PROCEEDINGS

45TH

ANNUAL CONFERENCE
MID-ATLANTIC GOLF COURSE
SUPERINTENDENT ASSOCIATION

January 7-8, 1974

SHERATON LANHAM MOTOR INN
NEW CARROLLTON, MARYLAND

These proceedings were published through the combined effort of the Maryland Cooperative Extension Service, the University of Maryland, Department of Agronomy and the Mid-Atlantic Association of Golf Course Superintendents. Articles were edited by John R. Hall, Turfgrass Specialist, University of Maryland, Department of Agronomy.

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1973 - THE YEAR THAT WAS

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What kind of year did we have in the Mid-Atlantic in 1973? Well, it probably depended on your location as much as anything.

Following are some familiar phrases voiced during almost any given year and some quotes solicited by various people in the field to characterize 1973.

In spring and fall, the happy people tell us that, "Anyone can grow turf in weather like this and good turf is to be expected as the least you can do".

In July and August they say, "What's happening to our course? We would like a formal answer at the board meeting tomorrow night".

Al Radko went on record as saying it was one of the worse years in 20 years in the Northeast.

Richard Anderson bemoaned the effect of air pollution on turf, which he said promises to get worse if something isn't done.

A turf research man told me, "We heard a lot of bad stories from further north, but in my opinion, those people simply experienced the type of summer we go through in this area almost every year.

A turf extension man said, "1973 was one of the worst years we have ever had. I saw more lost turf this year than ever before".

A golf course superintendent to the south of the Mason-Dixon line said, "One of the best years we ever had, especially for bermuda. We suffered from lack of rain in October, but nothing very serious".

Mr. Ed Dembnicki to the south in Pinehurst, N.C. said that over all, this was a very good year for him and one of the best he has had in that area.

A salesman observed, "I didn't see anyone in real trouble turfwise unless they asked for it and not too many of those. I think we had a pretty good year".

All in all, I guess you can pay your money and take your choice. No year in memory has ever been without problems and no golf course I can remember has ever been 100% or even close every year.

I have been more than a casual observer of golf course conditions in the Mid-Atlantic for almost eleven years, and I have shared a lot of grief and a lot of joy during that period, but even my exposure is biased. My morning visit may be to a disaster area and my next three visits may be to courses that reflect only perfection or vice versa.

Now I would like to recall the weather picture in 1973.

The year began with too much rain, especially in isolated areas, and ended with not enough. October was really dry in most areas and all cool season turf was stunted and yellow. The conditions were especially rough on fall seedlings. The lack of rain which clears the atmosphere may also have aggravated the pollution problem that Dick Anderson talked about.

Climate, however, did not seem to be as decisive a factor this year as it was in 1972. Remember hurricane Agnes in July of '72? We used pontoons on the mowers almost all of that year.

I am acutely aware of rainfall during the year over the general area, but probably not in specific locations. On site observation of the problems is the strong point of the Green Section program and the opportunity to do this is limited to maybe once or twice during the year at a specific date and time. Due to these conditions, I am strongly motivated to look at each course, especially if problems are present, without regard for the weather. As you might imagine, this makes for some memorable experiences of spending the day in soggy clothes, heightened by the presence of cold temperatures. These occasions are not only easily remembered, but sometimes hard to forget for years to come. Using such a memory guide as my barometer, I have to say I was either in the right places at the right time in 1973 or it was not such a bad year weather wise.

On the other hand, it was plenty hot in the summer, but it did not seem so hot or humid as it has in many years past nor did we have so many bad days back to back for extended periods.

A video tape of life's past events would probably be helpful to all of us at home and on the golf course, but for now, we have to rely on memory which is often hazy and distorted by our microenvironment.

Now for a recap of what seemed to be some rather severe problems in 1973. No order of importance is intended, but the list is headed by labor, public relations, diseases of bluegrass, insects, OSHA, EPA, and an energy crisis.

One common problem expressed by most golf course superintendents seems to be the quantity and quality of labor. Golf course wages are not competitive with industry in the surrounding area, therefore, we usually get the manpower rejects. These people are basically unskilled and many times unreliable and untrainable. This all makes for some real problems which are reflected by poorer results in every area of the management program.

Public relations seems now to be almost synonymous with personal credibility. A lot of people in and out of politics in 1973 had problems with credibility and it is probably safe to say that these problems overshadowed our real grass growing problems.

More times than any of us would like to believe, I have seen capable and able turf superintendents discharged or resign under pressure while a neighbor who could barely hang on to his grass, and many times didn't, gets a pat on the back and a sizeable income boost as a vote of confidence from his membership. Only one thing made the difference and that was how the superintendent played his hand in club politics.

There are no pat answers for improving your public relations i.e., credibility; but honesty, a friendly, sympathetic attitude and attention to details of the job you were hired to do can't hurt.

If you complained about the growth and performance of bluegrass this year, you were probably more than justified.

Fusarium roseum reached epidemic proportions and since no good controls or preventatives have been found, this disease will be a triple threat in 1974.

Over nine years ago Dr. Houston Couch, then at Penn State, predicted that Fusarium roseum would virtually wipe out bluegrasses on golf courses in the United States. My first observations of this disease as a real problem to Mid-Atlantic turf came three years ago in western Virginia. Since then, the disease has spread like wild fire and was responsible for loss of bluegrass turf ranging from slight to total destruction on every course observed from mid-July on this year.

Insects were as bad as they have been in several years and in some cases our hands were tied by the EPA when it came to using the most effective controls. The last two mild winters brought out more insects than usual and federal and state regulations gave us less to fight back with than ever before.

The EPA has, or threatens to, put a crunch on many of our basic chemicals unless we can muster enough information to the contrary and get it in the hands of the right people in time to stop wholesale restrictions.

OSHA is looked on as a means of upgrading some substandard working conditions, but also as a heartless bureaucracy bugging superintendents with heavy fines for minor infractions and requiring endless paper work. Where will it all end? No one knows, but the way it is going, it's going to take a PhD and a clerical staff just to get the paperwork done before we can start growing grass.

Fuel shortages hampered some and promise to get worse in 1974, and when we look ahead, we can most likely expect fertilizer shortages and higher prices for everything.

Whether 1973 was a bad, good or an average year is somewhat academic and in most cases depends on what particular facet you are talking about. It certainly makes you wonder what we will be saying about this time in 1975.

Perhaps I can leave you with the thought that it is much more important to look ahead than relfect on the past, and that we must look for answers rather than excuses when things go wrong. Only answers will solve problems as well as explain why they happened and prevent their reoccurrence. Excuses simply tell others why we failed.

TURFGRASS BREEDING IN THE SEVENTIES

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The breeding and selection of truly outstanding varieties is one of the greatest needs of the turfgrass industry. This is especially true in this transition zone where neither the cool-season nor the warm-season grasses perform at their best.

The most important attributes of an improved turfgrass variety are dependability, durability, reduced maintenance requirements and attractive appearance. Each of these can be improved as we add resistance to diseases, insects, nematodes and weeds, better turf-forming properties and tolerance of environmental stresses. Adaptation to specialized uses and environments are also important. Turfgrass varieties with better tolerance to shade, wear, close-mowing, and poor soil conditions would greatly enhance the usefulness of our present species. Varieties of unique or striking color and appearance would be very useful for diversification in special landscape patterns and effects.

