these new species and on the more traditional turf species. Many herbicides that can be safely used on turf are damaging in seed production. Among some of the most promising new herbicides we have evaluated are Glean, Poast and Fusilade.

Glean is a selective post and pre emergent herbicide developed to remove most broad leaf and some grass weeds from small grains at very low rates. In our area we have found we can use it effectively on Kentucky bluegrass at one half to one ounce per acre to remove many weeds, either fall or spring applied, with no crop damage. On perennial ryegrass, however, it retards plant growth and greatly reduces yields. It has a fairly long soil residual, especially under non-acidic soil conditions. This characteristic is a benefit in weed control; however, wheat and barley are the only species that germinate well in soil that has been treated within the previous six months. This herbicide may also be useful in certain turf applications, but testing needs to be done.

Poast and Fusilade are similar herbicides that selectively remove grasses, except fine leaf fescues, from broadleaf plants. We hope to use it in our flower, clover, and fine leaf fescue production to remove volunteer bluegrass, cheatgrass, windgrass, and panicum. These compounds are just now receiving initial labels in soybean production.

Two new varieties, Countess chewings fescue and Duchess colonial bentgrass, represent a new approach to weed control. They were developed in Northern Ireland to be resistant to the herbicide aminotriazole (Amitrole T) applied at 0.89 lb. per acre in seed production and 2.26 lb. per acre on turf, with no ill effects. This enables volunteer grass rogues and weeds to be effectively removed from their turf with this herbicide. This selection of plant varieties resistant to specific herbicides may become even more prevalent in the future, enabling unwanted weeds to be easily removed. We will begin testing these varieties in the U. S. after this year's harvest.

Sodwebworms can be a serious problem in production as well as in turf. On many varieties we find it necessary to treat for larvae or adults when an economic threshold is reached. On a new variety of perennial ryegrass, ALL*STAR, developed by Dr. Reed Funk of Rutgers and Dr. Gerry Pepin of International Seeds and owned by J. & L. Adikes of Jamaica, N.Y., we will not have this problem in production of turf. This variety and Pennant perennial ryegrass were both selected for sodwebworm resistance and excellent turf characteristics. Recent evidence suggests this resistance in both varieties is due to a fungal endophyte in the plant and seeds.

A problem becoming increasingly serious in production is ergot. Ergot is a fungal disease where scleriotia bodies replace seeds in grass seedheads. The presence of ergot in seed does not affect the turf established with it; however, it does cause production problems in a variety of ways that do affect the price and availability of seed. The majority of ergot sclerotia from a primary infection can be removed in seed processing, however, the secondary infection can produce partially ergotized seed that is difficult to separate. The result is that the infection decreases yields, increases cleaning costs, and can affect the purity of the seed by increasing the inert fraction. This can result in a lot that has no crops and no weeds unable to qualify as sod quality because of high inert. We have extensive chemical trials to attempt to find a control for this disease. However, we believe the best control will be to breed varieties that resist or avoid ergot infection. To this aim we have established a new series of bluegrass crosses to obtain new hybrids. The parents of these plants were selected for a high level of apomixis, especially on the female side, and early flowering to escape infection. The bluegrass varieties of the next decade may be among these plants.

One method we currently have available to partially control the severity of ergot the following year is field burning, which destroys many of the sclerotia in the soil. In addition, field burning increases seed yields the following year by removing residues that block sunlight and perhaps physiologically shocking the plant.

Field burning is necessary, but to lessen the impact on surrounding areas, growers in our area have voluntarily supported a weather station to help predict when the proper weather for burning exists. In addition, we have set up extensive burn trials to determine if there are any varieties that can produce a satisfactory quality and quantity of seed without burning. On these trials we have also been evaluating the effectiveness of the growth regulator PP333 on increasing yields under burn and non-burn conditions. In Oregon, on perennial ryegrasses and tall fescues, this chemical has looked very promising in increasing yields primarily by controlling lodging. The effectiveness on bluegrass initially appears to be varietal dependent and not to be primarily dependent on lodging control. We will have larger trials with this growth regulator this spring.

Burning has other beneficial side effects such as reducing rodents, disease incidence and some insect populations. An additional problem with not burning is residue removal and disposal. The residue can be baled to be removed, but has very low feed value because it is cut after seed maturity. Various suggestions on disposal include nitrogen enrichment so it can be fed to cattle and utilizing it as fuel. Unfortunately, at this point what often happens is the bales cannot be sold and end up rotting at the edge of a field that could not be burned.

All aspects of current production techniques are being constantly evaluated to benefit the farmer and the consumer. We are comparing current fertilizer practices with possible alternatives, including liquid nitrogen, to obtain the optimum yield for the price. We evaluate new harvest techniques and seed handling procedures to optimize yields and insure quality. New techniques and technology are continually being developed and evaluated to insure that the best price and quality are achieved.

Research Needs Of The Lawn Care Industry

David P. Martin, Director of Research
ChemLawn Corporation
Columbus, Ohio

The professional lawn care industry was founded and developed primarily during the late 1960's and 70's. Local landscape companies and individuals were involved in lawn maintenance for many years before that, but often in a personal gardener or total maintenance basis. The concept of relatively inexpensive fertilization and pest control for lawns for large numbers of urban residents by commercial interests rather than "do-it-yourselfers" is a phenomenon of the last two decades. During this time period the professional lawn service industry has grown very rapidly to where an estimated 7.7 million residential lawns were treated in 1980 according to one estimate./[1]

The growth of the professional lawn care services has created a need for specific research on pests, chemicals and equipment for the industry. In the early years, most companies relied on generally available turf knowledge and commercial product manufacturers for their information. Now many universities are directing a portion of their research toward the specific needs of the lawn care industry, several lawn care companies have their own research programs, and others are conducting evaluations of their programs on a split lawn basis.

The major research needs for lawn care companies exist in fertility, weed control, and insect control disciplines. Additional areas of research include equipment, diseases, pH and liming, growth regulators, etc.

Fertilization. In the early days, the lawn care companies used water soluble nitrogen sources almost exclusively. These carriers provided a rapid growth and green-up response, but they also produced too much surge growth, short residual, and a lot of burn potential during adverse environmental conditions. A limited amount of slow release nitrogen was used by granular applicators, and during the mid-70's a quantity of finely ground ureaformaldehyde products were sprayed on lawns as well.

Fertilizer technology for the liquid application lawn care services has been developing rapidly in recent years. Several methylol urea products were developed by the chemical industry with reduced burn potential characteristics. More recently a short chain methylene urea suspension product has been developed with greatly improved turf response characteristics. It is likely a number of improved products will be available to this industry in the next several years. They will have characteristics such as rapid response, reduced surge growth, produce dark green quality turf, have a residual of 8-16 weeks, be slow release by definition, provide greatly reduced burn potential, and have sprayble characteristics. Several companies are involved in this type of basic development work and several lawn care companies and universities are evaluating these products in their testing programs. Phosphorus and potassium sources for our industry have not changed in some time, and will continue to be the same for the near term.

Micronutrients are seldom required in most cool season turfgrass market areas. Occasionally iron is needed on a very limited basis where a specific deficiency has developed. Deficiencies are certainly a greater problem on warm season turfgrasses where iron and sulfur responses are fairly common. Micronutrient use has the accompanying problem of corrosion and serious equipment failure problems.

Weed Control. Control of annual grasses and broadleaf weeds in customers' lawns represents the biggest success opportunity next to green color for lawn care services. But because of the difficulty in controlling certain weed species, it also develops into a frequent service call item and the possibility for customer cancels. This often results from the customer perceiving weed control as total elimination of all weeds rather than the preferred perception of keeping the weed population to a critical minimum.

Several requirements for weed control herbicides also can create problems. One is the fact that our industry would prefer one broad spectrum herbicide controlling all weed species. When it in fact doesn't, the uncontrolled species can create customer dissatisfaction and require improved weed control procedures on a service call basis. Also, because of the 8-12 week application schedules, herbicides may be applied on a marginally acceptable timing basis. Unsatisfactory control and a service problem may again be the result. In the case of pre-emergence herbicides for annual grasses, applications must be started early enough to complete all accounts prior to the germination season. Weed populations may result from late application after germination or insufficient late season residual from early application.

A number of research needs therefore exist. A partial summary follows:

1. An additional preemergence herbicide would be desirable.
2. A longer residual preemergent for full season annual grass control.
3. An effective herbicide for selected difficult-to-control summer annual broadleafs.
4. New broadleaf herbicide combinations for persistent species.
5. Replacement compounds for phenoxy herbicides.
6. Better application methods and timing within the framework of lawn care operations.
7. Increased safety methods of herbicides on ornamentals and the total turf community.
8. Application methods to reduce herbicide drift potential.

These are a few of the items needing research attention. They may be resolved by new herbicides, more effective formulations or combinations of existing herbicides, or better timing and application procedures for the problem weed species.

Insect Control. Insufficient information on turfgrass insects during the 1960's and early 70's resulted in some severe problems for the lawn care industry. Life cycles, injury symptoms, threshold populations, and optimum treatment schedules were not well defined for some insects. The universities, lawn care services, and others worked well together in many areas during the

70's to obtain the answers. Several notable examples include timing of insecticide applications for control of the bluegrass billbug and obtaining 24-C registrations for control of the greenbug aphid. The insecticide OFTANOL, registered two years ago for soil insect control will also be very helpful for grubs and other soil inhabiting insects. There are still a number of priority research areas. Predicting occurrence and threshold population limits for many insects is still very difficult, life cycle information in different geographic areas must be improved and also related more precisely to environmental conditions, and additional soil insecticide candidates evaluated. Some parts of the country have organophospate resistant chinch bug populations, which is another problem requiring research attention. There are also small infestations of several uncommon insects that have been observed and need to be monitored.

The entire industry needs to reduce unneeded and over-applications of insecticides. Better dianostic and sampling techniques will facilitate more appropriate application decisions. The importance of irrigation frequency and other cultural practices needs continued examination. Alternatives to insecticides such as soap sprays, pherome traps, and insect growth regulators need to be investigaged along with the development of integrated turf management principles for incorporation into the lawn care industry.

Disease. For a number of reasons, diseases are considered a minor research priority area for the majority of lawn care companies. Diseases are generally not the primary problems on home lawns, they are very unpredictable in terms of fitting into the programmed application schedule of lawn care services, and for several diseases there is no fungicide available that will provide adequate residual control from one application. Diseases such as leafspot, brownpatch, and Fusarium blight can certainly be serious problems, but they are better handled on an individual, service call basis.

Equipment. This is a major area for most companies in the lawn service business. It is not the intent to cover equipment research needs here, but a few will simply be listed as follows:

1. Split tanks for multiple, programmed mixes.
2. Double pumping systems for multiple mixes.
3. Injection at the gun and/or reel.
4. Application methods for specific targets.
5. Fiberglass tanks and/or equipment.
6. Corrosion resistant parts.
7. Closed pesticide fill systems.
8. Commercial size equipment.

Other Research Areas. Additional research is needed in a number of relatively minor areas depending on geographical location and the types of services your firm offers. Cultural practices and systems need upgrading on many customer lawns. Soil pH and liming practices offer unique challenges. Growth regulators

may have future potential for certain types of turf areas and provide an area of interesting research opportunities. Pesticide safety, ornamental effects, product compatibility, etc., are all areas for extensive research and investigation.

The lawn care industry has grown very rapidly and solved many problems in the last 15 years. Many problems and opportunities remain for the 1980's. Universities, chemical companies, and the lawn care industry will respond to the opportunities cooperatively and through directed research programs meet the challenges of the decade ahead.

/[1] McNamara, Tom. 1981. "What is Upper-Limit of the Lawn Care Industry?" (President, Nuventures Consultants). 5(4): 1,34-36.

Lawngrass Seed - A Cultivar Clinic

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The Lawn Institute, at the present time, has files on 127 turfgrass cultivars. There are 40 bluegrasses, 25 fine fescues, 32 perennial ryegrasses, 11 turf type tall fescues, 11 bentgrasses and 8 specialty grasses. We have lists of cultivar names for which, to date, we have not obtained sufficient information to be able to make adequate evaluations.

In addition to these new listings, there are others that have been withdrawn from the market because of lack of continuing seed production. Further, each year there are an increasing number of experimental varieties being tested and evaluated around the country, and many of these in time will be marketed and named.

This whole matter has been referred to as the Varietal Dilemma (VD) and even described as a disease of the overall turfgrass industry. Dr. Robert Schery, past director of The Lawn Institute, in an article entitled "New Lawn Varieties - Bane or Boon?", outlined several advantages of having an abundance of cultivars on the market and available for public selection and use. A copy of this article is available from our office.

Thus, we recognize a situation of almost constant change that indeed does create some uncertainties in the selection and specification of cultivars for a wide variety of uses. It is well established that the consumer is curious about cultivars. (Another of Dr. Shery's articles that is available for your information carries this title, "Curious About Cultivars"). Now, cultivar clinics concerned with seeded lawngrasses are seen as a means for regular review and updating of the state of the art.

Changes made through breeding have produced grass types that are easier to establish, maintain and develop into high quality turf. This has been achieved by selecting for greater tolerance to adverse conditions.

Turfgrass Growth Tolerance

Dr. Terrance Riordan, of the Department of Horticulture at the University of Nebraska in Lincoln, presented some turfgrass evaluation data in an article, "Selecting the Right Cultivar Can Improve Your Turfgrass", published in September 1982 Park Maintenance and Grounds Management. He rated the bluegrasses, fine leaved fescues, turf type tall fescues and perennial ryegrasses for tolerance to shade, cold, heat and drought and for rate of establishment, fertilizer requirement, mowing height and disease potential. Low numbers were best and high numbers were worst or least.

Tolerance for:	Bluegrass	Fine Fescue	Tall fescue	Perennial ryegrass
shade	3	1	2	4
cold	1	2	3	4
heat	2	3	1	4
drought	3	1	2	4
rate-establishment	4	3	2	1
fertilizer requirement	1	4	3	2
mowing height	1	3	4	2
disease potential	3	1	4	2

Even though there were many differences among cultivars in each of these broad groups, there were tendencies for growth characteristics to be different between groups.

Turfgrass Descriptions

A review of the descriptions of the most recent proprietary turfgrass releases produced the following list of characteristics:

Basic appearance -

- attractive ground cover
- dark green foliage
- high quality for intended use
- uniform ground cover

Limits of tolerance -

- heat, cold
- drought
- low soil pH
- low height of cut
- pesticide
- sun
- soil compaction
- disease and insects
- low soil fertility
- wet soil
- wear, use
- shade
- low maintenance

Types of growth

- persistent
- strong growth habit, rapid fill in & recovery
- fine texture (narrow leaves) or coarse texture (wide leaves)
- shoot growth for dense cover
- soft leaves,ease of mowing or fibrous leaves, wear tolerance
- leafy, not stemmy
- slow rate of vertical growth
- low spreading growth habit, prostrate
- tillering for dense cover
- sod strength
- rhizomes or stolons, deep, spreading

- compatibility in the sward
- compact growth, dwarf
- vigorous, competitive
- adaptable under wide range of conditions
- early spring green-up
- late fall dormancy
- deep rooting

Seed Characteristics (for those grasses propagated by seed)

- rapid germination
- seedling vigor
- seed quality, germination
- seed yield, large seed

These characteristics represent the types of desirable growth habit we attempt to maximize through sound cultural practices. What are the chances that we can improve on what we have now?

New Turfgrasses

World-wide there are some 600 genera and 10,000 species of grass. Those to be found in the United States amount to 170 genera and 1,400 species. At the present time there are 4 genera and 14 species for turfgrass use. There are some 300 cool season turfgrass varieties and cultivars in use or under evaluation. Three hundred entries in Agricultural Experiment Station and private research evaluation trials is not uncommon. And there are more varieties in the making. These include types not yet ready for release to regional trials.

There are also new warm season turfgrasses coming along. Work with bahia, bermuda, zoysia, centipede and St. Augustine grasses is continuing. Although recent developments have not been of the magnitude noted for cool season grasses, the likelihood of several new, improved warm season types is great.

The Lawn Institute Variety Review Board

The Lawn Institute administers a Variety Review Board that has the responsibility for evaluating all lawngrasses available in the United States and then selecting those that are best suited for specific types of lawn and turf conditions. Both public and private research results are considered. The following selections were made for 1982-1983:

Bluegrasses

Adelphi	Enmundi	Glade
Sydsport	Vantage	Nugget
Bonnieblue	Ram I	Touchdown
Majestic	Arboretum	America
Birka	Merion	Plush
Merit	Fylking	Monopoly
Eclipse		

Fine leaved fescues

Koket	Highlight
Banner	Ensylva
Waldorf	Ruby
Agram	

Turf type tall fescues

Falcon	Rebel
Houndog	Clemfine

Perennial ryegrasses

Derby	Pennfine	Fiesta
Regal	Manhattan	Citation
Yorktown II	Diplomat	Omega
NK 200	Blazer	Pennant

At the present time, warm season grasses are not considered by the Variety Review Board. Such consideration should be initiated in 1983.

Closer Look at Turf Type Tall Fescues

Tall fescue, Festuca arundinacea, has been about the only cool season species well adapted to the "transition zone". This includes roughly an area that extends east to west from Norfolk, Virginia, to Tulsa, Oklahoma, and includes country on either side of this line for at least two to three hundred miles.

Tall fescues are essentially non-spreading types, and this growth characteristic is subject for change in the newer releases. Old types have had a rather coarse texture. Improved releases are now fine texture. Since seeds are large, a relatively high rate of seeding, eight to twelve pounds per 1,000 square feet, are recommended. At these rates, the crowding of seedlings helps to produce an even finer textured leaf.