Pest Resistance

Plant breeding often makes its greatest contribution in the development of varieties with genetic resistance to major disease, insect and nematode problems. Prospective restrictions on the use of pesticides make genetic resistance and other means of biological control of even greater significance. Varieties undamaged by disease and insects are more resistant to weed invasion. A few years ago, Merion was the only Kentucky bluegrass variety with good resistance to the Helminthosporium leaf spot and crown rot disease. Presently, a substantial number of other bluegrass varieties with good leafspot resistance are available. Many of these newer varieties also have the added advantage of resistance to the stripe smut disease. Programs to develop resistance to powdery mildew and dollarspot are producing varieties resistant to present races of these diseases. However, it appears that rapid development of new races of these disease organisms may make the resistance of many of these varieties of a temporary nature. The skillful blending and mixing of resistant varieties and species may be helpful in providing the genetic diversity needed for a more permanent type of resistance.

Considerably more effort needs to be directed towards controlling the Fusarium blight disease through the development of greater genetic resistance. A breeding program located in the Maryland, Virginia area would be most helpful in this respect.

There has been very little effort expended to improve the insect resistance of our cool-season turfgrasses. Nevertheless, studies and observations indicate that substantial progress might be made. Scientists at the University of Kentucky reported considerable variation in the amount of sod webworm injury observed on different selections of Kentucky bluegrass.

Alexander Radko of the USGA Green Section has selected bluegrasses with apparently good resistance to chinchbug attack. Considerable variation has been noted in aphid damage to Kentucky bluegrass varieties in nursery plantings at Adelphia, New Jersey.

Herbicide Tolerance

The development of turfgrass varieties with specific resistance to highly effective herbicides would permit much more selective control of present weed problems. Certain zoysia varieties are highly tolerant of atrazine and simazine (Engel, Funk and Kinney 1968). This difference appears to be the result of a single gene. Such tolerance permits the use of these highly effective herbicides in the selective control of many weeds troublesome in the establishment and maintenance of zoysia. Would it not be possible to breed a bluegrass variety highly tolerant of a chemical which could then be used to selectively remove bentgrass or tall fescue? Research in this field should be initiated.

Shade Tolerance

The combination of trees, ornamental shrubs and turf in lawns, parks, and recreational areas adds greatly to the beauty and enjoyment of our outdoor environment. The development of turfgrass varieties better adapted to such shaded locations would be of great benefit. The successful performance of Warren's A-34 Kentucky bluegrass in moderate shade demonstrates that Kentucky bluegrass varieties with improved shade tolerance can be developed. Such varieties must have good resistance to powdery mildew and other diseases which are particularly damaging under moist, shaded conditions. They must also have the ability to limit vertical leaf elongation and thereby divert the food produced by photosynthesis to tillering, root and rhizome production and carbohydrate storage. The ability of some of the fine fescues to tolerate the poor, acid, infertile soil conditions frequently associated with many shaded locations undoubtedly contributes to their success as a shade tolerant component of a mixture. Darker green, more compact growing types of Poa trivialis are showing considerable promise in some shade trials in New Jersey.

Turf-Type Growth Habit

The fine-leaf, dwarf-type bermudagrasses developed by Dr. Glenn Burton and others illustrate the profound changes that can be made in the growth habit of a species. The growth habit of Kentucky bluegrass is greatly modified by day length, light intensity, and temperature. During short days bluegrass assumes a more decumbent growth habit, rate of leaf elongation is reduced, and abundant tillering occurs. During long days growth is more erect and leaf elongation is more rapid. Reproductive development also occurs during the long days of late spring.

Common Kentucky bluegrass and varieties such as Park, Delta, and Kenblue have a rather erect growth habit with a rapid rate of vertical leaf elongation. Such varieties will not tolerate high nitrogen fertility and close mowing, especially during the spring and summer seasons. During the long days of spring and summer these varieties divert most of their growth upward. Leaf area is mowed off so frequently that a good, dense turf is difficult to attain. Carbohydrate food reserves are depleted and such varieties become highly susceptible to damage from the Helminthosporium leaf spot and crown rot disease.

Varieties such as Glade and Nugget appear to exhibit the short-daylength response of decumbent growth and slow leaf elongation through much more of the year than the common type bluegrass varieties. Increased understanding of the differential varietal growth response to daylength should be of great value in breeding turfgrasses with better turf-forming properties and a reduced mowing requirement. Such programs may well make increased use of germplasm collected from arctic regions where summer days become very long.

Color

Renewed interest in better color during late fall, winter, and early spring has been stimulated by recent research in Rhode Island and Virginia on late fall and winter fertilization. This is especially evident in areas of moderately mild winter temperatures and where turf receives some protection from cold, drying winds. Kentucky bluegrass varieties differ greatly in their ability to maintain good winter color. Kentucky bluegrass varieties such as Adelphi, Bonnieblue, Majestic and Georgetown are outstanding in their ability to retain excellent color into the winter and green-up early in spring.

Practically any shade of green color can be observed in experimental turfgrass planting. Types like Brunswick have a very attractive, bright, moderately light green color. Adelphi and Nugget have a bright, dark green color. It should be possible to develop turfgrass varieties of any shade of green dictated by personal preference.

Tolerance of Problem Soils

Turfgrass is grown on a wider range of soil types than any crop plant. Varieties with specific adaptation to particular problem sites can be developed. Breeders in Holland have developed salt-tolerant fine fescue varieties such as Golfrood for use in stabilizing dikes. Such varieties should be very useful as parental material in the development of fescues tolerant of the heavy amounts of salt used for ice control on many of our highways. Recent success in hybridizing Belturf Kentucky bluegrass with a Canada bluegrass selection suggests that a Kentucky bluegrass with better adaptation to poor soils could be developed.

Heat Tolerance

Improved tolerance of our cool-season turfgrasses to the summer heat and drought conditions of the transition zone would be of great benefit. Most of the very attractive, dense, lower-growing varieties selected in the cool-summer climates of Northern Europe and from other breeding and evaluation tests located in less severe environments are disappointing in Southern trials. An extensive program to collect and evaluate adapted germplasm from summer stress areas of the Mid-Atlantic area should provide varieties with greatly improved summer performance and dependability.

Reproductive Systems in Turfgrass

The genetic improvement of a turfgrass species is dependent upon its reproduction system. Turfgrasses, like other plants, may reproduce sexually or asexually (without sex). Sexual reproduction can result from either cross-pollination or self-pollination. Asexual reproduction can occur as either vegetative propagation or as apomictic reproduction. The method of reproduction regulates the amount of genetic variability present in a turfgrass variety and also determines the breeding methods and techniques used to develop improved varieties within a species.

Sexual Reproduction

Most turfgrass have perfect flowers containing both male and female components. Buffalograss is an important exception with male and female organs found on separate individuals as in the rule among animals. Corn would be another exception as male and female flowers are separated but on different parts of the same plant.

Sexual reproduction involves the union of male and female gametes and serves to recombine some characteristics of both parents in the offspring. Both male (sperm nuclei of the pollen) and female (egg) gametes are produced as a result of a reduction division termed meiosis. As a result, the sperm and egg contain only one-half the chromosomes of the parent. When united in fertilization, the sperm and egg combine to restore the original chromosome number of the species.

Nearly all turfgrass species are mainly cross-pollinated (table 1). Even though most of these grasses have perfect flowers, various self-incompatability mechanisms combine to favor cross-pollination. In fact, many ryegrass and fescue plants produce little or no seed when pollinated only with their own pollen. Annual bluegrass would appear to be the only important turfgrass species reproducing mainly as a result of self-pollination which is the breeding method of a number of important crop plants including wheat, oats, rice, barley and soybeans.

Self-pollination rapidly leads to a high degree of genetic homozygosity. After five or six generations of self-pollination, truebreeding lines which reproduce themselves with a high degree of genetic uniformity result. Our leading varieties of wheat, oats, barley, rice and soybeans resulted from the selection of such true breeding, pure lines. Every plant within such a variety is genetically similar to every other plant of the variety. Genetic improvement is made by hybridizing two or more complementary pure-line parents, waiting five or six generations for the progeny to become homozygous and then selecting the single pure line which recombines the greatest number of favorable characteristics of the parents.

Cross-pollination maintains a high degree of genetic heterozygosity in the interbreeding population. No two plants have the exact same genetic constitution. Seed collected from any plant give a progeny segregating for many characteristics.

Table 1. Method of reproduction of important turfgrass species.

Mainly cross-pollinated	
Agrostis canina L.	Velvet bentgrass
Agrostis gigantea Roth	Redtop
Agrostis stolonifera L.	Creeping bentgrass
Agrostis tenuis Sibth.	Colonial bentgrass
Cynodon dactylon (L.) Pers.	Bermuda
Festuca arundinacea Schreb.	Tall fescue
Festuca ovina L.	Sheep's fescue
Festuca pratensis Huds.	Meadow fescue
Festuca rubra L. subsp. commutata Gaud.	Chewings fescue
Festuca rubra L. subsp. rubra	Red fescue (creeping and spreading)
Lolium multiflorum Lam.	Annual ryegrass
Lolium perenne L.	Perennial ryegrass
Poa trivialis L.	Rough-stalked bluegrass
Zoysia japonica Steud.	Japanese lawngrass
Mainly self-pollinated	
Poa annua L.	Annual bluegrass
Mainly dioecious	
Buchloe dactyloides (Nutt.) Engelm.	Buffalograss
Mainly apomictic	
Poa compressa L.	Canada bluegrass
Poa pratensis L.	Kentucky bluegrass

Many of our earlier varieties of cross-pollinated turfgrasses including 'Kentucky 31' tall fescue, 'Seaside', 'Astoria' and 'Highland' bentgrass, 'Chewings' fescue and 'Linn' perennial ryegrass are merely ecotype selections. Naturally occurring, moderately diverse populations were recognized, named and increased as varieties with little or no effort being made to improve their genetic makeup. Most such ecotype selections result from many years of natural selection and show good adaptation to environments similar to their area of origin. In many cases, different seed lots of the same variety may vary considerably in appearance and performance.

Recently, turfgrass breeders have been developing synthetic varieties of our important turfgrass species. Examples include 'Penncross' creeping bentgrass, 'Fortress' red fescue and 'Manhattan' perennial ryegrass. Promising parental clones are selected from old turf areas, plant introduction or hybridization programs. Such clones are then screened for disease resistance and turf performance. The best are then tested for their ability to transmit favorable characteristics to their progeny. Finally, the clones with the best overall performance are combined to produce a synthetic variety. In the case of Penncross creeping bentgrass, the three parental clones are vegetatively propagated to establish large, isolated seed production fields in Western Oregon. Random cross-pollination occurs and first generation certified seed is produced. First generation synthetic varieties such as Penncross will have a higher level of uniformity and hybrid vigor than found in subsequent generations of synthetic varieties produced from seed. This is especially true where only a few clones are used. In the case of Manhattan perennial ryegrass and most other synthetics, only "Breeders" seed is produced in vegetatively propagated seed increase field. Ten pounds of "Breeders" seed of Manhattan ryegrass produced in an isolated crossing field at Rutgers was used to seed a 10 acre "Foundation" field in Oregon. The seed produced from this 10 acre foundation field is adequate to plant thousands of acres of certified fields which produce millions of pounds of certified seed for turf establishment. The Breeders, Foundation and Certified fields are all established on isolated clean fields essentially free from contamination by other ryegrass and objectionable weeds and maintained under constant supervision of Official State Inspectors. Minimum tolernaces are set for off-type plants. other varieties, fluorescence level, and germination and purity percentages. Uncertified seed comes from fields unable to meet the standards of quality and genetic purity set by the breeders and the certification officials.

Vegetative Propagation

Vegetative propagation has many advantages in a turfgrass. Most of the improved bermudagrass and zoysia varieties are propagated in this manner as are many of the creeping bentgrasses and 'Warren's A-20' Kentucky bluegrass. In the absence of somatic mutation or contamination, every plant in a vegetatively reproduced variety is genetically identical to every other plant. Such a variety is highly uniform in appearance and performance. All plants of the variety have the same strengths but also the same weaknesses. Such a variety may not be as widely adapted to different conditions as a variety of greater genetic diversity.

Vegetative propagation greatly facilitates the genetic improvement of a turfgrass. Breeding merely requires the development of a superior plant.Hybrid sterility frequently found in interspecific crosses is not a problem and may even be an advantage as in the case in many of the improved bermudagrasses.

Apomictic Reproduction

Apomictic reproduction is frequently found in both Kentucky and Canada bluegrass as well as dandelions (Solbrig 1971) and many of the warm season grasses including tetraploid Bahiagrass (Paspalum notatum). In apomictic reproduction the egg contains all the chromosomes of the mother plant and develops into the embryo of the seed without fertilization. The effect of apomictic reproduction is to produce offspring that are genetically identical to the mother plant. Thus, apomictic reproduction combines the advantages of "seed" with many of the advantages of vegetative propagation. Hybrid vigor and uniformity are characteristics of apomictic varieties. Also, apomictic reproduction helps overcome many of the problems of hybrid sterility frequently found in making wide crosses.

We have not found a Kentucky bluegrass which is completely apomictic. All varieties appear to produce at least some seed through the sexual process. Some Kentucky bluegrass plants are highly or completely sexual in their reproductive behavior. Of 100 plants selected from old turf areas of the Northeast and tested for level of apomictic reproduction, 16 were between 90 and 100 per cent apomictic, 34 were between 80 and 90 per cent apomictic and 50 were over 20 percent sexual (Funk and Han 1967). Most of our standard cultivars of Kentucky bluegrass are over 80 percent apomictic.

The development of better bluegrass varieties can be accomplished by either selection or hybridization. Individual plants collected from old turf areas have about a 50 percent chance of being sufficiently apomictic to reproduce a stable variety. If such a selection has sufficient merit in comparison with other available and potentially available varieties, it might be released and enter into commercial production.

Hybridization of Kentucky Bluegrass

Rutgers has been the first institution to exploit hybridization in the improvement of Kentucky bluegrass. Hybridization allows the breeder to recombine the best characteristics of two or more parents into one plant. Apomictic reproduction allows us to use this plant as the foundation of an elite hybrid variety. The development of hybridization techniques in the greenhouse involving the night-time pollination of selected bluegrass parents has allowed us to product thousands of hybrids for evaluation. The best hybrids show promise for commercial use (Pepin and Funk 1971).