The new turf type tall fescues such as Clemfine, Falcon, Galway, Houndog, Jaguar, Olympic and Rebel are polycross combinations that promise to recast lawn making in the "transition zone" states. These new cultivars combine the stamina and deep-rooting with finer texture, lower stature and greater density. These grasses should better endure long, hot summers and also find use under shade.

The following list of improvements are included in most descriptions of turf type fall fescues:

Basic appearance

- beautiful
- dark green
- persistent

Improved tolerance to:

- heat
- drought
- shade
- wear

and

- improved disease resistance
- low maintenance

Types of growth

- strong
- tough
- rugged
- medium texture
- dense
- leafy
- deep extensive root system
- improved tillering

Seed characteristics

- quick seed germination
- rapid seedling development

The following notations on cultivar genesis provide an indication of how each was selected and developed:

Clemfine

Three clones were chosen by Dr. Fred Ledeboer. They came from South Carolina and North Carloina sand hills. Equal numbers of each were used in an open pollinated breeding procedure. No "off" type plants were observed, and a stable uniform variety was produced.

Falcon

Clones were selected by Dr. Reed Funk from old turf stands in Alabama, Georgia, New Jersey, Pennsylvania and Virginia. These were space planted in nurseries at the New Jersey Ag Experiment Station. Sixteen clones were selected from these and an advanced generation synthetic variety produced.

Houndog

A three hundred spaced plant breeder block consisted of 150 plants from a Lexington, Kentucky selection and 150 plants from six selected turf plots at the New Jersey Ag Experiment Station. Four of these selections were from "Rutgers T1". Dr. Reed Funk derived an advanced generation synthetic variety from the open pollinated progenies of the seven parent clones.

Rebel

Clones from old lawns, pastures and turf areas in New Jersey, Pennsylvania, New York, Connecticut, Delaware, Maryland, Virginia, West Virginia and Washington, DC were selected. Trispecies hybrids of tall fescue, meadow fescue and perennial ryegrass were developed. The most promising selections were evaluated in space-plant clonal nurseries. These were interseeded with Linn perennial ryegrass and maintained at a two inch mowing heights. Tillers from selected clones were grown in isolated spaced-plant seed production nurseries. Open-pollinated seed was harvested from selected plants and used to establish 130 single plant progeny plots. These were thinned by stress of frequent close mowing. Surviving tillers were selected and used to establish a second isolated spaced-plant seed production nursery. Seed from selected plants was used to establish 330 second cycle single plant progeny turf plots. Again, tillers were selected and established in an isolated spaced-plant production nursery. Open pollinated seed was harvested from selected plants and used to establish nearly 1,000 third cycle single plant progeny plots. Tillers were selected from the best third cycle progeny plants and planted in an isolation nursery. Breeder seed was harvested from this nursery. No objectionable off-types or variants were observed. The resulting cultivar was the result of work by Dr. C. Reed Funk.

Conclusion

Results of state and regional evaluation trials are extremely helpful in making final recommendations. Since the availability of each cultivar varies some with location, there is an advantage in the substantial inventory of similar releases. In addition, local environmental conditions result in some variation of plant growth.

The more thorough the understanding of growth characteristics of the new grasses and the more complete the appreciation of the complexity of their development, the better and more successful use will be made of this plant resource. We are indeed fortunate to have such a selection to work with.

Turfgrass Germplasm Explosion

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Recent articles by Dr. Robert Schery, past director of The Lawn Institute, have featured titles such as "The Cultivar Revolution", "Evolution of Improved Lawngrasses in America: A Review of Major Events Leading to the Kentucky Bluegrass Cultivar Revolution", and "Has Turfgrass Development Plateaued?". These articles, copies of which are available from our office upon request, describe the fantastic advances in the development of specialized turf type plants from pasture species. This has indeed been a revolution and even a turfgrass germplasm explosion. And, really, it's all just begun!

The September 1982 issues of Golf Course Management presented an article entitled, "Game Plan for Golf - The First Zillion Years". Excellent! Grass priorities were outlined under the following categories:

- tolerance to drought
- tolerance to salt
- lower mineral nutrition requirements
- close clipping - dwarf varieties
- tolerance to heat
- tolerance to cold
- tolerance to wear
- pest resistance - weed, insect, disease

Much progress has been recognized in the improvement of old standby pasture types to include many of these features. The real future is in the germplasm explosion that will maximize the expression of these essential growth characteristics for fine turf.

In recent years, increased interest has developed in turfgrass exploration. The objective of modern turf research explorers is the collection of grasses that fit the climate. Grasses from regions where growth conditions are representative of those desired, or where growth conditions may have enhanced the natural selection process have germplasm potential for the development of new, improved varieties.

The following division indicates the relative abundance of various turfgrasses in use today.

Numbers of Turfgrass Varieties and Cultivars in the United States

Grass Category	Under Evaluation	On the Market	From LIVRB*
Bluegrasses	100	40	19
Fine Fescues	50	25	6
Perennial Ryegrasses	50	32	12
Turf Type Tall Fescues	20	11	3
Bentgrasses	50	11	4
Special Purpose Grasses	40	8	1
Total	310	127	45

*Lawn Institute Variety Review Board

As of the fall of 1982, the USDA Plant Variety Protection Office listed 77 cultivars that have been recognized by the issuing of a certificate - U. S. Protected Variety.

Bluegrasses	24
Fine Fescues	15
Perennial Ryegrasses	28
Turf Type Tall Fescues	8
Bentgrasses	1
Warm Season Grasses	1
	77

The passage of the 1969 House or Representatives Bill HR 13631 and the establishment of the Plant Variety Protection Office within the USDA brought forth increased interest and effort in turfgrass improvement. Without this protection, it is unlikely that the large investment in time and money necessary for new variety development would be made by private enterprise. With this protection, both the land grant university (public) turfgrass breeders and the seed trade (private) turfgrass breeders have become highly effective in a cooperative effort to improve turfgrass quality.

At the 1982 meeting of the American Seed Trade Association, a resolution was presented entitled: "Recommended Policies for Release of Germplasm, Varieties and Related Technology from Public Institutions". This resolution recognizes the strength in cooperative effort by public and private breeders and outlines ways and means for enhancing this relationship. The past ten years of turfgrass breeding research have developed a strong foundation for continuing achievement. Many turf managers are asking The Lawn Institute, "Where are we going from here? What does the future hold for new grasses? How many are on the way? Are we really in the midst of a germplasm explosion?"

Much of the future prospect for turfgrass breeding depends on new methodology. Two basic long standing techniques have involved plant selection and hybridization. Plant selection involves the isolation of superior plants that occur naturally. Often these plants spread under the local environmental conditions and exhibit exceptional growth characteristics.

Hybridization involves crosses between compatible plants. The pollen from one fertilizes the egg from another. Kentucky bluegrass is facultatively apomicitic, which means that most of the seed produced bypasses the normal sexual reproduction cycle. This seed is identical genetically to the mother plant. Only a small percentage of seed are genetically different. Few hybrids are produced in apomictic plants. Once hybrid seed is obtained, cycles of turf evaluation from seeded plots, selection of desirable types, seed production, including further hybridization, followed by more seeded plot evaluation are followed through. Seed of the best appearing hybrids is finally harvested, cleaned, and used as breeder seed.

Now, new methods are based on recent explosive advances in biology. They work simply because each cell within a plant contains the necessary genetic information to develop a whole new plant. The gene within the cell contains the genetic code that regulates growth and development. By transplanting certain genes from one plant to another under controlled conditions, new plants can be constructed. The new term, genetic engineering, is used to describe this process. Whether the plant function is photosynthesis or nitrogen fixation, genetic engineering provides a means for bringing about improvements.

With crosses between plants the limitation of compatibility and the time consuming process impose a real handicap . New tissue culture techniques, which have developed as a prerequisite to genetic engineering, produce cellular hybrids, even crosses between otherwise incompatible plants. Mutant cells may be selected and interspecific and/or intergeneric crosses include haploid culture and protoplast fusion.

Tissue culture involves the development of callus tissue, simply a group of undifferentiated (all the same) actively divided and growing cells. Root tips, seed embryos or apical meristems may be used effectively. Highly specialized growth media containing nutrients, vitamins and hormones are required. Much research has been conducted to determine exact specifications for this work. The development of callus tissue in time produces mutations or changes in the cells. This bypasses the normal or natural sexual processes of pollinization. At this point, nutrient, vitamin and hormone changes may be made in the growth media to stimulate the regeneration of whole plan from callus cells. Once accomplished, plants are evaluated for geneticial changes.

Other treatments may be made in conjunction with the callus tissue. For example, single cells may be isolated. Cell walls are removed by specific degrading enzymes, thus yielding fragile naked protoplasts. These may be mixed with other protoplasts from different cells to bring about protoplast fusion. When this happens, the genes from both cells or plant types are combined into one distinctly different hybrid cell. This new cell will contain genetic information from the two parent cells that could well be greatly different and incompatible in nature.

One of the most difficult processes in genetic engineering is the redevelopment of the cell wall around the fused protoplasts and the redevelopment of callus tissue and whole plants. This is accomplished by adjusting types and concentrations of nutrients, vitamins and hormones step by step. Temperature and light are also of critical importance in the formation of vascular, cortical and epidermal tissue and finally shoots and roots. Through this whole process the importance of contamination is of prime concern to the genetic engineer. Failure to keep foreign organisms removed from the system brings about total loss.

There are several variations of approach that must be worked out for turfgrasses; however, from what is known of this science, which is still in its infancy, we have not yet seen the germplasm explosion. It is yet to come.

Starting Grass Seedlings

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Once the seed is in the ground, the starting of grass seedlings becomes a period of prime concern. Some few procedures in the creation of an environment suitable for germination and seedling establishment and an understanding of the nature of grass seedlings go a long way towards making this an easy and successful venture.

Research results and considerable practical experience indicate that major control of only one factor, moisture, is necessary for successful seedling establishment.

Turfgrass Seedling Characteristics

There are four interrelated conditions of seedling stands that make them particularly vulnerable to moisture stress. These are: succulence of tissue, immaturity of tissue, thinness of stand and restriction of root system.

Succulence of Tissue - Seedling turf has soft, water filled leaves that are easily injured by lack of moisture. At the same time, this succulence tends to increase proneness to damping off and other seedling diseases at times when the soil becomes too wet. Thus, in striving to develop seedling turf, a balance is desirable between plant stress from lack of soil moisture on the one hand, and excess of soil moisture on the other. The more uniform the seedbed environment, the easier it is to realize this balance.

Immaturity of Tissue - Seedling tissue, including leaf, stem and root, is immature by virtue of the limited growing time following germination. With increased time, these tissues mature and "harden off" and become less sensitive to environmental conditions that induce stress or weakness within the plant system. Thus, this early period of seedling establishment is critical for the well being of the plant population. Any and all measures that protect seedlings at this time are worthwhile. Of course, cultivars that possess growth characteristics of rapid germination and seedling development have an advantage of promoting maturity of tissue within a shorter time frame so that there is less liklihood of adverse environmental changes.

Thinness of Stand - Seedling turf is characterized by thin stands, more or less, depending on rate of seeding, cultivar or cultivars selected and rates of germination and seedling development. Thin stands of grass leave exposed soil. Loss of moisture by evaporation from the soil, in combination with loss of moisture from succulent leaf tissue by transpiration, can easily reach levels that induce moisture stress. This combined process of moisture loss is measured as evapotranspiration. Unusually high levels of evapotranspiration are often the cause of seedling turf failure.

Restriction of Root System - Because seedling turf stands have shallow undeveloped root systems, simply because of insufficient time for more adequate proliferation, they have a smaller volume of soil from which to absorb water to maintain the relatively high demand of young growing leaves. Thus, the combination of increased evaporation from exposed soil and shallow roots near the soil surface create ideal conditions for the development of moisture deficit.

Practices for Optimum Seedling Moisture - Practices to create and maintain optimum seedling moisture relationships may be grouped in four categories. The first is seed related practices and includes such items as use of pregerminated seed and/or use of companion grasses. The second is cultivar selection and includes such matters as rate of growth, use of early mowing practices and weed, insect and disease relationships. The third is soil related influences and includes irrigation and natural rainfall variables associated with soil moisture holding capacity, use of mulches or other soil protectants, and wetting agents. The fourth is climatic influences including light, wind, temperature and humidity.

1. Use of Pregerminated Seed - The practice of pregerminating seed has been advocated for years. Many formulas have been worked out for mixing carriers like Milorganite, sawdust, vermiculite, and sand with water and seed. Optimum temperatures and mixing for prescribed periods of time start the germination process. Prior to seeding, the mixture is dried down or diluted with dry carrier so that it an be spread uniformly. This process may also include use of growth regulators that speed up the germination and rate of seedling establishment. In order to be consistently successful, it is necessary to standardize practices to local conditions and carriers. Getting a seedling turf well established quickly allows less time for unfavorable moisture conditions to interfere.

2. Use of Companion Grasses - Some turfgrasses germinate and establish more rapidly than others. The new perennial ryegrasses are most rapid, closely followed by turf-type tall fescues. The fine leaved fescues are next, and the bluegrasses are generally slower. There is some cultivar variation within these groups. Using fine leaved fescues with slower germinating bluegrasses creates a situation where the fescues protect the bluegrasses during the establishment period. This protection is realized through reduced moisture loss by evaporation, and in addition through improved disesase resistance within the seedling turf.

3. Cultivar Selection - New turfgrass cultivars have been developed to feature reduced proneness to disease and insects, increased competitive edge in relation to weedy plants, and generally improved growth rate and response to mowing. In order to establish seedling turf effectively, these improved growth characteristics are highly desirable. They bring about an early tillering or spreading of individual plants and an earlier maturity of tissue.

Early mowing with a sharp mower, even if only a small bit of leaf tip is removed, will stimulate plants to tiller. Mow at the recommended height for the cultivar used when the leaf tips are just slightly above this height. In some instances, where growth is a bit sluggish, mowing somewhat below the recommended height is advised. The earliest possible tillering helps to develop a tight cover and reduce loss of soil moisture by evaporation.

4. Soil Modification - Since the soil is the rootzone and since root growth is the key to successful seedling establishment, any and all practices that make the root environment more favorable for plant growth should be carried out. Really, the objective is the development of an optimum moisture holding capacity.

This means having just the right amount so that the soil is neither too wet nor too dry during the germination and establishment period. It means having textural components (sand, silt and clay) that provide,along with organic matter, a good structure (aggregation of soil particles). It means working the soil to a uniform condition within the rootzone. And it often means using a wetting agent to create improved moisture penetration and movement.

In addition, the use of mulches or other soil protectants help to enhance germination and seedling establishment by protecting the soil surface, thus creating more ideal temperature and moisture conditions around the seed or seedling. Straw, netting and various fibrous materials have been successfully used as mulch. Soil bonding agents have some usefulness for limited periods.

With all these conditions checked and balanced insofar as possible, irrigation practices that feature light, frequent watering will produce ideal moisture relationships for seedling establishment.

Adjusting Climatic Variables - We talk about the weather but usually can do little about it. Thus, light intensity and quality, wind speed, temperature and humidity from drying to saturation to precipitation all influence germination and seedling development,and we must generally accept conditions as they are. Site planning and modification provide us with the only means of controlling these influences.

Shade may be modified to increase light intensity or reduce it. Light quality is also changed in this way. Exposure to wind that creates drying or chill may be adusted by landscape changes - new planting or architectural features may be put in place.

Too little air movement brings about stagnation, high humidites and temperatures and resulting disease. In such instances, vegetation may need to be removed or thinned.

Changes in grade may be required to contrd surface water and keep it from accumulation in the wrong places. It is obviously difficult to make changes of this type after turfgrass establishment.

Conclusions - Thus, starting grass seedlings is really an easy process. It only involves close attention to water management. And since water is becoming an ever more precious natural resource, it should be natural for us to strive for conservation and wise use. In the long run, well established turf must be our first priority in conservation of soil and water .

The Golf Course Improvement Process

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There are two ways to run any business - to service the existing market or to build a new market. Most believe that building a market like Volkswagon, Sony, and Apple did, is preferred because you develop a customer loyalty that will support you through bad times and good. The key to building a market is to determine your customer's needs and fill them at a fair price. Golf, like any other business, must do the same, so the golf course improvement process is really determining your customer's needs and expectations, and making changes that increase your patron's pleasure and your long term profit.

Some indicators that improvement might be needed are:

- Not playing to full capacity at the highest reasonable price
- Problems or injuries from golfers or adjacent land owners
- Little player loyalty or no stream of positive comments
- Reduced number of actual playing days due to wet conditions
- Excessive hand labor required to maintain course
- Imperfect putting surfaces or bare tees
- Charting course shows inadequate diversity of shot value.

After you recognize the indicators for improvement, next you must understand your patron's needs and expectations of what a golfing recreation experience should be. Sociologists tell us that any recreation is a five part process:

1. Anticipation of the experience
2. Travel to the site of the experience
3. The recreation experience
4. Travel back home
5. Remembrance of the experience.

This demonstrates that recreation is a cumulative process of one emotional exepctation and realization built upon another. Therefore, your golfing patron's recreation experience begins the moment he decides to play golf, and continues to build and intensify from when he approaches the golf course until he has completed the round and is on his way home. This means that every single thing that he senses at the golf course either adds or detracts from the total recreation experience. Therefore, his round of golf begins the moment he first sees the golf course or turns into the parking lot, and thus it is here that the improvement process begins. I have made a list of items important to golfers and have placed them in order of importance to your customer.

1. aesthetics of entrance way and parking lot
2. personality of person behind counter
3. cleanliness of Pro Shop and restroom and golf carts
4. condition of practice green and first tee
5. condition of greens
6. condition of traps
7. condition of tees
8. condition of fairways
9. condition of roughs
10. design of golf course

The design of the golf course is almost always the last factor which influences his measure of fun, but if everything else is equal, it can be the thing that gives you the edge over your competitors or will allow you to charge higher prices.

The first three most important items on my list is another group of topics altogether. However, it is enough to say that if one ignores those factors then he is ignoring three inexpensive improvements that can definitely increase golfer pleasure and possibly your profits.

I would like to begin discussing the physical factors of the golf course by making some general observations, and then getting more specific as we go on.

First, consider the practice green. The golfer expects and appreciates the practice greens and therefore they should be given the same or better care than your would give to your other greens. Because practice greens get so much concentrated traffic, we normally build two of them, each as large as possible (maximum of 7,000 sq.ft.) and built with some rolls similar to what you find on the course. It can and should be dressed up with some nice landscaping or flowers.

The first tee should be your best maintained tee and one of your most colorful spots on the golf course. Increasingly, the golfer expects to see flowers or landscaping on the course, but if they are formal flowers or plants, they should be kept in formal locations, and the most formal location of a golf hole is the tee. If the plants are informal, such as wildflowers or native grasses, then they should be used informally and out of play for ninety percent of your golfers. The same should be said of trees and shrubs on a golf course; formal plants in formal locations, and informal plants in out of play areas.

Speaking of trees, consider the impact of trees on golf. First, as you know, there are no trees on the birthplace of golf, namely the Scottish Links land. In fact, the highest growing plant is gorse which gets only about four to five feet tall. So, when golf first moved inland into forested areas like the Heathlands south of London, the links golfers called trees unfair hazards, and no British Open was ever played on these courses. In America, we consider trees an integral part of a golf course and one without trees looks naked. But when selecting and planting trees one must consider that he is placing the second most severe hazard in golf, except for water, and so tree planting should be done very carefully. When selecting and placing trees I try to use the differences

in height, color and texture to create a pleasant visual sensation or to frame or highlight an area, but yet evaluate their impact on the playing of golf. I personally believe that out in normal impact areas and close to play lines the trees should have a low growth habit. This means that if one hits directly into the trees then he is severely penalized, but if he hits behind them any distance he can play over them without much difficulty. However, if a tall tree were placed in the same location, then the person under the tree has an easier shot than one back behind it a ways. Then tree selection should be based not only on adaptability or price, but also, color, texture and heights and especially location relative to play areas.

The most important parts of the actual course are the greens. Your patrons will overlook a lot of deficiences if your greens are perfect. By perfect I mean a tight sod, good color, 1/4" mat, no grain, and a medium-fast speed. Most golfers don't know Poa annua from corn stalks, so composition of the turf means little to them, but how the ball rolls on them is very important. On so many courses the greatest improvement that could be made would be to mow the greens every day, give them a couple extra pounds of nitrogen a year, and get rid of some thatch and grain. In fact, the next four items on my list deal with the condition of the golf course. Maintenance is more important than design.

Assuming your course is reasonabl well designed with no major problem areas, then the most critical design factor is safety; safety to golfers, maintenance personnel, and adjacent landowners. We all know the dangers of golf courses so everything else must become subordinate to safety. If this means sacrificing the greatest golf hole in the world, it should be done if it presents an unreasonable safety hazard. Since this is so important I will spend a few minutes discussing safety.

The first consideration is the layout of the course with regards to proximity of play areas and safety buffers. First we like to have the OB on the hookside because most people slice. Then, normally, for a single hole we like to have a 300'-350' wide corridor, and for two adjacent holes there should be 240' between centerlines or about 500' total, depending upon topography, trees, buffers, etc. When one is forced to put holes closer together than this we try to stagger the impact areas so that two holes aren't slicing into the same impact area. Next we try to build safety buffers between the holes where possible, using trees, traps, mounds, lakes, tall grass, etc. If necessary, screens or barriers could be constructed, for nothing is more important than safety.

Next we try to eliminate blind spots where a golfer is hidden from view of the group behind. This can be done by cutting the hills or ridges that hide the golfer, raise the tee, build a periscope, or a combination of these. Our goal is to be able to see a man from the waist up who is in normal play.

We examine slopes of hills to try to eliminate areas where maintenance equipment or carts might slide or tip over. Slopes steeper than 3:1 should be avoided at all costs. Where this is impossible, such slopes should be fenced off or warning signs installed to alert people.

Bridges and cartpaths present such a huge liability that we completely remove ourselves from any planning or construction activity. We might suggest a preferred cart routing but we avoid selecting exact locations because of the implicit liability of perhaps constructing an unsafe situation. Our suggestion has always been to get an engineer to review bridge construction, and have a manufacturer's representative to certify in writing that his equipment will safely negotiate your cartpaths or hills. Place the burden on the equipment supplier and don't assume that yourself. Further, we recommend very accurate maintenance logs for every cart or major piece of equipment. This is not only good business to find out if some items are a greater drain of assets than others, but it is also support evidence in the event of litigation.

Next to safety, the biggest improvment to golf courses is improved drainage, both surface and subsurface. Good drainage permits easy conditioning of the course, removes ugly areas, increases the amount of time your course can stay open throughout the year, and it reduces your overall total expenditures. We always provide surface drainage on tees and greens and use subsurfaces or tile drainage as a compliment to good surface drainage. Tile lines can be clogged when covered with as little as 1/16 inch of silt, so we use gravel backfill wherever possible. Surface drainage should have at least two percent fall, or two feet vertical for every 100 feet horizontally, and tile lines a minimum of 0.5 percent fall.

Only after you have corrected all of your unsafe areas and have a well drained golf course would I invest in physically altering the golf course to make a better test of golf.

Whenever I say "better test of golf" everyone always assumes that I mean making the golf course more difficult. That is only partially correct, for my design philosophy is to make the course easier for the less skilled player and harder for the most skilled ones. In fact, the essence of strategic golf course design is to reward the best players but not penalize the poor player. Sound impossible? Well, it is not easy or alway totally successful, but that is the design goal. As an example, at my home club the par is 71, it is rated at 68.4, but when the District Qualifier for the U.S. Amateur was held there, the medalist was nine over par, and when the P.G.A. Assistants played it to qualify for Class A membership status and needed a score of 156, or 15 over par, no one qualified. The point is that for the average member the course is fun to play, but with only minor changes it is a very stern test because of the design features which I will discuss with you that you can use.

First, one should chart the golf course to see what clubs are most often played by the average man and woman. This shows you the potential shot value of the course. The ideal is to make you play every club in your bag. From this chart one can see if yardage changes should or could be made. To me, the ideal middle distance is 6,400 yards; 6,850 from the back and 5,400 from the front tees.

The strategic design intent must also analyze the preferred landing zone and offset the play angle to give the back tee player the most difficult drive. If there is a major hazard to the left, then the front tee should be built as far left as possible so that they are hitting away from the hazard. Likewise the back tee should be placed to the right so that they are forced to hit directly at the hazard, and middle tees are placed somewhere in between. By offsetting the angle of play the hole not only is longer, but it plays harder because they are forced to face the hazards. However, to reward the player who risks the left hazard on the drive, the green should open up to that side and the green should be defended against the approach shot from the safe driving zone or right side. This is not often possible with a round green, oval flank traps, and straight line fairways; this design I call the "freeway design". So the trend has been to free-form flow lines with a maximum amount of integration between all golf elements of a hole. In other words, the flow line of the greens traps match the flow line of the green as does the contour mowing lines.

As you can see, the first nine improvements can be made without the aid of a golf course architect, but if after you have made all of these improvements within your abilities, then you should consider hiring a qualified and experienced architect to guide your improvements to the golf course. This would seem like a simple process but I suggest choosing one as carefully as you would a spouse. (In both cases a bad choice can haunt you for years). I suggest the following steps:

1. Write American Society of Golf Course Architects at:
   221 North LaSalle Street
   Chicago, IL 60601
   for a list of their members

2. From that list select several near you and ask them to submit proposals as to how they work, to what extent they are personally involved, and how they charge. Most importantly - ask for a complete list of improvement work they have done in the last five years and the contact at each job.

3. Review proposals and select three to five of the best ones and then go inspect their work and talk to their past clients.

4. Next interview the top two or three candidates and walk a few holes with them and let them tell you what they see.

5. Make a selection and contract with the architect spelling out probable timetables for the work.

6. Obtain a recent aerial photograph (no more than one year old), and a contour map of the course, noting property lines and rights-of-way.

From your interview you know what to expect from the golf course architect in terms of the type of plan he will do. The options are:

1. A one page master map showing suggested improvements

2. Small sketches of the individual holes noting changes

3. Complete master plans plus drawings of individual holes along with a written rationale for each proposed change

4. In any case, it is reasonable to expect a priority of the changes and an estimate of the cost to make the changes on each hole. These lists will aid the club in phasing the improvement and allocating the necessary funds.

Once the plan is complete and approved by the entire membership or owners, then the actual construction can be started or bid by a contractor. Usually this work should be started early enough in the fall so that it has sufficient time to grow in the fall and thus is completely ready for spring play. Sometimes this means starting in early August if greens rebuilding is planned.

To illustrate,I will use a sample golf hole and take you through the design process to improve that hole. Although the existing hole is nice, it is visually uninspiring, has a weak integration of elements, and is disproportionally difficult for the less skilled player because of its length and slice-side water. Since the prior hole requires a 180 yard approach shot, I suggest shortening this hole by selecting a desired impact area at 160 yards from the green, then building multiple tees diagonally across the hillside so that the further forward one moves, the more he is hitting away from the water. Beyond the impact area I would integrate the pond and hillside by extending the pond into the fairway and use the resulting fill to build two ridgelines out from the hillside. Strategically, the more one is willing to risk playing near the pond, the greater will be his reward of an unobstructed approach shot to the middle and newly extended left portion of the green. The green should be protected in the right front by a complex of mounds planted to hard fescue that is seldom mowed. These mounds should be visually linked to the new ridgelines by heights, color, and texture, for they too will be planted to hard fescue and seldom mowed. The left front bunker should be raised 18 inches above the putting surface and made free-form much like the new rear backdrop bunker. The fairway and rough areas have been reduced in non-play zones, and planted to low maintenance wildflowers or native grasses. To complete the hole it should be landscaped with weeping willow trees, several low profile accent trees, some extended beds of heaths and heathers or other adapted ground cover, and controlled cattail growth.

Records, Planning and Budgets

Wm. E. "Bill" Lyons
Lyons Den Golf, Canal Fulton, Ohio

A study of this topic reveals there is not a standard system of record keeping for the turfgrass industry. Record forms that are simple, easy to use, non-time consuming must be developed by the manager. You may get some ideas from the ones we shall present.

The psychologist tells us we are all creatures of HABIT. This we found out when we installed a burglar alarm system.Our habit was to unlock the back door first. After setting off the alarm several times we had to change our habit.

It is easier to give up whisky or sex than to break an old habit. Yet it is more difficult to create new habits because it requires new thinking and thinking is more work and no one wants that.

In our shop we have a motto that reads, "There has to be a better way". Here is an example. For thirty years we changed cups using just one cup cutter. We would force half the cut into a pail then make the second cut. What a messy way. Now we use two cutters. The first cut is left in the cutter, as is the second cut in the other cutter. Now the plugs go into the old hole without the mess of using just one cutter. A lot of time is saved.

It is easier to mow grass than to connect the mind to arm to pencil to record the many phases of turf management. Why? Because to some of us it will be creating a NEW HABIT.

Ted Woehrle,CGSA, Past President of the GCSAA, Oakland Hills Country Club in Michigan said this, "The two best tools that the GCS has at his disposal are a pencil and a 35 mm camera." And we added, knowing how and when to use them.

Tom Mascaro, the man who invented the aerifier, who lives in North Miami, Florida, stated in one of his fine lectures that if one can save one hour a day on routine operations you have earned a two week paid vacation. ($6,000.00)

Malcolm McLaren, retired from Oakwoood Country Club, Cleveland, another past president of the GCSAA, said this, "Watch the laziest man in the crew. He will show you the easiest way to do a job, and that will save time."

Daily records will show where savings can be made in time and materials.

The (green) Workman's Daily Time Ticket is an old form that has been in use for many years. Again it calls for the use of a pencil. You may have to help some workmen to fill it out at the day's end. There are a few good workmen who cannot read nor write. Make up your own master weekly form. Tickets can be purchased from Vestal-Monroe Printing Co., 213 W. Institution Pl., Chicago, IL 60610.

The Daily Record of Weather and Agronomics (Lyons form) is like a diary. It is your personal record of your successes or failures. (We hope you have none of the latter.)

Dr. James Watson, Vice President of Toro Manufacturing Co., who assisted in editing this form said, "The value of this type of daily record will be to look back a year or two to help plan the week's program." For example, what time last year did we apply fungicide to prevent snow mold? Record showed the soil temperature was near 50 degrees F. The bent had slowed its growth. The result was excellent. Preventive maintenance to turf and equipment is the key to success. Your past daily (diary) records can help you look for trouble before trouble finds you.

With the ever-increasing cost of equipment a record of every unit is a MUST! The Equipment form, developed by Garland C. Parsons, Superintendent, Pine Valley Golf, Wadsworth, Ohio, is printed on grease resistant ledger paper. On the back he records the cost of repairs to the unit. An addition would be the man hours to make such repairs.

When the cost of repairs, labor and down time lost, plus obsolesence get out of hand, it is time for replacement. This record is a must in the aid of determining personal property tax value and replacement tax value based on investment credit if you operate on a profit or loss basis. Annually, a set of your equipment records should be in the club safe or with your accountant who would need them in case of fire or theft.

The power golf car has been the life saver, financial angel to many clubs and courses. Unfortunately, the care of them grew like a cancer when the club bought rather than leased. For the owners of golf cars the Garland Parsons record form on each car becomes important. A golf car reconditioned properly can earn just as much as a new one. Like other units the taxable value and investment credit come into play.

Government requires all legitimate businesses to record every expenditure and source of income. You and I are on the expenditure side of the ledger. Our accountant satisfied the revenue collectors showing them the following:

Labor	Utilities - Phone, Elector, Fuel
Postage and Freight	Building Maintenance
Maintenance Equipment	Auto, Truck, Tractors
Fertilizer, Chemicals, Seed	General Upkeep, Grounds (Irrigation)
Pro Clinic, Dues, etc., Travel	

At year's end we study these figures on a percentage basis and compare them to the previous two years, allowing for inflation. From a year's complete set of records it becomes an easy task to set up a budget for the following year. The GCSAA has a booklet free to members entitled, "The Budget Process". Also, for $6.00, "Golf Course Budget Forms".

The October issue '82 of Golf Course Management magazine has a good story on computer for the turf manager. Just like a set of good daily records, the input into the computer must be daily and accurate.

Visiting many courses I find that few turf managers have a decent office, yet they are responsible for millions of dollars of club assets.

Here is a simple idea. Some of the forms can be put into an 8-1/2" by 11" loose leaf binder. A box can be nailed to the wall with a chained drop side for writing, and the binders stood up on the shelf. I learned this while a dairy farmer. I had to keep a record on every cow after milking , feed, calving time, etc.

So even if you don't have an office or a secretary, create some hew habits through the aid of simple forms.

Dr. O. J. Noer, of the Milwaukee Sewerage Commission, coined the phrase, "A golf course is no place to save money. It is no place to waste it either." Your records will show how wisely you used it. A budget is a worry tool - less worry to budget for less worry afterwards.

Editor's Note: The Turf Manager's Handbook, Chapter Five, pages 60-64 has the format for ten forms developed for record keeping.

Operating The Small Budget Course
Dwight Ladd, Co-Owner
Mooresville, Indiana

After talking with Dr. Daniel I really should have changed the title of this presentation to "Operating A Golf Course With No Budget."

On June 1,1980, my wife and I purchased a nine hole course in Mooresville, Indiana. The term, "mom and pop" really applies to us. Roz, my wife, runs the club house, pro shop, rents golf cars and handles the snack bar. Her only help comes from me in the evenings and on weekends after getting the golf course ready for the day. I maintain the golf course with a high schooler and a retired gentleman. The retired man does mainly tractor mowing, and the high schooler is kept busy push mowing, running a weed eater and numerous other tasks. My days seem to fly by; equipment repair takes a large portion of my time.

Budgeting for a "mom and pop" operation for us is quite simple. Unless the money is in the bank, we purchase nothing. This may seem a little simplistic, but it keeps grandiose ideas and impulse purchases to a minimum. Golf equipment sales people are always promoting specials on clubs, balls,etc. The old "Buy now and pay later" for a small operation such as oursis not well advised.

Roz and I spent the first year learning the operation and people. After this initial year we both made up our own list of improvements, changes in our operation and things we could learn to improve ourselves and the operation. I hope you notice that I refer to operation - this means golf course and total club function. Being owners, we are here to show a profit; this is a total business involvement for us.

The lists were compared and changed numerous times before a five year plan was formulated. This plan included everything to get our facilities to a realistic level, one that we could be proud of and still be affordable to the area people and allow us a profit. The plan we formulated leaned heavily toward the golf course in the last three years. The first years were to start long range improvements to the golf course and solve immediate problems. One of the immediate problems was to improve the club house. This included new carpet throughout along with painting for a total new look.