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BUDGETING: AN ECONOMIC OVERVIEW

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The purpose of this presentation is to give a general introduction to business planning or budgeting. Mr. Watson will make specific application of budgeting in the following presentation.

The success or failure of a business ultimately rests with the decision making ability of management. Management is the great unknown in the operation of a business. Management must make all final decisions which will ultimately determine whether or not the business is operated efficiently and economically. Managerial decisions made to solve past probąems are not necessarily the proper decisions for problems of today and probably are not completely applicable to the solution of future problems. This is true because businesses operate in a dynamic society. That is, governmental policies change, new technologies are introduced, input-output price and input-output relationships change and the goals and objectives of businesses change over time. To keep abreast of changing time, managers must continually examine their business in order to maintain the proper allocation of resources within and outside their operation if they hope to receive a reasonable return to the resources and/or a satisfactory level of living.

Adjustments to change create problems of what to produce, how much to produce and how to produce. This leads to economic problems concerning cost and combinations of practices and systems which ultimately lead to maximizing returns and/or satisfaction to the manager (business). To identify and effectively analyze the most profitable adjustments and the most efficient methods for obtaining these adjustments, the business manager must be proficient in the use of management procedures or methods currently available to analyze economic problems. For business managers to effectively use management procedures or methods in economic analysis, they must be made aware of these and be taught the importance of economics in the decision making process.

Whether it is recognized or not, economic decisions are generally made by following a logical progression. That is, the progression or steps would include 1) observation, 2) analysis, 3) decision making, 4) action taking and 5) accepting consequences. The manager observes his business as well as other similar operations before completing an analysis of adjustment possibilities for the individual business. The analysis could include the calculation of cost and revenue figures for every production alternative. After the analysis, the manager makes a decision. If the decision is made to change the operation, certain actions must be taken to implement the change. Regardless of economic outcome, the manager must accept the consequences of the change. However, this does not mean that he cannot start the planning process over again.

There are many techniques that can be used to analyze a business. However, because of time, space and my assigned topic, I will limit my comments to the general area of budgeting.

A budget is a plan or record (capital, labor, cash, operating, cost, etc.) of the operation of a business for some period of time. Managers need to make both long-run and short-run (annual) plans. A long-run budget would include data for a long period or several years into the future. It would show where management wants to be sometime in the future. It might represent the businesses' long-run goal. Certainly we realize that no single plan will be best for all future periods. Yet, management must have some general goal on which to base future investments. Of course, the outlook may be entirely different at the end of five years and management might be forced to make a completely new long-run budget, even if the first one is planned for ten years into the future. This was my point in the introduction when I referred to businesses operating in a dynamic society.

Once a long-run plan or budget, whether for five or twenty-five years, has been decided upon, one should construct short-run or annual budgets each year. The annual budget should be made to fit the individual year. The long-run budget could call for certain investments, changes, etc. at particular future time periods. However, with high prices (costs), low revenues, labor scarcity, etc., management could be forced to break away from the long-run plan for the next few years, and return to it or a modified plan sometime in the future. Also, the short-run or annual budget is needed in planning transition from the present to the future business organization. If a plan is adopted which calls for major changes, all the changes will probably not be made in one year. Hence, an annual plan will keep management informed on progress being made toward reaching the long-run plan or goal.

Closely intertwined with long and short-run budgets is complete and partial budgeting. Complete budgeting refers to making a plan for the entire business or for all decisions of one part of the business. Partial budgeting is used to test the profitability of some practice or operation which might affect various parts of the business but which does not call for a complete business reorganization. Consequently, only those costs and/or revenues that change with the new way of doing business must be estimated. For example, if management is considering the economics of two sizes or types of mowing equipment, a partial budget could be used to determine the most economical alternative. Here, the decision of equipment size and type would probably only affect mowing (time, cost, etc) and not the entire business organization. From this, one can see that considerable time and effort can be saved by using a partial budget. The only problem is in being able to judge which cost and return items will and will not change. The best way to handle this is accurately define the problem, list all possible effects and then summarize the problem in budget form.

The above brief discussion does not exhaust the area of budgeting. However, it does set the stage for the application of budgeting session which follows this presentation. Too, if management will study and use long-run, short-run, complete and partial budgets, the paper goes a long way in informing managers of the important analysis techniques available to businesses in analyzing economic problems relevant to individual operations.

PLANNING, PRESENTING, AND EXECUTING THE BUDGET

Alex Watson
Golf Course Superintendent
Sparrows Point Country Club

With this paper I have endeavored to give you some basic information on budgeting. You are all well aware of the fact that I could spend hours on the subject, but rather than go into too much detail I will cover a standard budget proposal and stay away from the many calculations.

Each year as we approach the fall season our thoughts and energies turn once again to the task of preparing a budget proposal. A budget lists the funds to be provided for the necessary capital and current expenditures required to make a plan workable. In order to perform the many and varied duties that confront us as turf managers, we must take each facet of our maintenance program and align or fit it into a well designed budget. Let's take a look at just a few of the items we should take into consideration; aerification, topdressing, fertilization, planting, trap work, mowing operations, slicing or spiking greens, leaf removal, storm damage, spraying, and, of course, vandalism.

As has been said on many occasions at seminars, field days, and conferences; "No one set of conditions suffices to satisfy the needs of each and every facility". In the March '71 issue of the U.S.G.A. Green Section Record, Bill Benneyfield states, "Comparing Two Budgets on Two Golf Courses is like comparing two of anything else. They may appear similar at the outset, but the more you know about them the less similar they become". O. J. Noer once said, "A golf course or turfgrass facility is not the place to save money - or to waste it". With these thoughts in mind, we would hope that what is presented here will be of some value in helping you with your budgetary planning, presentation,and execution.

Planning the Budget

It is hardly necessary to point out that one necessity for efficient management of a golf course or turfgrass facility is the proper record keeping. All data, forms, and papers connected with your budget should be recorded and filed according to a definite system. Having this information provides a number one tool for formulation of each years budget proposal. There are two dangers which you must be cognizant of in planning your budget. They are: 1. A complicated one which becomes overloaded and overbalanced or 2. A system so crude and simple that it will not suffice for a continuing management program. The best solution is a middle-of-the-road course. A system which is fairly simple, and yet so designed that it can later be expanded or elaborated upon to fit your needs. A basic budget form can be found in Bert Mussers Text - Turf Management. It is simple and easily manipulated to fit any turfgrass operation. Basically this is the form developed a few years ago and I have used it up to the present time with only a few minor changes. To summarize our form it is as follows: A supervisonal expenses; B. Labor; C. Equipment maintenance and repairs; D. Gasoline, oil, and lubrication; E. New equipment; F. Utilities; G. Materials; H. Fertilizer; I. Miscellaneous; J. Mosquito control; and K. Construction. Now - you can continue this outline to make it functional for what the needs are at your particular facility.

You should have forms for every need, but on the other hand, do not use forms unless they have a definite job to perform. Someone said that when there is a key on your ring, the use of which you cannot tell at a glance, that key should be left at home. Always bear this in mind when preparing your budget. Determine what the needs of your facility are for the season ahead. Is it reconstruction, drainage, beautification, or fairway renovation? What do your members or Board of Directors expect in the way of improvements or changes? What changes do you anticipate? Go over several years figures in order to have some basic ideas and concepts of what your expenses will run. Get all of this information and data together, sharpen a few pencils, find a good eraser, have an adding machine or calculator handy and begin.