Golf cars badly needed to be upgraded. We talked with several people about various manufacturers and selected E-Z-GO. Six cars were purchased our first year, and a replacement program of four cars per year was started. With 25 cars for a nine hole course, the income is very important. By purchasing four cars a year we will be able to replace the fleet every six years and hopefully reduce down time and repair costs.

Drainage is so very important as our golf course had several wet spots. To keep golf carts running and improve the overall conditions, 1600 feet of four-inch tile was installed. The golf car and drainage problems were considered to be important for the short and long term.

There were other projects that were done. One was an addition to the maintenance building. While planning this, a club member who built pole buildings was asked for his advice. While talking about construction he pointed out that his business was slow and he had time to build the addition for me. This he did for the cost of what the materials would have been for me. He just needed to keep busy, and I had a nice addition for storage at a very attractive price. There have been many members who have helped me topdress, put mowers together in the spring, and have helped in other ways to improve the course.

Long range improvements have been started. Tree plantings have been fifteen a year. We are planting basic native trees to have a good foundation to add specimen trees later. A tree nursery has also been established.

We are trying to replace maintenance equipment as soon as dollars allow. We have been very fortunate to have been able to purchase some good used equipment. This will allow us to improve our maintenance as down time is being cut.

On our pay-as-you-go approach, all the basics are planned and provided for before any more projects can be marked off the list.

Using An Economy System
Allen Wehr, Superintendent
Huntingburg Country Club
Huntingburg, Indiana

In late summer of 1979, after six years of being the superintendent of the Huntingburg Country Club, I was tired of the hassle of greens irrigation. To many of you, these problems are familiar.

First, there is the problem of finding qualified individuals who are willing to wake at 3:30 a.m., rise out of their nice warm beds and go out into the wonderful surroundings of a golf course and fight the darkness, kinks in hoses, and wind up about half wet until 7:00 in the morning. Believe me, it is asking a lot from a person.

If you are fortunate enough to find the individual and he does the best he can, when the July and August heat and humidity set in, you face the same problem of lost turf in the approach areas due to lack of water, and some wet wilt in the lower lying areas of the greens due to an overflow of water.

Our golf course uses city water, drawing off of four meters with no pump to provide additional pressure. We were used to that fact because under the drag hose system, we had to leave the sprinklers at one setting for approximately ninety minutes, with three settings per green - a very time consuming process!

Finally, along with these problems, the Board of Directors decided they had $75,000 to "improve" the club house. I decided enough was enough. It was time to draw a little attention to the golf course.

I contacted my local irrigation representative, and took a survey of the existing water lines to see if they would be adequate. We found seventy percent of the greens had adequate sized lines to supply three pop-up sprinklers per green, but only if one green was to run at a time.

Next we figured the amount of additional line we would need, types of sprinklers and valves to be used. In order for this system to be considered, an exact breakdown on the costs of the project was compared with the current labor-consuming system we had been using. This was important in selling this to the Board of Directors.

Finally the project was submitted, and, to my surprise, approved! The project began in March 1980. I contracted with a company to pull in all irrigation lines and wire. The machine was a modified Ditch Witch with a steel bar which had a vibrating motion. On the lower section of the bar there was a three inch steel bullet attached, and from this bullet there was a chain with a wire mesh finger about four feet long. As the machine advanced the bullet made an opening for the pipe to be pulled along to its destination. One of the longest pulls we made was approximately 350 feet. This was done in one complete section.

Since the system was going to be automatic we had to plan 24,000 feet of wire to connect the valves to the clock located in the maintenance area. The plowing of 3,000 feet of pipe around the greens took eight hours. The 24,000 feet of wire was in the ground in twelve hours. Keep in mind the pipe and wire were buried to its destination, all to be connected later.

The plowing of pipe and wire was a great savings due to the fact that there were no open trenches anywhere which must be backfilled, no problems of settling, or need to resod the trenched area. There was little damage to sod surface. Within two days following the plowing we could hardly see where the lines had been installed.

We installed #41 Rainbird sprinklers with 1-1/2" electric valves all controlled by a 12 station clock located in the maintenance building. In April the system was ready for operation.

The cost breakdown of the program was:

- Sprinklers, valves, pipe, wire, fittings, etc.	$4,500.00
- Contracting machine to pull in pipe and wire	1,500.00
Total "outside" costs to install system	$6,000.00

As far as the economics of our irrigation system are concerned, the actual water usage has been reduced, simply by distributing the water equally as needed. The dollar value varies from season to season. The labor savings equals between $1,000 and $1,500 per year. With the cost of our system at $6,000 dollars,the labor savings alone will pay for the system in a three to four year period.

There is another money saving advantage of an irrigation system and that is the amount of turf which was formerly lost in our aprons and approaches which we had to overseed annually. During the past years of having our system, the bentgrass is moving out around the greens, and the bluegrass is finally putting up a fight against the Poa annua.

I hope I have explained my economy system thoroughly. Many of you are in the same position I was in, and perhaps this may be an idea worth considering.

Zoysia Into Fairways

Larry Hantle, Superintendent
Rolling Hills Country Club
Newburgh, Indiana

In the mid-seventies the golf committee at Rolling Hills Country Club decided to change the fairways from bluegrass to a warm season turf. This was to facilitate lower mowing heights and better playability. The committee was split between seeding common bermudagrass and vegetatively planting zoysiagrass. The final decision reached was to seed bermuda, although the golf course superintendent voted for zoysia. After two unsuccessful attempts to seed bermuda, the USGA Green Section was called in to consult. Their opinion was that Meyer zoysia which turfed the Rolling Hills tees was more adaptable to the Southern Indiana climate than seeded bermuda.

There are two zoysia nurseries totaling between one-half and one acre at Rolling Hills which was established when the tees were sprigged in the early seventies. This was to be the source for moving zoysia into the fairways. Strip sodding was chosen because there would be no large capital outlay for plugging equipment. The nurseries were large enough to allow for moderate conversion. It was estimated that in ten years the program would be completed. Another factor was that the program was to be completed with existing manpower.

In the summer of 1978, Meyer zoysia was first strip sodded into a fairway area. The equipment used was a 12" Ryan sodcutter. The blade was replaced by two 3" blades mounted on each side twelve inches apart. A fairway area would be selected and rows approximately twelve inches apart were cut. The sod was picked up and hauled to a dumping site. The sodcutter was then taken to a nursery area and the zoysia was cut with overlapping cuts, leaving about four and one half inches between the rows. The rows in the fairways were fertilized with 18-24-6, then zoysia was laid and watered heavily. The nursery rows were then filled with topsoil from a stockpile on the course.

In September 1978, I was hired to become the superintendent as of January 1, 1979, when Ed Michael was retiring. The zoysia program continued in 1979 as Ed had started it. The criteria for selecting fairway areas to be strip sodded was identifying areas of bluegrass which had been thinned by disease, mainly leafspot, dollarspot, and Fusarium. No money has ever been spent on fungicides for fairway turf at Rolling Hills.

Following the 1979 season, I decided that a more organized method of selecting areas to be changed over was needed. After conferring with the golf chairman it was decided to concentrate on landing areas and approaches to greens first then move to the rest of the fairways. In 1980 the worst landing zones and approach areas were targeted for improvement. This has continued and as of this date only one of the approaches remains. The landing areas are between 60 and 90 yards long and the approaches are between 20 and 40 yards out from the green. In 1983 we plan to start extending these areas towards each other.

Our fertilization program has been to give the strip-sodded areas about 4 lbs. of N per year using a 31-3-10 fertilizer. This continues for two or three years until the strips have grown together. At this time we cut back to 1 lb. N. per year. It generally takes two full growing seaons for the zoysia coverage to be 80 percent or more. Also, we have found the coverage to be slowed by a mowing height of 5/8 inch using a greensmower versus a one inch height with a fairway gang mower.

After five years of the program we have made some adjustments in our methods. First, we skip mowing the sodded area only one time. This prevents the bluegrass from becoming too tall and being scalped. Originally, we waited seven to ten days to allow the zoysia to completely knit down. By mowing earlier we keep the area neater and return it to play after the first mowing or about three days. Secondly, instead of using fresh topsoil to refill the nursery area, we take the old strips from the fairway and insert them in the rows green side down. This is much faster and prevents waste of material. Thirdly, we cut the strips to a depth of one and one half inches instead of less than one inch for regular sod. We have found the sod to hold together much better. Also, the greater depth is needed when mowing over the undulations in the fairways. This insures that the zoysia will fit into the strip deep enough and not be scalped off.

Lastly, we have found that the later in the year zoysia is transplanted, the longer it takes to cover. Accordingly, we try to move the majority of our sod before August 15th. We have had survival of the zoysia moving it as late as September 20th, but it takes an extra year for coverage. Beyond September 20th, we have seen a loss of some of the zoysia.

There are many ways to introduce zoysia into existing fairways. We feel that our method at Rolling Hills satisfies our members' desires for better fairways, does not significantly interrupt play, and does not require spending large amounts of money at one time to accomplish the conversion.

Regrassing Greens - My Story

Timothy Kelly, Superintendent
Village Links
Glen Ellyn, Illinois

The five basic areas I would like to discuss today are as follows:

1. C-15 decline and resulting bad putting green turf
2. The publicity - to our golfing clientele
3. The regrassing program - 18 hole course complete; 9 hole course
4. Cost of project and revenue impact
5. Results - success and payback

The Village of Glen Ellyn Recreation Department is an enterprise fund operation owned by the Village of Glen Ellyn. It is not tax supported. The Department consists of 27 championship holes of golf, driving range, two passive recreational parks and a large athletic field complex. The Village Links of Glen Ellyn represents the 27 holes of golf and driving range components of the Department. The subject matter of the following report involves the Village Links and related budgets only.

The Village Links has been a successful operation since first opening in 1967. The golf courses had beautiful C-15 greens, established from Warren's Turf Nurseries and these greens were mowed at 3/16" with riding triplex greensmowers. The Village Links had 29 C-15 greens or approximately 240,000 sq.ft. or 5.5 acres.

In June of 1980, we suffered our first attack of C-15 decline. Other golf courses in the Chicago area had problems with this mysterious disease, and many were suffering along with us. We struggled with the disease throughout 1980. In June of 1981, disaster struck as the disease reached intolerable levels resulting in very bumpy and poor quality putting greens. After doing some research in 1980, Dr. Vargas and D. L. Roberts of Michigan State University suggested that we try Oxytetracycline as a control. This material was applied to our greens frequently and at varying test rates. Some measure of control was observed, but nowhere hear the desired level. Oxytetracycline also affected the greens causing them to be susceptible to wear from heavy play and traffic, causing further turf loss. The disease was still active and poor, unacceptable putting green turf remained.

Michigan State University research, using an electron microscope, showed that a bacterium type organism was the causal agent of the disease. This bacterium was living in and off of plant tissue in the xylem vessels. They would multiply and cause blockage of the turfgrass's vascular system causing the turf plant to die.

After the devastating attack in June and July of 1981, a decision was made to regrass to a different resistant bentgrass variety, and a two phase plan was developed. First, close down nine holes at a time on the 18 hole golf course and eventually regrass all 18 hole greens to reopen in the spring of 1982. Second, keep the nine hole golf course open and continually overseed these greens with resistant bentgrass varieties. I researched what other superintendents had done with regrassing and overseeding greens, concentrating on those who had done this type of regrassing after suffering the ravages of C-15 decline.

After combining the knowledge from these gentlemen with my own experiences and opinions, I decided to use the seeding method for regrassing our 18 hole greens. I determined that we would have smoother, truer, faster and overall better quality greens sooner! In addition, there wasn't any putting green sod available for fall planting in 1981. I chose the Penncross creeping bentgrass because of its proven track record in the field and its excellent heavy play or overall wear tolerance. Our 18 hole golf course at the Village Links plays approximately 45,000 rounds annually.

An important component of the regrassing program was to keep our golfers well informed. We published a special fall newsletter which fully explained the how, why and when relating to the C-15 decline, closing, regrassing and opening of the 18 hole course, as well as the overseeding of the nine hole greens. The traditional spring newsletter (February 1982) contained some further follow-up information about the regrassing/overseeding project. This kept our players informed and they were ready to begin play in 1982, which helped our overall revenue picture. Our golfers were happy to be well advised, and they had a positive feeling about the regrassing program.

As previously stated, our program would be a two phase one. The 18 hole greens would have the advantage of quick, one-time conversion, but the nine hole course needed to remain open for the following reasons:

1. Generate some revenue
2. Cultivate continued golfer interest at the Village Links
3. Regrassing all 27 greens at once would cost more than could be spent at one time.
4. It would be difficult to regrass all 27 greens at once. A later seeding would produce greens that would not quite be ready for a spring opening.

The steps for regrassing the 18 hole greens are listed below:

- Remeasure, reshape and contour greens; mark edges with paint
- Aerify greens twice using Dedoes aerifier
- Remove all sod, leave 1/4" to 3/8" thatch
- Haul away old sod
- Aerify remaining soil/thatch surface once using Dedoes
- Fumigate greens using methyl bromide (hired outside contractor, Hendrix & Dail) 48 hours of fumigation to kill unwanted weed seeds, fungus, insects, bacteria, nematodes, etc.
- Air out greens three days
- Grooved seed bed 1/4" deep with vertical mowers, two directions against water drainage flow
- Deep seed greens, 1/2 lb. Penncross seed per 1,000 sq.ft.
- Topdress greens, 2 cu. yds. per green, using 2 sand/1 soil mix
- Drag soil level, but not perfectly smooth
- Seed greens, 2 lbs. Penncross seed per 1,000 sq.ft.
- Fertilize greens, 2 lbs. actual NPK per 1,000 sq.ft., USS 12-12-12
- Roll greens smooth
- Apply hydromulch (hired outside contractor).

Nine greens were done at a time, allowing 18 holes to remain open to play 14 days longer. The project was begun on the 17th of August and actually finished on September 9th, six days ahead of schedule.

Some follow-up steps included the following:

- Spray Subdue fungicide on newly sprouting greens to prevent Pythium/damping off disease
- Continue topdressing throughout the fall, three times @ 1/2 yd, and one time @ 1 yd. of topdressing per green
- Fertilize new greens; 1 lb. actual NPK/1,000 sq.ft., USS 12-12-12 (five weeks after initial fertilization)
- Cut greens with riding triplex greensmower throughout fall, two cuttings @ 5/16", eight cuttings @ 1/4"
- Monitor irrigation system for absolute proper irrigation
- Hand spike and seed small bare spots on greens during fall 1981-March 1982
- Spray winter fungicides (Cal Clor and Tersan 75)
- Spray anti-dessicant (Clear-Spray)

Throughout the fall the newly regrassed 18 hole greens progressed nicely and appeared to be ready for the targeted May 1st opening. This phase of the project cost $24,274.00.

Nine hole greens overseeding began September 1981. This process would be done while the golf course remained open for play. Representative overseeding steps are listed below:

- Aerify greens one or two times using Dedoes aerifier
- Slice or spike greens 3/8" to 1/4" deep
- Mow off debris if sliced
- Seed greens, 1 lb. Penncross per 1,000 sq.ft.
- Topdress greens 3/4 to 1 yd. topdressing per green
- Drag topdressing smooth

The nine hole greens were overseeded twice in 1981 and five times in 1982.

In the spring of 1982, the nine hole course and greens opened in late March. The 18 hole course and greens opened on May 1st to restricted play, and a regular non-restricted schedule from September forward.

During 1982, the 18 hole greens improved rapidly and were in excellent shape for most of the playing season. Some spot seeding in early March and continued topdressing along with sound groundskeeping assured that the greens would be in quality condition. Stimpmeter readings were taken throughout the season to monitor green improvement. In late April the greens were rolling about 6',which is medium slow for regular play. By June 25th they were rolling 7' 7", which is medium fast for regular play. In mid-July readings showed 9', which is fast for regular play and medium for tournament play. Greens remained at approximately this speed throughout the season. In addition to rolling fast, the greens were resilient and very smooth for putting. The greens improved so much that limited play restrictions were lifted entirely after June. Record numbers of golf rounds were played in July, August, September and October. The greens were groomed and cut at 5/32" with riding triplex mowers in the late spring and fall. During June, July and August, walking greensmowers were used to cut at 3/16".

Our nine hole greens were adequate throughout 1982 until the early fall when the remaining C-15 turf fell under heavy disease pressure. During all of 1982, the greens were groomed and cut with riding triplex greensmowers at 3/16". 1983 should be our final year of overseeding the nine hole greens.

In addition to the actual cost of regrassing/overseeding, our revenue was limited due to the early closing of the 18 hole course. Overall profits were reduced from a projected $90,703 to a projected $4,000. See below for outline of financial impact:

1981	Budget	Actual	Rounds	Projected	Actual
Income	$745,950	$654,000	18 hole	44,000	36,000
Expenses	655,247	650,000	9 hole	32,000	30,000
Net profit	$ 90,703	4,000	Total	76,000	66,000

The 1982 budget was written with restricted play through August and a projected loss. Our customers were happy, and we had a profit.

1982	Budget	Actual	Rounds	Projected	Actual
Income	$785,711	$947,864	18 hole	27,300	35,874
Expenses	798,658	807,728	9 hole	34,700	34,469
Net profit	($ 12,947)	140,118	Total	62,000	70,343

By applying sound groundskeeping principles throughout 1982, it was a very successful year for the Village Links. In 1983 we are looking forward to continued success with satisfied golfers playing on well maintained golf courses.

Bluegrass Blend After Roundup
R. L. Harris, Superintendent
Hillview Country Club
Franklin, Indiana

Our club had nine holes, built in 1926. In 1971, our club expanded to 18 holes. At that time the construction specifications called for the seeding of fairways exclusively to Park bluegrass. As a result we have experienced a severe loss of turf to Fusarium fungi while in the stress period.

Being a low budget club, we find the cost to make fungicidal treatment to be prohibitive. This prompted us into evaluating a Roundup and reseeding program.

In July 1980, I was granted approval to apply Roundup on our #15 fairway. This slide illustrates the poor quality grass in mid season. Certainly, this is not good playing conditions for golf. I explained to my board of directors that the Roundup product would kill all vegetation. Our objective was for the removal of K-31 coarse fescue, Poa annua, and the Park bluegrass.

Following the chemical application we would then reseed with a four way blend of choice bluegrasses. Those selected would be more disease resistant and more drowth tolerant.

I was concerned at first as this was a new experience for me. To kill a fairway?? To destroy all the turf?? How will the members accept this project?? I thought, "Well,Lord, I sure hope this works."

On September 18, 1980, we applied the Roundup on our #15 fairway. We made the application in the early morning so as to avoid higher winds, being cautious not to permit drift onto a golf green or another area for which the application was not chosen. The presence of the dew on the turf at the time of spraying was helpful in marking the pattern for a uniform application.

We notified the members in advance that the back nine would remain closed until noon. This would permit the chemical to dry on the treated area and not be tracked onto the green.

On October 21, 1980, a uniform new turf showed, 33 days after the Roundup was applied.

As a result of this experimental fairway in 1980, our members have given us their support to continue with others. On September 15, 1982, we selected four additional fairways, all of which may be seen from our clubhouse. Those chosen were a Par 3, a Par 5, and two Par 4's. The Roundup was applied at the rate of two quarts per acre of formulation. I used a John Bean sprayer equipped with the R-10 series pump. We selected 8006 tee jets, 30 psi, and a ground speed of 4 mph, thus delivering 39 gpa.

Eight days following the Roundup application discoloring of the turf was evident. Four days later each of the fairways was irrigated for 45 minutes to prepare the soil for maximum penetration with the aerifier tines. The fifth day of the program we aerified six times, using the Ryan Renovaire equipped with 3/4 inch tines.

Eight days following the treatment of Roundup we began the seeding process. Each of the selected fairways were cross seeded at the rate of 87 lbs. per acre, or 2 lbs. per 1,000 square feet. To obtain calibration with our seeder we weighed 2 lbs. of seed, placed it in the empty hopper, then measured a distance of 250 feet. The seeder was four feet wide, so we operated the unit, making any needed adjustment until the proper setting was achieved. We again chose a four way blend consisting of America, Adelphi, Glade and Touchdown. On the day of the seeding we applied the starter fertilizer products, delivering .7 lbs. of N, 1 lb. of P, and .2 lb. of K.

Every attempt was made to keep the newly seeded areas moist at all times to promote germination. On September 30, 15 days following the application of Roundup, and seven days after seeding, germination was evident.

On October 4, 12 days after seeding, we applied 31-3-10 product, putting down an additional .4 lbs of N to promote the new seedlings. On the 22nd day we repeated the 31-3-10 application.

With the mild fall we experienced in 1982, 48 days after the reseeding the new turf was mowed for the first time at a height of one inch.

Once the Roundup was thoroughly dry the treated fairways remained open for play at all times. Following the seeding process we posted signs appealing to the members to refrain from operating the electic golf cars on the fairway.

Following the spraying of Roundup, the tank and booms were flushed with a solution of two quarts of household ammonia in 50 gallons of water.

I am excited about working with these improved bluegrass varieties in conjunction with our newly converted and completely automatic irrigation system. Plans at this time are to continue the program this year.

Sand Topdressing 1975-1982
Raymond Knapp, Superintendent
Tuckaway Country Club
Franklin, Wisconsin

In the past eight years, since large numbers of courses have been using sand topdressing, many questions have been answered. At the conception of the idea of topdressing with sand it was thought that other materials such as fertilizer, seed and pesticides would be mixed into the sand to cut down on the number of applications. The mixing of pesticides with sand was soon eliminated because of the danger of handling the material by the applicator. Few have followed up on mixing seed or fertilizer. This is mainly because equipment has not been presented that would do this easily. In the future, if exisitng or newly designed equipemnt could be found, a trend towards topdressing with additives could develop because golf pressure is increasing and there are fewer hours left to complete maintenance practices.

In 1974 I listed eight advantages of using sand in my presentation to the Tuckaway Country Club's Board of Directors. Now after eight years I would like to go over this list again:

1. Golf play is not affected immediately after topdressing. - Because sand is easier to work into the green, this is basically true; however, it has been found to make the ball faster. In many cases, it makes the green putt truer.

2. Easier to handle than topmix soil. If you have a good topsoil mix there is not much difference in handling the two materials; however it is sometimes difficult to get a good mix.

3. Will not be affected by becoming wet. - If it rains after or during topdressing with sand there is not as much of a problem to get the material worked into the turf. With many pieces of equipment wet sand spread more evenly.

4. It has been reported to control Poa annua and other weeds. - I've heard testimony from many other superintendents that verify this fact. I personally cannot support this idea. I think it does slow down the spread of weeds.

5. A material can be found that is uniform over a long period of time. - Suppliers of sand have assured us that for the next twenty years they can give us the same material. Right now I'm not going to worry about what happens after the year 2003.

6. Topdressing can be mechanized easier. - Even some of the poorest designed equipment can be used to spread sand. Some pieces work better, but they will all do the job.

7. Water infiltration rate will be increased over the year. - This is certainly true. Now that many courses have over two inches of sand built up, this is being proven in the field. The lens of clay that I had three inches below the green surface eight years ago is now five inches down. Even though the infiltration rate of that layer hasn't changed, I have now got a larger reservoir for water.

8. Sand cannot be compacted by mechanical or foot traffic. - The fact that sand does not compact is one of sand's most important characteristics. Because of this, there are fewer noticable footprints around greens topdressed with sand, as compared to topsoil topdressed greens.

Sand topdressing has helped make the trend of cutting at a lower height of cut easier. Chart #1 shows the height of cut at Tuckaway for ten years. This trend is typical of many clubs throughout the country. I feel the height of cut has reached a plateau and will not coninue down. If the greens are lowered much below the present level, the golfer has a hard time controlling the ball in many areas of the green. Because of contours, it will pick up momentum.

Unfortunately, the manufacturers of bedknives have not quite kept up with the demand for this lower cut. Even with the newer, thin bedknives, modifications must be made to provide clearance. The bedknives either have to be worn down while cutting higher, or the mower unit must be turned upside down and the bedknives ground off.

Nitrogen usage has declined in the past eight years. Chart #2 shows this for Tuckaway. Low rates of nitrogen result in thinner turf. The thinner turf satisfies the golfer more readily because of its truer putting characteristics. Tbe negative result is that the grass is not as aesthetically appealing. A part of the art of green maintenance is hitting the balance of nitrogen that will allow the turf enough vigor not to become too thin.

Through trial and error I have concluded that 3.5-4 lbs. of nitrogen per 1,000 sq.ft. per year is needed to give enough vigor to maintain adequate turf at Tuckaway. Rates that were used in 1980 and 1981 caused more thinning than desired early and late in the season during wet, cool periods.

My primary source of nitrogen has been natural organic materials with smaller amounts of synthetic organics, late and early in the season. I have been basically following a program developed by Wayne Otto of Ozaukee Country Club. He would dormant fertilize in the late fall with 25-50 lbs. of milorganite per 1,000 sq.ft. Additional nitrogen would not be needed until late summer.

One of the biggest problems associated with sand topdressing is localized dry spots. Only on tees that are aerified four or more times per year are they not a problem. Up until last year I always had problems on greens with isolated dry spots, despite using 32 ounces of wetting agent.

Last year I switched to using a different wetting agent because of a suggestion by Dr. James B. Beard. In experiments conducted at Boyne Mountain Golf Course, he concluded that there were only two materials that would prevent localized dry spots. One of the materials was Aquagro. I tried this for five years, but still had some localized dry spot problems. The other material, Hydrowet, he found gave some dry spot control the year after application. The 1982 season was the first I have not had localized dry spots. My program is basically as follows:

In spring apply three separate applications at 8 oz. per 1,000 sq.ft. of Hydrowet. In summer a fourth 8 oz. application can be made. Each time an application is made it should be watered in immediately. I plan on modifying this program to two spring applications of 12 oz. per 1,000 sq.ft.

In summary, we have come a long way in eight years of sand topdressing. The percentage of clubs topdressing with sand has gone from near 0% to over 50%. By having these large numbers many different programs have been following, giving much useful information. Equipment has evolved to using larger drop spreaders or broadcast spreaders. The frequency of application varies from weekly to three to four times per season. The total quantity of sand used per season could be fairly closely predicted if the amount of nitrogn used is known, when no thatch is maintained. To combat localized dry spots one must aerate or use wetting agents.

Chart #1

Tuckaway Country Club - Green Height

Year	Early spring	Regular	Tournament
1973	.18	.165	
1974	.18	.168	.151
1975	.18	.156	.141
1976	.18	.156	.139
1977	.18	.153	.135
1978	.18	.155	.129
1979	.18	.150	.119
1980	.15	.125	.120
1981	.14	.125	.115
1982	.14	.110	.110
1983*	.12	.110	

*Projected

Chart #2

Tuckaway Country Club - Greens Sand & Fertilizer

Year	Sand	Fertilizer		
	cu.ft/1000 s.f.	N	P_2O_5	K_2O
		pounds		
1975	22	5.8	1.1	5.8
1976	23.2	5.7	2.3	3.5
1977	20.5	4.8	.7	0
1978	16.2	4.4	1.3	5.4
1979	21.9	4.2	1.9	4.6
1980	15.0	3.2	1.2	1.7
1981	17.0	3.0	.6	2.7
1982	21.0	2.8	5.0	4.5

Gleneagles Golf Courses
John Souter
Souter of Stirling Ltd
Scotland, U. K.

In the early 1920's, James Braid, the famous golf course architect was commissioned to design and build a new golf complex in one of the most beautiful and scenic parts of Scotland. Three courses, 2 of 18 holes and 1 of 9 noles, were created and were grandiosely named - Kings, Queens and Princess. They have since become world famous.

The holes have traditional Scots names and are descriptive of each area:

3rd - Braid's Brawest - as in "it's a Braw Bracht Moonlicht Nicht, the nicht" to be translated - "It's a fine, bright, moonlight night tonight."

5th - The Net Girdle - Andy Bertoni through this may have been the gear worn by the older hooker in Bourbon Street, New Orleans - alias a flat pan for baking pancakes.

8th - Whaup's Nest - A short hole surrounded by bunkers, resembling a curlew's nest.

In the late 70's the Princess has been extended to 18 holes and another course, The Glendevon (18 holes) built.

The Hotel is one of the most prestigious and luxurious in Europe, is especially well known to Americans, and justifies the only 5-star rating in Scotland. It hosts a new leisure complex, built during 1982, at a cost of some $3,000,000, and offers swimming, squash, snooker, keep fit saunas, Turkish baths, horse riding, bowls, tennis , croquet, soccer and fishing. Membership of the complex for a family is $500 per year and for the courses, $350 per year.

Condominiums and luxury homes surround part of the area, some costing $400,000.

A new and progressive group bought out the assets in 1981 and have ambitiously set out a program for all the grass areas, esepcially the Kings, to extend its yardage from the existing 6,500 yards to 6,930 yards, and to make it possible to be included in the European Golf Circuit and other prestige matches. With present R & A regulations, the British Open is only played on seaside or links courses such as St. Andrews and Royal Troon.

It has to be understood that the brief for the new extensions was simple - "Make it look as if it had been there since 1920!" With the natural settings available this was a challenge, which, with the help of our professional, Ian Marchbank and superintendent, Scott Walker, we hope we have achieved. At least the appreciative comments of low handicap and professional golfers indicate success, and after all, they will be the judges.

Once the settings for the tees had been chosen, levels were set and the bases formed, in some cases 20-30 feet high - using a material from areas (hidden) within the course. The areas were allowed to consolidate. After consolidation, mainly by weather, the top or rootzone of sand/soil was added. After tramping and raking turf was placed, having been cut from within the course.

The existing greens remain untouched, as Braid would have wished. It is all too easy to alter, usually with adversely disastrous results. Some contouring to the approaches was implemented, and within two years they should blend successfully with the existing.

Greens are large. In the case of our 18th, King's Hame, the putting surface extends to some 16,000 sq. ft. Somehow we may examine and possibly restrict the area of some of the surfaces and create larger aprons.

Problems occurred during the winter of 81-82, similar to those encountered in the U.S.A. and it is envisaged that within the next two years the texture and quality of the putting surfaces will return to their former glory.

New management and forward planning techniques are being introduced, with the approval of our in-house executives, to ensure Gleneagles will be one of, if not the finest and most natural golf and leisure complexes in Britain and Europe.

We thank you for a warm welcome and this opportunity to speak and we would invite you to visit us on your next trip to Scotland.

Anthracnose of Annual Bluegrass

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Annual bluegrass,like any other turfgrass species, has its advantages and disadvantages. The main advantage of annual bluegrass is its ability to adapt to low mowing heights. Annual bluegrass provides an adequate putting surface at 1/8 inch or an excellent fairway turf at 5/8 inch. As a fairway turf, annual bluegrass provides an upright lie for the golf ball and a relatively soft playing surface during the summer. Disadvantages associated with annual bluegrass are tendencies to 'overrun' established Kentucky bluegrass or creeping bentgrass turfs, many seedheads, and the problem of annual bluegrass dying in the summer.

The reasons annual bluegrass 'overruns' other turfgrass species is due to the fact that each turfgrass species has its own ecological niche. (Table 1).

Table 1. Requirements for competitive survival of cool season turfgrass

	Kentucky bluegrass	Creeping bentgrass	Annual bluegrass
Mowing height	1-2"	1/8"-3/4"	1/8"-3/4"
Irrigation	infrequent	infrequent	infrequent
Nitrogen requirement (lbs/1,000 sq.ft.)	1-4 lbs	1-1/2 lbs.	3-4 lbs.

If you maintain your turf under one inch mowing height and irrigate frequently, annual bluegrass will out-compete and out-survive Kentucky bluegrass. If you maintain creeping bentgrass at high nitrogen levels and irrigate frequently, again you will encourage the survival of annual bluegrass over that of creeping bentgrass. The conditions that you maintain your turf under, will in a large part, determine the type of grass that will be present.

Regarding the problem that annual bluegrass dies in the summer, it should be asked what grass species replaces Kentucky bluegrass or creeping bentgrass when they die? The answer is annual bluegrass. What replaces annual bluegrass when it dies? The answer is annual bluegrass. The point is if you mismanage a Kentucky bluegrass or creeping bentgrass turf, it dies once and is replaced with annual bluegrass. On the other hand, if you mismanage an annual bluegrass turf it will die and keep dying year after year if you continue to mismanage it.

All turfgrass species have environmental restrictions and disease problems. The key is to identify the problems, so management strategies can be initiated to minimize their impact.

This paper discusses diseases, specifically anthracnose, that cause damage to annual bluegrass. Remember, turfgrass species each have their own set of diseases. The key is identifying the diseases that infect each turfgrass species or cultivar.

Anthracnose

One of the more important diseases of annual bluegrass is anthracnose, incited by the fungus Colletotrichum graminicola. The disease was first reported in 1928 as causing severe damage to annual bluegrass turf in New Jersey. No information regarding the disease was further reported until 1954 when it occurred in England. In the mid-1970's, Dr. Joe Vargas at Michigan State University, reported the disease as a critical factor in causing death of annual bluegrass in the summer.

Symptoms appear as irregularly shaped patches of yellow-bronze turf ranging in size from a few inches to several feet. Leaf lesions initially appear as elongated reddish brown spots on the leaves. The diagnostic key for this disease is the development of numerous black fruiting structures (acervuli) that have black spines (setea) protruding from them. The disease is severe during periods of high temperatures and humid conditions.

Proper cultural practices can reduce the severity of anthracnose. Research at Michigan State University revealed that moderate rates of nitrogen (3/4 lbs./ 1,000 sq.ft./year) with 1/2 pound applications through the summer significantly reduced the amount of anthracnose. A recommended schedule for nitrogen applications is shown in Table 2.

Table 2. Nitrogen fertility schedule for annual bluegrass (lbs/1,000 sq.ft.)

May 1	June 1	July 1	August 1	September 1	Oct.-Nov.
	1/2	1/2	1/2	1	dormant)
			Dollar Spot		
(----------					)
			Anthracnose		
	(----------				)
			Brown Patch		
		(----------			)

The duration of wetting period (the time free moisture is on the leaf blade) is critical for anthracnose disease development. Reducing the period of wetting will result in a reduction of anthracnose. Obviously, turfgrass managers can help through wise irrigation practices, mechanically removing the dew or changing from early evening to late morning irrigation cycles.

Fungicides are the most effective means of controlling anthracnose. A proposed fungicide program for controlling anthracnose, dollar spot and brown patch in central Indiana is listed in Table 3. However, not all fungicides are labelled for all the diseases and should only be used according to the label.

Conclusions

If your golf course contains a majority of annual bluegrass it makes little sense not to try to manage it with the proper cultural and chemical programs. Some of you may be skeptical, so try a small area and see what kind of results you obtain.