Don't forget to include any and all information necessary to present the minimum expenditures required to maintain a well-rounded, top-grade turfgrass program. Use the many, many fine trade journals, magazines, and periodicals associated with our industry. There is a wealth of information here just for the reading, now - lets go back to the basic summary we presented a few minutes ago.

<u>Section A</u> - (see appendix 1) - Include all of the supervisional expenses you will incur for the coming season. If it is required list your salary, your assistant or foremans salary. Add in expenses for conferences, dues (local and national), short course, magazine, and trade journals.

<u>Section B</u> - Our largest and most direct cost in the maintenance program is labor. We are always concerned with certain ways of reducing costs. We employ all sorts of devices such as wage reduction, mechanization, and substitution of products and materials. Many of us have found that at any given time and place there is a point below which it is impossible to reduce or lower costs. Mechanization limits are set by the progress or invention and wages cannot be reduced in this day and age if we are to keep trained personnel. We have to be innovative and give more consideration to the people who work on our turfgrass facilities. If job incentives are not a part of our program it will fail. Substitution of cheaper less familiar products and materials in most instances reduce or make some parts of any maintenance program inferior.

List your number of permanent employees, their number of hours worked during the growing season, and the number of hours worked during the dormant season. This latter reference to dormancy I'm beginning to have some after thoughts about as the only item that has gone dormant on our facility this season is the bermudagrass. Give a resume of each man's particular skills and ability. Next add your seasonal and part-time people as to number of hours worked per week, per season. List all personnel's individual wage and total your figures. Don't forget that the efficiency of any and all functions performed on a turf facility can be compared by a record of the time necessary to perform these functions. In other words, man hours per job or function is our most important way of comparing the efficiency of work done under our present wage scales. Lastly add in all of your miscellaneous costs such as hospitalization, insurance, vacations, and raises. With a complete tally on this section you will have your total labor figure.

Section C - Equipment maintenance and repair. This section could most probably be worked differently dependent upon the requirements of your facility. We figure ours on a per hold per year total for 27 holes of golf plus grass nurseries, tennis courts, picnic area and club grounds. We include all mechanical malfunction and breakdown of motorized equipment. You might want to include a parts inventory and any other items which come under this category.

Section D - Fuel and gasoline. This section is self explanatory and includes all gasoline, oil, and lubricants on a basis of cost per hole per year.

Section E - New equipment. Itemize each piece of equipment needed and give sound reasons for your requests. Have brochures available as additional aids in picturing the new pieces. List trade-ins you might have or prices you might expect from sale of used equipment. You can detail each item you have reference to and justify all of your requests.

Section F - Utilities. This section is also self explanatory.

Section G - Materials. Under this heading list all of your seasonal requirements for chemicals, seed, topdressing, sand, and any other items needed. Give al necessary information on the materials for your program. Adhere to EPA standards as regards your selection of chemicals.

Section H - Fertilizer. This is an all important category and we take it as a separate entry in our budget - make up. The results obtained from a well planned and balanced fertilizer program are many, just to list a few, increased turf density, more vigorous root structure and turf color; better playing surface; lesser need for chemical weed control; and better satisfied members. List your requirements for greens, tees, fairways; and club grounds and how you plan to use the materials.

Section I - Miscellaneous expenditures. In this section we have a fund for stores and supplies, services, and grounds beautification. We also allow a contingency fund for storm or weather damage.

Section J - Mosquito control. This unit is also self explanatory; however, if you do have this type of program at your facility, be sure that the materials you select as controls meet the EPA specs.

Section K - Construction. Under this heading include all proposed changes in irrigation, drainage, cart path installation, reconstruction and any other similar items that might need monetary consideration.

When you have completed and expanded your budget outline, go over each section checking your requests and totals. After you have done this and arrived at the total figures you feel will fulfill the absolute needs of your program, then make up a summary comparing last years figures with your new proposal.

Presenting the Budget

Next - arm yourself with your new proposal, utilize, graphs, indexes, catalogs or equipment, and any other means necessary to present your budget in as clear, concise, and complete a manner as possible when your committee or board calls their meeting. Have copies of your proposal available for each member attending the meeting, so that they can follow your presentation. Keep in mind that you are also selling yourself along with your management abilities. Go over each and every item on your proposal and explain the program needs. Tell it like it is as regards business trends in the labor market, machinery, chemical, and fertilizer industries because their problems are also yours. Prepare yourself for any and all questions that may come from your committee. Conduct yourself as a businessman and you will be pleased with the results.

Execution of the Budget

Now - when the budget comes back to you in a finalized and approved form, the last but in no way the least part of the program is put into operation - budget execution. You must pursue the problem of making your budget work for your facility. Don't forget - if any part of it fails its yours responsibility. Keep your cost account records and bookkeeping system up to date so that you can visually check all sections at a glance and see that you are remaining within the framework of the figures you presented. Operate your department in a business-like manner, and get the maximum out of each dollar invested. Stay abreast of jobs on the facility. Check with your assistant or foreman and mechanic as to employee and machinery performance and make daily course inspections, and always be looking for ways to improve operations. Mechanize, as new equipment has been proven and made available thus cutting down man hours, and increasing efficiency. The same is true in selection of chemicals and fertilizers by choosing and using the more sophisticated materials that have been thoroughly researched and proven in the field for our benefit. Make Bi-weekly, Monthly or quarterly reports of your activities and operations to your chairman or board. Keep them informed as to the progress or budgeted projects - look ahead to the next season and check with previous and past budget experiences in order to come up with a new set of proposals and implementations for the next budget season.

When your operation functions properly and you see your labors bearing fruit - you can then have more time to pursue your hobbies, whether they are: fishing, hunting, golf with friends, or just plain old relaxing on your patio-out-back - and enjoying a beautiful sunset.

Appendix 1

Date________________

FROM: ______________________________

TO: ______________________________

SUBJECT: PROPOSED MAINTENANCE BUDGET OF THE GOLF COURSE AND GROUNDS FOR 19--

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Attached hereto is the proposed budget for 197_ of the golf course and grounds.

budget:

Section A. Expenses only are listed since salary is not a budget item.

Section B. 1. Labor. List number of men working plus their average number of hours worked weekly. Also give an indication of what they will be doing - winter and summer.

2. Explanation of why labor figure will fluctuate - or how it can be contained. - New proposals.

Section C. Equipment and repair: Included in these figures are mechanical malfunction, and breakdown of mobile equipment, and purchase or spare parts. We would propose - We will prepare lists on tractor units for checkout and repair.

Section D. Gasoline, oil, lubrication.

Section E. New equipment. Attached to this proposal are brochures of various items that are being requested. We will list each piece of equipment and give our reasons for request.

1. Item - explanation.

2. Item - explanation.

3. Etc.

Section F. Utilities, telephone service, etc.

Section G. Materials

1. Chemicals - explanation (brief).

2. Soil conditioners - explanation.

3. Sod to be used - explanation.

4. Peat moss - explanation (if to be standard item in budget).

5. Seed - explanation.

Section H. Fertilizers. We will need ________ also extra lime, etc.

Section I. Miscellaneous expenditures. Grounds beautification (purchase of trees, shrubbery, etc.) - any explanations.

Section J. Mosquito control or some other inexpensive single operation.

Section K. Top dressing mixture - if purchased - we would propose continued purchase of this material as it cannot be mixed by our forces for such a price as we have been paying.

Section L. Special proposal - i.e. uniform service - explanation.

Name
Course Superintendent

_________ COUNTRY CLUB

MAINTENANCE BUDGET - 19__

GOLF COURSE AND GROUNDS

SUMMARY

A.	Supervision Expenses	Amount
B.	Labor	"
C.	Equipment Maintenance and Repair	"
D.	Gasoline, Oil, Lubricants	"
E.	New Equipment	"
F.	Utilities	"
G.	Materials	"
H.	Fertilizers	"
I.	Miscellaneous Expenditures	"
J.	Mosquito Control	"
K.	Top Dressing Mixture	"
L.	Uniform Service	"
		Total Amount

___________COUNTRY CLUB

MAINTENANCE BUDGET - 19__

GOLF COURSE AND GROUNDS

A. Supervision:

1. Expense (turf meetings, conferences (local and national), short courses, magazines, journals, dues, etc. --------) Amounts

B. Labor:

1. Full time attendants
Complete listing of all attendants and their hourly rates. Amounts

2. Additional men for summer work. (April-November) - Hourly rates Amounts

3. Miscellaneous labor cost - night watering, emergency, etc. Amount

Total Labor Amount

C. Equipment maintenance and repair per hole per year on ___holes @ amount/hole

Total Equipment Maintenance Amount

D. Gasoline, oil, lubrication per hole, per year on ___holes @ amount/hole Amount
Fuel oil, furnace, steam jenny, etc. Amount

Total Fuel Amount

E. New equipment

1. Amount
2. Amount
3. Amount

Total New Equipment Amount

F. Utilities

Total Utilities Amount

G. Materials		
1. Chemicals		
a. Fungicides	Amount	
b. Chlordane	Amount	
c. Etc.	Amount	
2. Soil conditioner	Amount	
3. Sod	Amount	
4. Seed		
a. Types of seed @ $____/LB.	Amount	
5. Herbicides	Amount	
6. Aqua-Gro	Amount	
7. Etc.	Amount	
Total Material		Amount
H. Fertilizers		
1. Tees, fairways, rough____ton X analysis	Amount	
2. Greens		
a.	Amount	
b.	Amount	
c.	Amount	
Total Fertilizers		Amount
I. Miscellaneous Expenditures (ground beautification, towels, flagpoles, etc.	Amount	
Total Miscellaneous		Amount
J. Mosquito control X units @ ____ 1 Gal.	Amount	
Total Mosquito Control		Amount
K. Top Dressing Mixture X tons @ _____1 ton	Amount	
Total Top Dressing		Amount
L. Uniform service	Amount	
Total Uniform Service		Amount
Total Budget		Amount

Remarks: Various pieces of new equipment are detailed on the enclosed brochures. We are familiar with the various makes and state that we can get excellent service no matter which pieces are purchased. Below we will give companies who we can receive bids from on the machinery and chemicals. The sod and seed might well come from the same companies as before:

Equipment A	X Company
Equipment B	Y Company
Chemical A	Z Company
Fertilizer C	X Company

Etc.______________________________

FUSARIUM BLIGHT OF TURFGRASSES

Houston B. Couch
Professor, Department of Plant Pathology and Physiology
Virginia Polytechnic Institute and State University

In 1959, a severe foliar blighting was observed on Merion Kentucky bluegrass in southeastern Pennsylvania. The symptom pattern did not fit that of any of the known foliar diseases of turfgrasses, and isolations from diseased leaves only yielded pathogenic organisms that were known to incite symptoms distinctive from those observed for the disease in question.

During 1960 and 1961, this same disease was found occurring on Merion Kentucky bluegrass, bentgrasses and creeping red fescues in eastern Pennsylvania, eastern Ohio, eastern New York, New Jersey, Delaware, Maryland and the District of Columbia. Beginning in 1960, and continuing through the following three growing seasons, plant and soil samples were collected from diseased turfgrass stands over the geographic area outlined above.

The isolations from diseased leaves consistently yielded two fungus species -- Fusarium roseum and Fusarium tricinctum f. sp. poae. Both of these organisms were known to be turfgrass pathogens, but had not been identified as foliar parasites. Fusarium roseum was known to cause a root and crown rot of turfgrasses, while tricinctum had been recognized for several years as the cause of "silver top", a disease of turfgrass floral tissue.

Pathogenicity tests with isolates of these two fungus species were made on Merion Kentucky bluegrass, Highland bentgrass, and Pennlawn creeping red fescue. While some of the isolates were weakly pathogenic, a very high percentage of those tested incited 100 per cent foliar blighting within 2 to 5 days from the time of inoculation. With further research, it was learned that the syndrome of this disease consisted of two phases - (1) blighting of the foliage and (2) a crown and root rot. Because of the predominant foliar symptom pattern, the disease was named "Fusarium blight."

Symptoms. - In overall view, affected turfgrass stands first show scattered light green patches 2-6 inches in diameter. Under environmental conditions favorable for disease development, the color of these patches changes in a 36-48 hour period to a dull reddish brown, then to tan, and finally to a light straw color. Initially, the shapes of the patches are elongate streaks, crescents, or circular patches.

The most characteristic feature of the gross symptomatology is seen in the later stages of disease development. At these times, there are present more or less circular patches of blighted turfgrass 1-3 feet in diameter. Light tan to straw colored, they often have reddish brown margins 1-2 inches wide and contain center tufts of green, apparently unaffected grass. This combination produces a distinctive "frog-eye" effect. When optimum conditions for disease development exist for an extended period of time, these affected areas coalesce. As a result, large areas of turfgrass may be blighted. Leaf lesions originate both at the cut tip and at random over the entire leaf. At first, lesions appear as irregularly shaped, dark green blotches. These rapidly fade to a light green, then assume a reddish brown hue, and finally become a dull tan. Individual lesions may involve the entire width of the leaf blade and may extend up to 1/2 inch in length.

Turfgrass plants affected primarily by the root rot phase of the disease are stunted, pale green in color, and do not readily recover from mowing or adverse weather conditions. Their roots are characterized by a brown to reddish-brown dry rot. As the disease progresses, these roots become darker in color due to the colonization of soil saprophytes. During periods of relatively high soil moisture, the pinkish growth of the pathogens can be seen on the root and crown tissue near the soil surface.

Disease Cycle - Both species of Fusarium spp. have been reported to be transmitted on turfgrass seed, and are known to be capable of surviving as soil saprophytes. These two sources constitute the main reservoirs of primary inoculum for the development of the disease in newly seeded stands of turfgrass. In established turfgrass, the main sources of inoculum are dormant mycelium in plants infected the previous season and thatch that has been colonized by the pathogens.

Infection of the leaves is accomplished by both germinating macroconidia and mycelium from the saprophytic growth of the pathogens on the thatch and other organic matter. The highest frequency of primary infections probably originates from the latter source. Macroconidia germinate 12 hours from the onset of favorable environmental conditions. Penetration of intact leaf surfaces occurs at the junction of epidermal cells. At the points of direct leaf penetration, there are no observable changes in hyphae morphology, nor is degradation of the host cell walls evident.