Table 3. Fungicide schedule for annual bluegrass turfs.

May 21	June 14 and July 14	June 24 July 24 August 14	Sept. 7
Acti Dione-TGR,RZ	Daconil 2787	Tersan 1991-S	Vorlan-S
Vorlan -S		Fungo 50-S	Chipco 26019-S
Chipco 26019-S		Cleary's 3336-S	
		ProTurf Fert.+DSB-S	
		Duosan-C,S	
		Bayelton-S	

Thatch: Adaphic Properties and Control

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Thatch is a tightly intermingled layer of living and dead stems, leaves, and roots that develops between the zone of green vegetation and the soil surface. A slight amount of thatch is considered advantageous because if provides resiliency, increases wear tolerance, and insulates the soil against temperature extremes. However, in situations of excessive thatch accumulation increased disease incidence, localized dry spots, poor response to fertilization, greater susceptibility to injury from temperature extremes and proneness to scalping are associated with it.(1)

In some instances of excessive thatch accumulation, the thatch layer becomes the primary growing medium for the turfgrass community. The crown of the turfgrass plant is no longer in contact with the soil surface but elevated into the thatch layer. Subsequent development of rhizomes and stolons, along with the majority of roots, occurs within the thatch layer (3). Previous studies have shown thatch to be a highly unfavorable growing medium for turfgrasses (2). In comparison to soil, thatch has good aeration properties and is resistant to compaction. However, thatch has poor nutrient and moisture retention properties.

Modifying the Thatch Layer

Excessive thatch accumulation is very undesirable due to the problems already mentioned. However, complete removal of the thatch layer may be impractical in some instances because it could result in the destruction of the turf.

A study was initiated to determine if the thatch layer could be modified by the incorporation of soil either by core cultivation (CC), vertical mowing (VM), or a combination of both. Core cultivation treatments were done at two intensities (1 or 3 times) with cores removed (NRI) or reincorporated (RI). The study was done on a Merion Kentucky bluegrass lawn.

The effect of cultivation on pH, organic matter (O.M.), bulk density (B.D.), cation exchange capacity (CEC) and CEC x B.D. (volume measurement of CEC) is shown in Table 2. Incorporating soil into the thatch layer through increasing intensity of treatments resulted in changing its properties to reflect values closer to that of the underlying soil.

No longer is there a 'pure' thatch layer but a hybrid or a thatch-like derivative with properties intermediate between that of soil and thatch. Thus, by cultivation practices, an improved growing medium can be achived.

Table 2. The effect of soil inclusion on thatch-like derivatives

Treatment [a]	pH	Organic matter	Bulk density	CEC	CEC*BD
		%	(g/cc)	(me/100 g)	(me/100 cc)
Untreated (thatch)	6.63 b[b]	81.50 a	0.140 f	80.57 a	11.27 e
1CC/RI	6.73 b	62.53 c	0.277 d	62.67 b	17.30 cd
3CC/NRI	6.60 b	57.00 c	0.263 d	63.97 b	16.83 cd
3CC/RI	6.73 b	34.93 e	0.437 bc	41.73 c	18.10 c
VM	6.73 b	70.70 b	0.203 e	70.47 b	14.33 de
VM + 1CC/RI	6.67 b	41.47 d	0.413 c	46.30 c	19.17 bc
VM + 3CC/NRI	6.67 b	58.00 c	0.277 d	64.63 b	17.80 c
VM + 3CC/RI	6.70 b	37.37 de	0.480 b	44.77 c	21.47 b
Soil below	6.93 a	6.77 f	1.370 a	26.07 d	35.63 a

[a] CC = Core cultivation; RI = Reincorporated cores; NRI = Cores removed; VM = vertical mowed

[b] Means columns followed by unlike letters are significantly different at 5% level by Duncan's Multiple Range test.

Conclusions

Thatch is an unfavorable growing medium but may be changed for the better by soil incorporation. Vertical mowing usually yellows the turf, and in cases of excessive thatch, the turfgrass plants may be severely damaged or killed. The reason for this is in situations of excessive thatch the turfgrass plants are growing within the thatch and not in the soil; thus vertical mowing will not only extract the organic debris but also the turfgrass plants.

Core cultivation, on the other hand, incorporates the underlying soil into the thatch layer. Research done at the University of Illinois showed that core cultivation with the plugs bring reincorporated back into the thatch layer is a safe, effective means of controlling thatch. When soil is reincorporated into the thatch it has better chemical and physical properties than pure thatch. What occurs is a combining of the desirable properties of thatch (resistance to compaction, aerification) with those of soil (moisture and nutrient retention) to form a more ideal growing medium.

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Turfgrass Pathology

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I am pleased to meet with the members of the Indiana turfgrass community today. As a new researcher of turfgrass pathology in Illinois, I am interested in learning of your problems (phytopathological) and questions concerning diseases of turfgrass.

Today I would like to review and update you on our current understanding of diseases caused by Fusarium fungi (Gerlachia patch, Fusarium leafspot and seedling blight, Fusarium crown and root rot, and Fusarium blight syndrome) and diseases caused by Rhizoctonia fungi (brownpatch and yellow patch.) In addition I will describe an unfamiliar disease of bluegrass. Prior to discussing the forementioned diseases, I want to encourage each of you to examine the new "Compendium of Turfgrass Diseases" published by the American Phytopathological Society. I feel it is the most concise and current source of information on turfgrass diseases.

Gerlachia patch or pink snow mold is a fall and spring disease of turfgrass. It requires cool (0-16 C^{o}) wet conditions, but not necessarily the cover of snow. This disease and another snow mold, caused by Typhula fungi, can develop under snow cover, thereby complicating the identification of the pathogen and the prescription for control. It is important to realize that several fungi can produce snow mold disease and more than one may be simultaneously attacking turfgrass. In the case of Gerlachia patch, several different Fusarium spp. attack grass plants and can produce similar disease symptoms. There are three cultural practices that will greatly enhance control of Gerlachia patch: (1) good drainage; (2) maintaining a low soil pH; and (3) maintaining a balanced soil fertility. Be especially conservative in fall nitrogen application to those areas that are susceptible to Gerlachia patch.

I will only briefly mention that effective fungicides are available for the control of Fusarium leafspot and seedling blights. In addition, let me emphasize the importance of proper diagnosis in terms of cost effective control of these diseases.

Fusarium fungi will also attack the crowns and roots of turfgrass plants. At least eight species of Fusarium fungi can invade these plant tissues. They cause irregularly shaped patches of dead or dying grass. The plants in these patches can have both leaf lesions and rotted roots, depending on the severity of the attack. It is most important to remember that all grasses of any age are susceptible to these fungi. This is not the case for development of Fusarium blight syndrome.

Fusarium blight syndrome is a newly suggested title for the previously named disease of Kentucky bluegrass, Fusarium blight. The word syndrome imples that the exact cause of the disease is uncertain, and indeed this is so. The symptoms of and the conditions for this disease are, for the most part, similar to those for development of Fusarium crown and root rot. The main differences in these two diseases are: (1) Fusarium blight syndrome attacks only Poa pratensis cv. and (2) Fusarium blight syndrome usually occurs on mature sod and not on seedlings. The most recent advance in the development of a management strategy for Fusarium blight syndrome deals with the use of Bayleton (MOBAY) as a protective fungicide. Test results indicate that Bayleton (2 oz. ai/m), when applied one to three months prior to disease development can reduce the severity of the disease. More research on important disease is essential if a consistent and effective control program is to be developed.

Three species of Rhizoctonia attack turfgrass (R. solani, R., cerealis and R. zeae). Rhizoctonia solani causes brown patch and R. cerealis causes yellow patch. In the midwest, brown patch and yellow patch are much more apparent than disease caused by R. zeae. Diseases caused by R. solani and R. zeae occur in the warmest part of the growing season, when temperatures are about 28-32 C^{o}, and when the humidity is high. These two fungi can attack both seedlings and sod. Rhizoctonia cerealis is mainly a problem on transplanted sod. There are numerous pesticides that are effective in controlling brown patch, but these are ineffective for the control of yellow patch. Considerable research is necessary to understand the yellow patch disease and develop a control strategy for it.

During 1982, an unfamiliar disease was witnessed in bluegrass sod in central and northern Illinois, Iowa, Wisconsin and Indiana. The disease has been tentatively named "yellow ring" because the symptoms are a ring (several inches thick and up to a foot in diameter) of yellowed grass. Beneath the yellowed grass is a mat of white fungal growth. We are currently investigating the cause of this disease and hope to discover what causes the yellowing and what can be done to prevent the disease. One consistent observation is that the disease is associated with mature sod having greater than one-half inch of thatch.

High School Football Field Renovation

Bill Lyons
Lyons Den Golf
Canal Fulton, Ohio

Harry Wilcox,Warren, Pennsylvania, made a study of turf related injuries to high school football players on good turf vs poor fields. His ratio is 1 to 30. He inspired this writer.

The Paul Brown Tiger Stadium field, Massillon, Ohio, had very poor turf. There was a little of everything including bentgrass, Poa annua, clover and very little bluegrass. Lots of divot holes...

We were asked to be their consultant to devise a program to improve the field to a playable condition. The date was late Novebmer 1980 after their last home game. Our suggestion: kill it and start over.

Mr. Edward Jordan, Monsanto Chemical Company, told us they had no experience applying Roundup so late in the season but he added, "If you get five days of sunshine it might work even if the soil freezes slightly at night."

Using the small (3 ft.) Meter Miser sprayer sold through Amchem, we put 12 ounces of Roundup in a tank full of clean water. It took two gallons of Roundup for the field and another gallon for the side areas and end zones. The kill was 100 percent.

Five days after Roundup 200 lbs. of 90 percent Manhattan ryegrass plus 10 percent A-34 bluegrass was sown with a Cyclone seeder. 500 lbs. of a 15-15-15 fertilizer were Cycloned on top the seed. Then 2 lbs. of a Dolomite limestone (bagged) was laid down through an old Ez-Flow Olympic. (Has 3" hole spacings.)

The field was really loosened up by going over it four or five times with a Westpoint spoon type aerifier and smoothed over with a Scotch harrow with the tines up. That night the field froze solid.

April 1 arrived and no grass! Their staff was worried. Close observation (that belly technique) showed a good stand was germinating, but we told them if it would relieve their anxiety they should put another 200 pounds of seed plus another 500 pounds of 15-15-15 fertilizer on the field. Ryegrass and bluegrass do best with high phosphorus so we use a 15-15-15 with the potash from sulfate rather than muriate.

When the soil warmed to 50° F they soon had a perfect stand of wearable turf. They leased for one year a 64" reel mower set at 1-1/2" cut. Irrigation was applied through #40 Nelson sprinklers with hose whenever the moisture meter showed 20 percent.

Sure, there was a weed problem, but as Professor Joe Duich, Pennsylvania State University says, "Establish the turf then fight the weeds." With mature grass by August 1, Banvel 4-S was applied. Crabgrass was not a major problem.

The field was fertilized with 15-15-15 at approximately 5 pounds per 1,000 sq.ft. (Cyclone spreader set on 5) in May, June, July, August and September. Just before the last game in 1981 the weakened areas were reseeded with the same mix with the Cyclone set on 4. Football cleats helped cover the seed. After the game a dormant feeding of 15-15-15, ten pounds per 1,000 sq.ft., was applied.

After the good results were obvious, about $1,500 came from "Heaven" to buy a 100 gallon trailer type sprayer with boom and two nozzle sizes. Only one or two applications of fungicide were made in 1981 and 82. But, at the first sign of disease two pounds of spray lime (300 mesh) plus one pound of Powder Blue nitrogen per 1,000 sq.ft. went through the new sprayer. In 1982 we used just one application of weed killer.

Three days before each game 3 ounces of sulfate plus one pound urea (45%) per 1,000 sq.ft. was put through their new sprayer. Result: a beautiful dark green turf with a strong root system to resist cleats.

Again, money came from "Heaven" to buy an 84" three gang National reel type mower ($4,500). They now have all the equipment, plus some rentals, to care for their field for the next ten years.

A near-by high school team played a game (lost) on the Tiger field. They were impressed by the good playing surface. Their own field was the poorest surface in the league. About June 1 they called on us to discuss what could be done to improve a field that was so bad that one could sprain an ankle just by walking over it. We accepted the challenge.

Those big divots had to be filled. Strings were put across the field every four feet. One boy was given a pail of seed mixed with five parts corn meal (from a feed mill). He dropped the mix into every divot in his four foot wide area. The boy or girl following him covered the well marked divots with soil enough to firm it up to level. (Mix was soil plus 20% humus). We gave the volunteers caring for a field a moisture meter to use as much water as available. They did just that. Four tons of Hi-Cal lime went through our old Olympic spreader. We fertilized with the Cyclone set on 5 using 15-15-15 in June, July, August and September.

This field went from the worst field in their league to the very best in just four months. There was not one turf related injury on this field in 1982! So, Harry Wilcox was right! Good turfed high school fields have a minimum of ankle and knee injuries. Many a high school athlete has had his career ruined on a high school football field in poor condition.

Again we are gambling with Roundup on November 10, 1982 on another high school field in poor condition. They are starting with a minimum of equipment. I am confident that once good playable turf is established that money will come from "Heaven" again for a 100 gallon sprayer, a good three gang reel type mower and sufficient chemistry to maintain good safe turf.

After seeing the result which was accomplished cheaply, two schools have gone to work on their practice fields (six fields to date). A program is in the works by coaches and athletic directors of a county wide league to buy or lease equipment not used too often on a co-op basis - a sprayer, aerifier, Scotch harrow. This idea was accepted by them and is now being proposed to their respective school boards.

Summary: From Mr. Mike Currence, athletic director and football coach, Washington High School Massillon, Ohio, whose home field is the Paul Brown Tiger stadium, "We have noticed a reduction in injuries since our field was replanted. Good turf certainly makes the difference. We had no major injuries this year (1982) in ten games on our field. We played two games on artificial turf in the play offs and doubled our injuries, including a serious knee injury which required surgery."

From Mr. Joe Demaree, athletic director, Perry High School, Massillon, Ohio, "We at Perry High want to extend to you our sincere appreciation for your efforts in returning our football field to the excellent condition it was in this past fall (1982). There were 22 contests plus band shows, and to my knowledge there was not one field related injury. Thank you for your service."

Managing the Purdue Athletic Turf - Some Problems

Daniel Weisenberger, Sports Turf Manager
Purdue University
West Lafayette, Indiana

Difference in Sands

Sands in Purdue field

- Local sand had wide range of particle sizes
- It was made for mortar
- It contains too much coarse sand which is of no benefit
- It was poorly washed so had some silt and clay (too much)
- These tend to slow or plug drainage
- The pH is high with
- High buffer capacity reading of 7.6-8.2 found

Dune Sand

- Costs more, used for topdressing
- It has most particles in fine to medium range
- Very little silt or clay
- It is firm but not compacted
- Has a neutral pH

A good sand should have at least 32% in the fine range and 98% in the fine and medium range, with less than .2% clay and silt. My advice is to find a sand with a neutral pH so you don't have to fight it.

Peat Moss in Topmix

- Our bulk peat supply in 1979 had considerable silt and clay in it
- So we had too much peat moss in our topmix
- And the mix gets hard
- The layer tends to restrict air and water movement so need much aerifying (four times per year)
- It can cause a perched water table
- Topmix needs to be stirred with top of clean sand to eliminate interface
- A sand field needs some peat moss. The amount depends on:
  - sod
  - washed sod
  - seeded
  - stolonized

Micronutrient Deficiency

- Purdue field had iron deficiency because
- pH of field was too high. Last readings were 7.6 topmix and 8.2 lower sand.
- Iron was lacking
- Washed sod, no soil to hold and provide nutrients
- Previously soil on sod had lower pH so made iron available

Enkamat in Front of Players Bench

- PAT System goes to edge of artificial turf over blacktop
- Players tramp out grass cover
- Sand is loose, forms pockets, trip hazard
- Other netting tore, caused trip hazard
- Enkamat keeps surface level
- Enkamat protects grass some

Moisture Meter

- Reads electrical conductivity and
- Is affected by salts
- It has adjustable dial to overcome effects when fertilizing
- There are six sets of probes in the field
- It is wired to operate irrigation system by diverting the common ground wire for all three valves through the automatic controller.

The PAT System was installed in 1973 so has been in for nine seasons. In 1982 it was an excellent turf. This has been a short discussion on some problems of current utilization.

Managing a Pro Field

Steve Wightman
Mile High Stadium
Denver, Colorado

Mile High Stadium is a multipurpose stadium seating over 75,000 for baseball and football, as well as various other special events. It is the home field for the Denver Broncos of the NFL, the Denver Bears baseball team of the American Association and the new Denver Gold football team of the newly formed USFL.

The trend in professional sports in recent years is to provide a stadium that will accommodate two or more sports. The tremendous expense of stadium construction and operation then becomes more economically feasible since it allows the facility to be occupied for more dates throughout the year.

Along with the greater number of events comes an increase in turf wear and tear. So much so that many stadiums have gone to artificial turf. However, through prudent field design and maintenance practices, a fine playing surface can be provided even for two or more annual sporting seasons.

Many of the maintenance practices used at Mile High Stadium will be discussed later but, for now, I would like to talk a little about the patented and licensed Prescription Athletic Turf (PAT) field that provides the playing surface at Mile High Stadium.

The PAT field consists of a water-tight plastic liner that cradles 16" of washed sand,at the bottom of which is a network of slitted pipes all interconnected to three suction pumps with drain valves at each pump. Located six inches below the grass line are electrical heating cables spaced every six inches throughout the entire playing field and sidelines. The grass is exclusively A-34 Kentucky bluegrass.