The most common area of penetration of foliage by the pathogens appears to be the cut ends of the leaves. With both direct penetration and entry through cut leaf tips, mycelial movement is direct intercellular over an area of 12 or more cells and then it becomes intracellular. Penetration of individual parenchymatous cells is usually characterized by a pronounced constriction of the mycelium at the point of passage through the cell wall.

Certain isolates of F. roseum and F. tricinctum have been shown to vary in their temperature requirements for optimum pathogenicity. As a general rule, however, the foliar phase of Fusarium blight is most severe during prolonged periods of high atmospheric humidity with daytime air temperatures of 80^{o} - 95^{o}F. and night air temperatures of 70^{o}F. or above.

Turfgrass grown under deficient calcium nutrition is more susceptible to Fusarium blight. Incidence and severity of the disease is also greatest under conditions of high nitrogen fertilization. Also, the development of Fusarium blight has been reported to be greater in turfgrass when the soil moisture content has been allowed to be extracted to the permanent wilting percentage.

Control. - Cultural Practices. While high nitrogen fertilization does increase the susceptibility of turfgrass to Fusarium blight, it is unlikely that a significant reduction of the disease can be effected by reducing nitrogen levels. In general, the level of nitrogen fertilization required to significantly reduce the severity of Fusarium blight is well outside the range necessary to meet the basic nutritional requirements of the grass. From a field standpoint, then, nitrogen fertilization, and its effects on the disease, should be considered with respect to thatch management.

Since the thatch serves as the major reservoir of inoculum in established stands of turfgrass, a successful program of Fusarium blight control requires that the quantity of this material be held to a minimum that is consistent with the proper management of the grass species in question. For most turfgrasses, this optimum thickness is approximately 1/2 inch. In order to keep the Fusarium blight potential of a stand of turfgrass to a minimum, then, increases in the rate of nitrogen fertilization should be balanced with concurrent increases in the intensification of the thatch management program.

Resistant Varieties. Ranked in order of susceptibility to Fusarium blight, the bentgrasses are the most prone to the disease. The Kentucky bluegrasses are next in susceptibility, with the fescues being most resistant. Among certain varieties of Kentucky bluegrass, the range of susceptibility to *F. roseum* and *F. tricinctum* is determined by a complex interaction of air temperature and pathogen and host genotypes.

Chemical Control. A preventive fungicide program, coupled with thatch control, is essential for effective control of Fusarium blight. The fungicide application should be made immediately after the first occurrence of night temperatures that do not drop below 70°F.

For most effective control of Fusarium blight, spray 1000 square feet with 6 gallons of water containing 5-8 ounces benomyl 50% WP. The total amount of benomyl applied to the turfgrass within 1 calendar year should not exceed 8 ounces.

"WHAT'S NEW IN TURFGRASS RESEARCH"

John R. Hall
Assistant Professor
Agronomy Department
University of Maryland

The turfgrass research program at the University of Maryland is expanding rapidly. Some of the experiments initiated by Drs. Deal and Powell are now providing very valuable research information. Turfgrass research is conducted at the University of Maryland Plant Research Farm near Fairland, Maryland and over the entire State of Maryland. Your cooperation and assistance in helping us find sites for research has been greatly appreciated. The Maryland turfgrass research program is designed to find solutions to problems that exist across the entire turfgrass industry. Experiments are currently being conducted to provide solutions to problems existing in the sod industry, on home lawns, on golf courses, on athletic fields, parks, highway roadsides, airports and in cemeteries. We hope that this research will be of value to all of the people managing the more than 250,000 acres of turfgrass in the State of Maryland.

I would like to elaborate upon the research being conducted that is pertinent to golf course superintendents. There are 17 different experiments being conducted throughout the State of Maryland to evaluate varieties of Kentucky bluegrass, creeping red fescue, tall fescue, and perennial ryegrass. To date 5 years data have been collected on the Kentucky bluegrass trials. Varieties that are performing extremely well at the $1\frac{1}{2}$'' mowing height are: Warrens A-34 and A-20, Fylking, Birka, Georgetown, Orion and blends of Merion, Fylking and Pennstar. At this time the commercial availability of Birka, Georgetown and Warrens A-34 is limited. Disease resistance is desired in all turfgrass varieties. Extreme resistance to Helminthosporium leaf spot has been observed on Sydsport, NJE P-56, Warrens A-20, Merion, and Fylking and blends of Merion, Fylking and Pennstar. Thatch data was taken on these 5 year old plots during the 1973 season. After 5 years considerable amounts of thatch had accumulated on varieties such as Vantage, Pennstar, Fylking, Birka, Sodco, NJE P-35, PSU K-107, Orion and Warrens A-10, A-20 and A-34. The lower rates of thatch buildup were found on the more common Kentucky bluegrasses such as Cougar and Primo.

Additional Kentucky bluegrass trials were seeded in the Spring of 1972 and are being maintained at a 1'' mowing height. This particular trial is important because there are many new varieties not utilized in the 1968 trials. Varieties performing very well in the first year following establishment were Fylking, Baron, Vantage, Monopoly, Parade, a blend of Vantage and Victa, and Warrens A-34. This trial maintained at the 1'' mowing height should provide some valuable information to golf course superintendents. Traffic is to be imposed on these varieties beginning with the 1974 season.

In a trial initiated in the fall of 1972 on the Eastern Shore very good drought tolerance data was obtained following the month of July, 1973 when the site received 1.25'' of rain over an approximate 40 day period. Individual varieties exhibiting very good drought tolerance and recovery were Merion, Kenblue, Baron, Georgetown, Vantage, NJE P-59, Sodco, Adelphi and Parade. Blends performing well under these drought conditions were Merion and Kenblue, Vantage and Windsor, NJE P-57, 30% Merion-30% Kenblue-30% Adelphi and 10% Creeping red fescue, 30% Merion-30% Kenblue-30% Victa and 10% Jamestown, 40% Victa and 60% Vantage, 95% Merion and 5% Manhattan and 90% Merion and 10% Jamestown. Later in the year *Fusarium* spp. attacked these same plots. Varieties exhibiting resistance to *Fusarium* spp. were: Kenblue, NJE P-151, Parker Shirling #2, Vantage, Sodco and blends of Nuggett and Park, NJE P-57 and NJE P-59, 30% Merion-30% Kenblue-30% Adelphi and 10% Jamestown Creeping Red Fescue, 30% Merion-30% South Dakota Certified-30% Victa and 10% Jamestown Creeping Red Fescue, 30% Merion-30% Kenblue-30% Victa and 10% Jamestown Creeping Red Fescue, 40% Victa and 60% Vantage, 95% Merion and 5% Manhattan perennial ryegrass and 90% Merion and 10% Jamestown.

These variety trials will be continuously maintained in an attempt to provide golf course superintendents throughout the State of Maryland with variety performance information which is valuable to them. Perennial ryegrass trials have been established and data will be taken on 15 different perennial ryegrass selections at mowing heights of 0.75 and 1.5" beginning with the 1974 season.