The PAT System was designed and developed at Purdue University under the direction of Dr. W. H. Daniel. The purpose was to provide the ultimate playability under virtually all weather conditions and to promote water conservation.

Ultimate playability is achieved by providing for excellent drainage with the sand sub-base and the pumps for quick draining and the heating system which extends the growing season and prevents the field from freezing. By keeping the ground from freezing the drainage system can be utilized in addition to providing better footing for the players.

Water conservation is provided by a subsurface irrigation system that allows for an adjustable water table depending on the prevailing weather conditions. For instance, if the weather is hot and dry the drains can be closed and water brought in from underneath or held from surface irrigation to a desired level in the reservior. The held water will then "wick" up to the rootzone to feed the turf during the hot dry spell, thus eliminating heavy surface irrigation. (A moisture sensing with automatic controlling is also part of the patented system.) The PAT System , in conjunction with proper turf management practices, can provide a very fine playing surface for virtual year round activity.

Eight main turf management practices are utilized at Mile High Stadium: watering, mowing, fertilizing, rolling,aerating, topdressing, sodding, seeding.

Watering is done in two different ways; surface irrigation and subsurface irrigation. Surface irrigation is used 90 percent of the time with the PAT drains open to promote a deeper rootzone.

Mowing is done with both a rotary and a reel type mower. The rotary is used with a vacuum attachment to collect clippings most of the time. It's fast and provides a good cut when mowing at 1-1/2 inches or more. The blades are sharpened after every third mowing. The reel mower is used when mowing at lower than 1-1/2 inch heights , such as the baseball infield and the football field. The reel mower also provides a more aesthetically appealing cut as it lays the grass in the direction of the cut so grid patterns occur. In conjunction with mowing, a nylon bristled sweeper is used to "lift" matted areas and for thatch control. The sweeper is also handy to have to collect the clippings after a wet mowing.

Fertilization at Mile High Stadium is a bit more extensive than a normal athletic field due to the hybrid turf and the leaching that occurs from heavy watering with the drains open. A ratio of 5-1-2 of NPK is maintained which has proven to be the best for our conditions. A slow release IBDU with minor and micro nutrients is used. Most applications are in the early spring and fall months when the turf is most aggressive. A total of eight to ten pounds of available nitrogen per year is administered in five to seven applications of 1-1/2 to 2 pounds per. This provides a good total year round feeding that promotes late fall turf development and early spring green up.

Rolling is done only when necessary such as sodding and following games that are played under wet conditions. Too much rolling obviously compacts the turf and reduces drainage capacity.

Aerating is done seven to eight times each year with a Dedoes. The Dedoes is fast with a good two inch penetration and has flexible tines. The flexible tines allow the tines to enter and exit the turf more at a 90 degree angle to minimize turf damage during the aeration process. The Dedoes is advantageous in maintaining the field at Mile High Stadium in that it collects its own plugs. This saves valuable time by not having to go back and rake them up. Aerating is probably the single most important procedure performed on the field in providing a quality playing surface.

Topdressing is usually done after every other aeration. Most of the time the material used when topdressing is washed sand with an occasional topdressing of sand mixed with the collected aeration plugs during the football season. This levels the divots and scarred areas created during football, and at the same time creates a soft field.

Sodding at Mile High Stadium usually amounts to about 25,000 square feet per year on the PAT field. This includes 17,000 square feet after the baseball season is completed, plus another 7,500 square feet midway through the football season. The mid-October sodding during the football season is mainly for the purpose of providing a better baseball field for the early April opening.

Seeding is done periodically on the football field toward the conclusion of the football season with 100 pounds of A-34. This helps fill in the thin areas down the center of the football field in the early spring. Also, the baseball outfield area that is under the movable section of the stands dies each year from lack of sunlight. This amounts to 45,000 square feet, and includes left field and left-center field. This area must be seeded each year and that is done with 300 pounds of perennial Pennfine rye, topdressed, and covered with perforated plastic to force germinate in order to provide a good stand by the baseball season opener in early April. The Pennfine provides a quick stand with a good color match for the light colored A-34.

In preparing the field each year for the baseball season the turf must be removed on the baseball infield and a specially formulated mix installed. The outfield area that was under the movable section must be reseeded. The mound must be put in, bullpens built, and outfield fencing installed. Once the season begins, daily maintenance practices must be kept up.

Mowing during the baseball season includes cutting the infield at 1" to 1-1/8" every other day with the outfield maintained at a 1-1/2" to 1-3/4" height every third day. Clippings are either caught or swept 90 percent of the time.

Watering during a homestand is done at night with the automatic sprinkling system, and averages about 1/4" each night with the drains open. Hot and dry weather conditions during a homestand require the drains to be closed or partially closed to slow down percolation rate when heavy field activity prohibits heavy surface irrigation.

When the baseball season is completed and the infield mix is removed, sand is put in to grade, and the area sodded for the football season. The infield area is sodded with A-34 cut 1-1/2" thick as opposed to the normal cut of 3/4". The thicker cut allows the field to be played on in a matter of a few days without being torn up. The normal time span between the last baseball game and the next football game is usually ten days.

In preparation for a Sunday football game the entire field is double cut at a 1-1/4" height on Monday or Tuesday. The field is then thoroughly watered with the drains open. On Wednesday or Thursday morning the field is again mowed at 1-1/8" height with the reel mower mowing every five yard line in opposite directions to provide a grid pattern for aesthetics. The field is then watered heavy again, this time with the drains closed to hold the water. The field is then painted with water based latex diluted 3 to 1. We've used Line paint which does not harm the grass, however it is about fifty percent more expensive and the drying time is considerably greater, so we no longer use it.

On Friday of game week the water level is adjusted depending upon the weather conditions. If more water is needed then it is brought in from underneath. The final watering from the top is normally done on Thursday evening during warm weather so the top will be fairly dry and solid for firm footing and to prevent turf wear. As mentioned before, during cold weather such as later in the season, the drains are left open all the time since very little evaporation occurs.

If it should start snowing prior to the game then the field is covered with tarps. Even with the heating system, snow will collect on the tarps if it snows hard enough. When it begins to collect on the tarps then two jeeps with rubber edged blades are used to push the snow to the sidelines and, if time permits, it is loaded and hauled away. The rubber allows the snow to be removed from the tarps without damaging them and has worked out very well for us.

In maintaing a field, whether it be professional or recreational, I think there are two very important ingredients required. One is to have dependable and knowledgable personnel. The second ingredient is to have dependable and versatile equipment properly maintained.

With hard work, a lot of pride, and a little luck any field can be maintained to provide the ultimate in playability and aesthetics for both the athletes and the fans.

Growth Regulators

R. P. Freeborg, Agronomist
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At Purdue University we began examining growth regulator compounds in the late 1960's to early 70's. At first the initial objective was to find a growth regulator that would either eliminate or reduce the frequency of the mowing required, thus reducing fuel and labor costs and equipment depreciation. So far, we have not found a compound that can satisfactorily eliminate mowing entirely. Our efforts have more recently been directed a finding a growth regulator that will reduce the mowing frequency requirement to perhaps every third or fourth week within a three month period. The mowing would be in the nature of a trim to improve the appearance of the turf, giving it better character, color, and uniformity.

The work done with growth regulator compounds has uncovered other important areas outside the turf industry wherein these formulations can, for example, enhance the sucrose content of sugar cane, as well as increase the nutritional value of forage crops. Some growth regulators have also been found to be capable of seedhead suppression which aids in weed control and reduction of weed competition. These discoveries have given rise to added incentive in the development of such compounds.

With some of the growth regulators we have examined we can inhibit a plant to almost any extent without complete kill. All the compounds we have tested will cause inhibition and reduction of growth. Some do so quite severely,but others will actually make a miniature plant that survives through almost any kind of environmental condition.

A compound that will be available in limited quantity this year is presently identified as EL500. It has proved to be a very good growth inhibitior. It enhances the color of the plant and promotes an improved root system. Our test plots have gone ninety days without mowing and without thinning or discoloration of the turf. This product will be marketed under a EUP permit as "Cutless" from Elanco.

As we examine growth regulators we must also be concerned about what is happening to the plant under the surface of the soil. We need to know what the compound is doing to the tillers, rhizomes, and roots. To accomplish this we have established a greenhouse test wherein sprigs of bluegrass (all taken from one clone to eliminate variability) are planted and then treated with a growth regulator. Thirty days after treatment we harvest them, measure the top growth, and count rhizomes and tillers, and evaluate root development.

The forementioned EL500 performed very well in this test. The plants treated with this product had dark green color, adequate inhibition, and an exceptionally healthy root system. Failure to inhibit seedhead development seems to be the only major drawback to EL500. The same is true of PP333,another promising compound which is not as yet as fully developed in the turfgrass industry. It is a product of ICI Americas.

A growth regulator that has interested us for some years is Ethephon, sold as Ethrel by Union Carbide. It is used in many agricultural areas to enhance ripening of fruit. One of its unique characteristics is that it tends to dwarf the plant moderately. Compared to other growth regulators it does not have the potential for as prolonged a period of inhibition, but it does keep all parts of the plant growing about equally. A major difficulty is the tendency toward species response, so that if you have a bluegrass, rye, fescue mix, you will find that each is inhibited at a different rate. This results in surface irregularities.

A more recent development in growth regulators has come from Monsanto, and is identified as MON4621 (wettable powder) or MON4623 (granule). It is a good growth inhibitor, it enhances turf color, and provides good seedhead inhibition. This compound will soon be available to the turf industry on a limited basis under an experimental use permit.

A problem that is associated with the use of growth regulators in in fact the result of their success an inhibitors. In a normal healthy turf new leaf growth continually masks or hides the older lower leaves as they senesce, or die. In an inhibited turf, natural senescence continues at a normal rate, and, if the plant is under stress, the rate will accelerate. The inhibited leaf growth cannot hide the dead foliage, and the result is a thin, discolored turf.

The previously mentioned difference in species response, and this appearance of senesced leaf tissue are problems to be overcome before we will have a good growth regulator on the market.

The ability of most growth regulators to suppress seedhead development has aroused interest in these compounds as a means of controling a plant species and also reducing mowing requirements. The reduced development of the seed stalk eliminates the need for it to be mowed. Over a period of time by reduction of seed development, a stand of turf can eventually be reduced until it becomes low enough to control what remains by a preemergent. With proper timing and use one can effect a potential reduction of new plants in the future. Unfortunately, the crucial time element is an obstacle to reliabiliby of performance.

Another possibility of the seedhead suppression capability is for control of broadleaf weeds by either reduction of seed quantity or seed viability within the inflourescence.

Two products currently available have the potential for seedhead suppression or selective suppression of annual grass growth. One of these is Embark, a compound that provides good prolonged growth inhibtion. It also gives excellent seedhead suppression of Poa annua without severe inhibtion of grass species in a stand of turf.

The other, and more recently available product, is marketed as Rubigan (EL222). It is a fungicide used for control of various turf diseases. In our early work with it we began to see that it inhibited Poa annua more than it inhibited the bluegrasses. Further testing revealed that it will selectively suppress Poa annua and, over a period of time, with frequent use, it will tend to eliminate it in a stand of cool season grass. Rubigan, although it is not a seedhead inhibitor, has this special ability to influence Poa annua.

These two products represent to some degree where we stand today. We are not only considering growth regulators as a means of possibly reducing mowing frequency requirements and labor costs, but we are also seeing them as selective herbicides that will reduce the ability of one plant to grow where another remains aggressive, thus effecting a change in turf population. Not every compound fulfills both functions, but there is much promise in the concept of using them in combination with each other.

Low Volume Lawn Spraying

Thomas F. Jessen, President
Perma-Green Supreme
Merrillville, Indiana

If you subscribe the Lawn Care Industry magazine, you've read the many articles concerning fuel costs. There have been five or six within the last year, with suggestions like keeping your tires properly inflated, scheduling your routes to minimize extra miles, switching to propane or diesel. It seems everyone in the lawn care industry has been trying for years to come up with a method to enable them to haul tons and tons of water economically. They have all been starting the search for lower costs beginning with the false assumption that the only way to spray lawns is to dilute the fertilizer with four or five or more parts of water. It has been a fruitless search. Indeed, it has been an impossible search because the more weight the less the mileage. But the reverse is also true - the less weight the greater the mileage. That is why low volume using less water is the only way to a significant reduction in high fuel costs, and as we will see, LV is also the answer to high capital equipment costs, as well.

Low volume spraying or LV, for short, is a technique of applying lawn fertilizer and pesticides using less water in the spray solution. While most companies spray three, four or five or more gallons of solution per 1,000 square feet, LV spraying uses a rate of one gallon or less. The first thought that occurs is that....it will burn the lawn! When I first heard about LV I thought the same thing. But there is at least one company spraying with less than one gallon per thousand for about fifteen years. The obvious success of that company convinced me to try LV.

Rates and Types of Fertilizer - When the first trucks rolled last spring with a 10-2-4 LV solution, spraying one pound of Urea nitrogen along with the phosphorus, muriate potash, and Presan per gallon, I was nervous. I sat by the phone waiting for burn complaints to flood the switchboard. Days passed, then weeks; no complaints. During Round 2 the temperatures were on the rise and I was spraying a 7.5-1.5-2 with 3/4 lb. Urea $N+K_2SO_4$ + 2,4-D + MCPP. Still no calls! During Round 3 the temperatures were consistently in the 80-90^{o} range, and we were in the middle of a drought stress period. I began including Formolene to supply one half of the N in the spray solution to formulate an analysis of 5-1-1. Still no calls.

Reliability and Safety - After 8,000 applications with no serious problems arising from LV, I was more than confident; I was convinced! LV was just as reliable and safe as the 3 gallon/1,000 technique I had used for the last eight years. Of the small handful of burns, most were very minor tip burn resulting from applicator error in trimming too heavily or occurred when using the muriate potash. As well as being safe, LV offers the advantage of superior weed control. I've been getting great results using only 2,4-D and MCPP. Would you believe I've curled up violets?

Why Wasn't There An Increase In Burning? - Maybe the answer lies somewhere in the fact that both High Volume and Low Volume solutions contain the same amount of active ingredients. The only difference is that HV has more water. If we look at what happens to both HV and LV solutions after an application, we'll realize that in about fifteen minutes or so (depending on temperature and humidity) all the water has evaporated, leaving only the concentrated material behind. This residue, whether from HV or LV, will contain like ratios of N-P-K once the water is gone. Most important, the molecules of residue left from LV will be in contact with less leaf area because in LV we don't saturate the lawn. Also, LV dries quicker because there is less water. In both methods a percentage of the material drips off the leaves.

LV Spray Equipment - The LV concept allows the redesign of spray equipment. In LV spraying, the spray pattern stays virtually the same. That way our applicators and customers can easily accept the change. Modified ChemLawn nozzles, smaller T jets, or flood jets can be used. Rapid production rates of 1,500 square feet/minute are possible. In LV terms that is only 1.5 gpm. It requires less than 20 pounds of pressure to deliver 1.5 gpm through 300 feet of one-half inch ID hose. With such low volume and pressure, a 12 volt electric pump can be used. It operates on the truck battery. A pressure limit switch shuts the pump off when the applicator shuts the gun off, and it goes on when he pulls the trigger. This means the battery won't wear down. Since the truck isn't running while spraying it takes zero fossil fuel to deliver the spray and there is virtually no noise. 12 volt mechanical agitation is needed. Any spray truck has to have the capacity to do a good day's work - a minimum of 150,000-200,000 square feet per fill up. Of course, in the world of LV that's only 150-200 gallons. The LV system is so light weight and compact that it can mount on a mini pickup truck that gets an honest 18-24 mpg. Mini trucks are economical to operate and easily service far away accounts. Applicators practially never have to search for parking places. The smaller trucks take up less room so more spray units can fit into existing warehouse space. A mini pickup does the work of a two ton truck and a 3/4 ton pickup becomes a two man rig. A comparison of estimated operating and purchase costs of this LV rig and a HV two ton rig will reveal some truly amazing facts.

Comparison Of Operating Costs Of LV Vs. HV - I'll start by comparing estimated operating costs based on 10,000 miles of driving per season. PTO fuel consumption for 900 hours of pump time, maintenance, and fertilizer and gas fuel fill-up time. I'm using International Harvester's mileage estimates of 4.78 and 8.48 mpg for a two ton gas and diesel respectively. The estimates for mileage, maintenance, and fuel fill-up time appeared in an article in the September 1981 issue of Lawn Care Magazine. The estimates for the mini pickup are based on my experience. The other component of fuel cost is the fuel needed to drive the pump. I'm using ChemLawn's estimate of 1.4 gallons/hour of PTO operation as it appeared in another article in Lawn Care Industry Magazone. (Please refer to Chart #1)

Estimated Operating Expense Comparison

	Mini Pick-Up Datsun	2 Ton IH 1724 Gas	2 Ton IH 1754 Diesel
Miles/Year	10,000	10,000	10,000
+ Miles/Gallon	18	4.78	8.47
= Gallons/Year	556	2,092	1,181
X $/Gallon	$1.25	$1.25	$1.25
= Fuel Cost Per Year	$695.00	$2,615.00	$1,476.15
Year			
Production Days	150	150	150
X Hours/Day	6	6	6
9	900	900	900
X Gallons/Hour	0	1.4	.7
= Gallons/Year	0	1260	630
X $/Gallon	$1.25	$1.25	$1.25
=PTO Time	0	$1.575	$787.50
(1300 RPM)			
Cost/Year			
Miles/Year	10,000	10,000	10,000
X $/Mile	$.0528	$.0528	$.0528
Maintenance/Year	$528.00	$528.00	$201.00
Gallons	200	1200	1200
+Gallons/Minute	60	60	60
=Hours/Fill	1/12	1/3	1/3
X Fills/Year	150	150	150
= Hours/Year	12.5	50	50
X $/Hour	$6.00	$6.00	$6.00
= Fertilizer Fill	$75.00	$300.00	$300.00
Time			
Production Days/Yr	150	150	150
+ Days Between Fill	2	1	2
= Fills/Year	75	150	75
X $/Hour	$6.00	$6.00	$6.00
= Gas Fill Cost/Year	$112.50	$225.00	$112.50
Total Operating Costs /Year	$1,410.50	$5,243.00	$2,877.25

Comparison of Vehicle And Equipment Purchase LV Vs. HV

The HV spray equipment estimate is from a well known manufacturer and includes a 1,250 gallon split compartment mild steel tank. The truck prices were from local dealers. These figures were determined by asking each vendor to give me their best shot at price, terms and interest rate. (Please refer to Chart #2 following).

Vehicle Purchase

	Datsun (Short Bed)	GMC 6000 Gas	GMC 6000 Diesel
Sales Price	$6,377.92	$15,003.04	$21,238.74
- Down Payment	$ 900.00	3,000.61	$ 4,247.75
Financed	$5,477.92	$12,002.43	$16,600.64
Monthly Payment	$ 176.71	$ 428.42	$ 592.55
X Months	36	36	36
	$6,361.56	$15,423,12	$21,331.80
+ Down Payment	900.00	3,000.00	4,247,75
Total Cost	$7,261.56	$18,423.73	$25,579.44

Spray Equipment Cost

	LV2000	Brand X (1250 Gallon)
List	$5,000.00	$7,920.00
- Down Payment	1,000.00	1;584.00
Financed	$4,000.00	$6,336.00
Monthly Payments	$ 141.39	$ 226.21
x Months	36	36
	$5,090.04	$8,132.56
Total Cost	$6,090.06	$9,727.56

Total Equipment Cost (Truck & Spray Equipment

$13,351.60	$26,567.29	$33,723.11

First Year Cost Comparison

This includes down payments, 12 monthly payments for truck and equipment, and one year's operating cost. (Please see Chart #4 below)

First Year Cost

Down Payment	$1,900.00	$4,584,61	$5,795.75
12 Monthly Payments-Tr	2,112.00	5,141.04	7,110.60
Operating Cost	1,410.00	5,243.00	2,877.25
12 Monthly Payments-Eq	1,696.68	2,714.52	2,714.51
	$7,118.54	$17,683.48	$18,534.07

Total Cost For Three Years

$17,581.60	$42,296.29	$42,354.86

Converting HV Equipment to LV - When I switched LV this year I had a couple of two ton trucks. Since the existing tanks are used with the new electric pumps and agitators, they now haul only one-third the weight and their mileage has improved by about one-third. PTO time is eliminated by installing the electric pumps. It now takes less time to fill up fertilizer and gas. Savings of $2,700.00 per rig are possible by converting HV to LV.

Implementing LV - The proper strategy to introduce LV is important! The first year continue using the large trucks (after they've been converted to LV, of course.) The customer doesn't know how much material is in the tank, and you can enjoy the immediate savings LV conversion offers. Add a mini truck to the fleet, giving everyone a chance to see it. Then as the larger trucks need replacing, downsize them. The customers will easily accept the change over if the change is gradual.

An Economic Choice - Will we continue to operate as in the past or will we sieze this opportunity LV offers us? If a new innovation occurs that enables us to provide goods or services more economically or at a higher profit, that innovation will be used by business.

LV is that innovation in the lawn care business that cuts costs, increases profits, and gives my company the competitive edge it needs to survive in the 1980's. As rational businessmen, I believe your decision to switch to LV is inevitable - just a matter of time.

Burn Characteristics of Ureaformaldehyde Reaction Products

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In selecting a nitrogen (N) source for liquid lawn care, an important consideration is the potential for the fertilizer to cause burn.

Fertilizer burn is the dehydration of plant cells caused by an excess of salts following a fertilizer application. Fertilizer burn can occur as the result of fertilizer being placed on turfgrass leaves and stems or from an excess of salts in the soil solution. Varying degrees of fertilizer burn can occur from a simple discoloration of the leaf tip (known as tip burn) to a complete browning of foliage and death of the turfgrass plant.

The salt index proposed by Rader, Jr., White and Whittaker (3) is a measure of a fertilizer's tendencey to raise the osmotic potential of the soil solution and is based on sodium nitrate being equal to 100.

Table 1. Salt indices of several N sources

Source	Content %	Salt index	Partial salt index (1)
Sodium nitrate	16.5	100.0	6.06
Ammonium sulfate	21.0	69.0	3.25
Ammonium nitrate	35.0	104.7	2.99
Urea	46.0	75.4	1.62
Natural organic	5.0	3.5	0.70

(1) Based on euqal amounts of N

As a group, the soluble sources of N - sodium nitrate, ammonium sulfate, ammonium nitrate, and urea - have a relatively high salt index. For this reason, precautions should be taken to minimize possible fertilizer burn. Standard recommendations when applying soluble sources of N in dry form include applying the fertilizer to dry foliage and following the application with irrigation. These steps help to insure that the fertilizer will not remain on the leaf surface where fertilizer burn can occur.

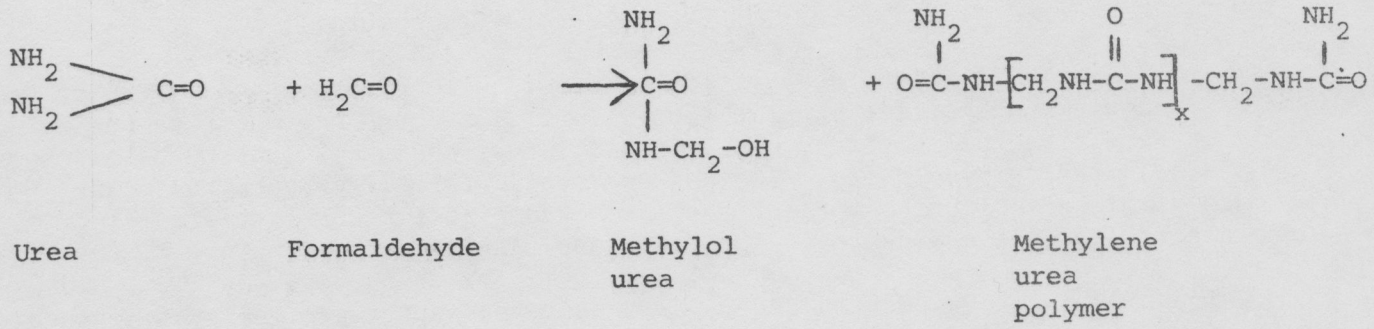
In addition to precautions before and after the fertilizer application, fertilizer burn can be minimized by using N sources such as natural organics (i.e, Milorganite) which are insoluble and have a relatively low salt index (3.5).

Sources of N such as sulfur-coated urea, isobutylidene diurea, and ureaformaldehyde will also minimize fertilizer burn because of their limited water solubility.

Since 1977, several liquid forms of ureaformaldehyde (UF) reaction products have been introduced to the lawn care industry as sources of N. One of the benefits promoted by the producers of the UF reaction products is that they possess a low potential for fertilizer burn.

UF reaction products are produced by reacting urea and formaldehyde (Figure 1).

Figure 1. Formation of UF compounds



Urea | Formaldehyde | Methylol urea | Methylene urea polymer

Variables such as the mole ratio of urea to formaldehyde, temperature, time, pH and catalysts used influence the methylol urea or methylene urea found in the final product. In comparison, formation of the more complex ethylene urea polymer with varying chain lengths and solubilities further reduces the potential for fertilizer burn.

Formolene and 4342 are two liquid products which contain soluble methylol urea as the predominant UF compound. (Table 2). Nitro-26 Plus is also a liquid with methylene ureas as the predominant UF compound. Fluf is a flowable liquid (a liquid containing microfine particles) which, like Nitre-26 Plus, contains methylene ureas as the predominant UF compound. In addition to soluble short-chain methylene urea, Fluf contains 20% water insoluble long-chain methylene urea. The burn potential of Fan is of interest since it is a newcomer and produced by reacting urea and acid aldehyde to form ethylidene urea.

Table 2. Liquid ureaformaldehyde reaction products

Trade Name	Producer	Nitrogen	Predominant UF Compound		Water Insoluble N	Urea
			Methylol urea	Methylene urea		
		%			% (1)	% (1)
Formolene	Hawyeye Chemical Co.	30	x		0	50
GP4342	Georgia-Pacific Corp.	30	x		0	50
Nitro-26 Plus	C.P. Chemical Co.	26		x	0	<15
Fluf	W.A. Cleary Chem. Co.	18		x	20	<16
Fan	" " " "	20			0	20

(1) % of total N

Knowledge of the relative amounts of urea, methylol urea and methylene urea contained in the liquid UF reaction products can be used as a guide in predicting their potential to cause fertilizer burn. Fluf would have the least potential to burn because it contains less than 16% urea, methylene ureas as the predominant UF compound, and 20% of the total N in a water insoluble form. Nitro-26 Plus, like Fluf, also contains less than 16% urea and methylene urea as the predominant UF compound but contains no water insoluble N and, therefore, could be considered intermediate in its burn potential. Formolene and GP4342 contain 50% urea with methylol urea as the predominant UF compound and would have the greatest potential to cause burn of the liquid UF reaction products.

Several field tests have demonstrated differences in the potential for liquid UF reaction products to cause fertilizer burn. Johnson and Christians (2) compared the extent of foliar burn caused by liquid fertilizers applied to Kentucky bluegrass turf. The average visual burn from applications of 0.50, 1.00, and 2.00 lbs. of N per 1,000 sq.ft. made in August of 1982 are given in Table 3.

Table 3. Effect of liquid fertilizer on foliar burn of Kentucky bluegras turf

Source	Visual Burn Rating (1)
Control	9.0
Fluf	8.5
Formolene	8.0
Fan	7.0
Urea	6.5
F.S.D. (0.05) = 0.5	

(1) 9 = no foliar burn; 1 = complete burn

Fluf and Formolene gave significantly less burn than Fan and urea.

Freeborg (1) measured the amount of burn (expressed as phytotoxicity) caused by both liquid and dry fertilizer formulations applied to bluegrass turf. Ratings of visual damage from applications of 3.0 lbs. of N per 1,000 sq.ft. made in June of 1980 are given in Table 4.

Table 4. Effect of liquid fertilizers on phytoxicity of Ky. bluegrass turf

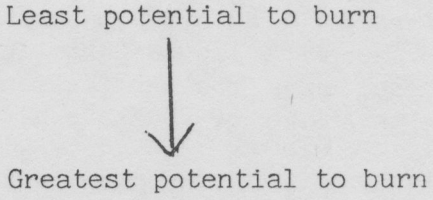
Source	Phytotoxicity rating (1)
Control	10.0
Fluf	9.0
Formolene	8.0
Urea	6.7
Ammonium nitrate	4.7

(1) 1 = total leaf damage; 10 = none

Although not subjected to statistical analysis, Fluf gave the least burn followed by Formolene and urea. Ammonium nitrate gave more burn than urea which would be expected since ammonium nitrate has a salt index which is greater than urea.

Based on the two field tests, the product with the least potential to cause burn would be Fluf followed by Formolene.

Illustrated below is a summary of both the prediction of burn potential based on the relative amounts of urea, methylol urea, and methylene urea and field burn test data for the liquid UF reaction products and urea.



Fluf
Nitro-26 Plus
Formolene and GP4342
Urea

Beyond the potential to cause fertilizer burn, other characteristics such as length of N release, handling and storage properties, and cost should also be considered by a lawn care company before making a final decision regarding sources of N.

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Storage on MO Nitrogen Fertilizers

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Before we really talk about storage of nitrogen we need to understand the benefit of some type of slow release nitrogen in our formulations, the spreadable sources that are available, the timing of applications, and some of the chemistry involved. These are important to understanding the storage and shelf life of some products.

Why do we need slow release nitrogen? Burn or turf phytotoxicity can occur from many of the things in your tank mix from your nitrogen source to your herbicide to your potassium source. You have to take a look at the entire complex before saying, "This causes burn."

We have to look at what turf phytotoxicity is. It is a physiological drought which is related to the salt index of a particular product. This brings us to the similarity or the relation of the salt index to the burn potential of your mix. Ammonium nitrate has a very high salt index, approximately 3.8 per unit of N. If you were to substitute urea as a nitrogen source the salt index is reduced to 1.6 per unit of N. Just by switching those nitrogen products you have reduced your burn potential by half. Potassium chloride or muriate of potash have a salt index of about .8. Again you are reducing the index by half.

When can we use these products effectively and safely? If you were to look at a 15-3-6 made of urea, ammonium phosphate and muriate of potash, it can be used very safely in the spring without any fear of burn phytotoxicity. As you get into Round 2, depending on what the temperatures have been and the soil moisture, when do you begin to switch to a very expensive and exotic nitrogen source? Remember that muriate of potash has a greater burn potential than urea. Then, inevitably, as it does begin to get very warm sometimes modifications in your nitrogen source must be made.

Of the sprayable sources available, IBDU is available in pellets. It can be sprayed, but there are lots of problems. This slide shows a lawn which was sprayed with the end of the tank mix. The agitation had ground the pellets into a powder. We literally painted this lawn white. Fortunately it washed off, and because of its low burn characteristic there wasn't a problem.

The next type of product is urea formaldehyde which is, of course, a very popular nitrogen source. These products are made by free urea and formaldehyde, which has a very high pH. The two mixed together do not react. You have free urea and free formaldehyde both in solution. If you add an acid to that solution, it serves as a catylyst and causes the pH to lower drastically. When this occurs it causes the urea to bind to the formaldehyde. If we look at a product like powder urea, a water insoluble, they let this reaction go until it is complete, or it has turned into what I call a little bit of plastic. Then if you physically grind it this shortens some of the long chain polymers. However, this product does contain some very, very long chain polymers which are very slow to release and can last from two to three years. I , rather than letting the reaction go to a solid state and then physically grinding it (as is the case with Powder Blue) technology allows you, during the reaction, to add a base in the middle of the reaction. This will result in a solution which contains 50% free urea and 50% short chain reacted polymers. The short chain polymers will become available in a relatively short time and you reduce your salt index and your burn potential.

As you store this product over time the tendency of the product to lower pH is there and as you lower the pH it begins to react again. Such is the case here. This slide shows the filter of my fertilizer pump. This is a urea formaldehyde product that I have stored over winter. In the spring I pumped out the entire tank and, what did I find? Some water insoluble polymers that had formed in the mix. We simply filtered them out and we didn t get more than a pint of polymers formed through that whole 1500 gallon tank.

As you try to store these products it is best to store them separately. As you begin to mix urea solutions with it, or especially a phosphate with a high pH it can react almost immediately, and can give you severe problems.

I want to go into another product that is available and that is Fluf. When it has reacted a little bit longer it has only 10% free urea and has 50% cold water soluble polymers, those are still in solution, and it has 30% cold water insoluble polymers which are long chain enough so they drop out, but they can still become available to the turf plant in a period of, roughly, sixteen weeks. The 10% hot water insoluble polymers are very long chain and they will take a long time to react. There are some problems associated with this product. It is a suspension and when you use it at a low volume of water you will get a coating and a discoloration due to the liquid suspension.

These new controlled release fertilizers are really a very big help to us since they enable us to reduce the salt index of our mix. One product is Formolene by Hawkeye Chemical, 30-0-0. Another product that you probably haven't heard a lot about is a 30-0-0 made by Georgia Pacific Corporation. This material is also 50% free urea and 50% reactive urea solution. It does a good job.

One thing to be very cautious about is the mixing of these two products and then storing them over a long period of time. If you're going to mix the products together, for instance using 15-3-6 and 15-3-0, and you use the product up within a couple of weeks you are not going to have any problems, but if you were to purchase a solution that is 50% UF and 50% urea solution mixed with it, and you plan to store it throughout the year, as you come down to the last few weeks of use there is a chance for this product to polymerize. Once this product sets up there is really nothing that can be done to reverse the reaction. So if you care anything about your storage tanks and equipment you might be cautious storing them. By storing these products separately there also develops an economic effect. The reason we are using this fertilizer is to reduce our burn potential. The MO nitrogen fertilizer products are obviously more expensive than straight urea products because of the reaction process that they must go through. If you can store the MO products separately you can mix these products at will and vary the concentration of MO nitrogen to straight urea solution to protect yourself during the warmer months.

If we have a week of rain in July, and we are saying, "This is a hot month and we have to protect ourselves", and then the temperatures are cool for a week and the soil moisture is high, you can safely use a urea solution at that time with less MO nitrogen better than when it is hot and dry. Having the flexibility of storing them separately allows you to vary the concentration of MO nitrogen to urea solution at will, and there is tremendous economic saving involved, especially with the larger companies with a larger number of accounts.

This is a picture of a metering system that might allow you to pull MO solution and urea solution. In our operation we have a separate mix tank where I will pump in so much MO nitrogen and so much urea solution and have enough for a two days' supply. If weather conditions do change I can vary that solution. Use what you need when you need it, and pay careful attention to both temperature and soil moisture.