Continuous testing of new herbicide materials is an important part of a viable turfgrass research program. Experiments are currently being conducted at Laurel Pines Country Club through the cooperation of Mr. Gilbert Shapiro. Endothal is being evaluated as a *Poa annua* herbicide. It is being applied at rates of 0, 4, 6 and 8 lbs active ingredient per acre. The initial treatments were applied in the fall of 1973 and will be repeated in the spring of 1974. Fall 1973 observations indicate that the 8 lb rate is providing satisfactory reduction of *Poa annua* without injury to the existing bluegrass.

Registered and experimental turfgrass preemergence herbicides are continuously being evaluated. In a study initiated by Dr. Elwyn Deal, continued by Dr. A. J. Powell and completed in 1973 some very interesting effects of repeated applications of preemergence herbicides to Kentucky bluegrass turf have been noted. This particular experiment was conducted on a Kentucky bluegrass creeping red fescue turf at the University of Maryland Plant Research Farm near Fairland, Maryland. The turf was maintained at a 1" mowing height and was annually overseeded with crabgrass. The experiment began in the spring of 1966 and was conducted through the spring of 1972. During this time experimental materials were applied each spring. Commercial materials evaluated in this experiment were bandane, balan, betasan, dacthal, tricalcium arsenate and siduron. The best combination of crabgrass control and turfgrass quality was achieved with betasan, tricalcium arsenate and a new material called A-820 (No-Crab) (Table 1). The only problem foreseen with this new material (No-Crab) is that the granular formulation is extremely light and might be difficult to handle. Both granular and emulsifiable concentrate formulations have been tested and granular formulations consistently improve the effectiveness of preemergence chemicals. Creeping red fescue was notably removed from the tricalcium arsenate and bandane plots. Dacthal slightly reduced the population of creeping red fescue but not as seriously as tricalcium arsenate and bandane.

Table 1. Effect of chemicals on preemergence crabgrass control and turfgrass quality at the 1972 Plant Research Farm, Fairland, Maryland.

Treatment	Formulation	Rate (lb a.i./a)	Smooth Crabgrass in Plot 7/21/72 (%)	Smooth Crabgrass in Plot 9/8/72 (%)	Turfgrass Quality 7/21/72 (Rating)[x]	Turfgrass Quality 9/8/72 (Rating)
Bandane	10 G[z]	35	0	0	3.2	2.5
Benefin	2.5 G	2	6	16	6.0	5.5
Ca_3AsO_4	48 G	187	0	0	7.2	5.0
Bensulide	12.5 G	12.5	0	0	6.0	6.5
DCPA	74 WP	9	10	25	6.0	6.0
A-820	2.3 G	4	0	8	6.0	5.7
A-820	2.3 G	5	1	26	6.5	5.7
A-820	2.3 G	6	0	5	5.2	6.0
Siduron	50 WP	12	28	57	5.0	5.0
Check		0	79	80	3.9	5.0
Bayes 5% LSD[w]			11	18	0.9	0.5

[w] Duncan, D. B. 1965. A Bayesian approach to multiple comparisons. Technometrics 7:171-222.

[x] Turfgrass quality ratings made on a 0-9 scale where 9=maximum turfgrass quality, 6=acceptable turfgrass quality and 0=bare soil. Quality estimate includes uniformity, density, texture and smoothness.

[y] Bandane, Benefin, Ca_3AsO_4, Bensulide, DCPA and Siduron were applied annually from 1966-1972 and A-820 only in 1972.

[z] The abbreviations are G=granule, EC=emulsifiable concentrate and WP=wettable powder. The number in front of: G is % active ingredient, WP is % active ingredient and EC is lb a.i./gal.

Continuous application of bandane and tricalcium arsenate significantly reduced the number of roots at the 3" depth (Table 2). The number of roots at the 3" depth were reduced 82%, 52%, 29% and 26% respectively by bandane, tricalcium arsenate, balan and betasan. Siduron and dacthal had little negative effect upon the number of roots at the 3" depth.

Table 2. Residual effect or preemergence crabgrass control chemicals applied on April 18, 1972 upon root counts taken at a 3 and 6 inch depth on April 12, 1973[x], Plant Research Farm, Fairland, Maryland.

Treatment	Formulation	Rate (lb a.i./A.)	Root Count/1.8 sq. inches 3 inch depth (Number)	6 inch depth (Number)
Bandane[x]	10 G	35	5.5 a[y]	5.7 a
Benefin	2.5 G	2	22.0 bc	17.2 b
Ca_3AsO_4	48 G	187	15.0 ab	15.7 b
Bensulide	12.5 G	12.5	23.0 bc	14.2 ab
DCPA	75 WP	9	27.2 c	17.5 b
A-820	2.3 G	6	26.5 bc	17.0 b
Siduron	50 WP	12	32.7 c	21.0 b
Check		0	31.0 c	20.8 b

[x]Bandane, Benefin, Ca_3AsO_4, Bensulide, DCPA and Siduron were applied annually from 1966 through 1972 and A-820 only in 1972.

[y]Columnar means with the same letter are not significantly different at the 5% level of significance using Duncan's Multiple Range Test.

[z]The abbreviations are G=granule and WP=wettable powder. The number in front of G and WP is % active ingredient.

Those superintendents who are interested in renovation chemicals will be interested in the new material coming on the market during the 1974 season called glyphosate (Roundup). The materials such as Paraquat and dalapon have several disadvantages. Paraquat is quite toxic to humans. The fact that it is not translocated to rhizomes makes it relatively ineffective against the common perennial weed grass problems such as quackgrass and bermudagrass. Dalapon has the extreme disadvantage of requiring a 60 to 90 day wait before seeding can be safely accomplished. The Roundup material is translocated to rhizomes and allows one to come in and spray as late as the middle of August; wait 10-14 days for regrowth, respray and seed shortly after the last spray. There is no injury to new seedings with the Roundup material as it is inactivated by soil contact. Glyphosate has been tested at the University of Maryland on quackgrass and has been found to be almost twice as effective at the 3 lb active ingredient rate as a 10 lb rate of dalapon (Table 3). This chemical holds much promise for the turfgrass industry.

Table 3. Effect of herbicides applied June 15, 1972 on Quackgrass Control measured in April 1974.

Treatment	(lb a.i./A.)	Quackgrass Control[x] 4/19/73 (%)
Dalapon	5	31
	10	46
Pronamide	1.5	17
	3	27
Glyphosate	1.5	45
	3	82
Check		0

[x]Total number of quackgrass tillers in each plot was determined. Individual control values were calculated.

Studies are being conducted to evaluate the effectiveness of herbicides such as Basagran, Destun and DSMA + 2,4-D for control of yellow nutsedge. The Basagran and Destun materials are not on the market at this time. The current disadvantage of combinations of DSMA and 2,4-D relate to the fact that they do sometimes burn turf when temperatures are above $85^{\circ}F$ in the presence of dry soils. The Basagran and Destun materials appear to be less phytotoxic under similar conditions.

Attempts to suppress bermudagrass with applications of Siduron have met with mixed success. Results after 3 years of study have been less than exciting. The best results are currently being achieved with 40 lb active ingredient per acre applications. The two most promising treatments were applied 20 lbs in May and 20 lbs in June or 40 lbs in May. It is possible that beginning the applications in April might create more successful control. With this in mind our 1974 studies have been planned to investigate this possibility. Fall verticutting and overseeding have been as successful in reducing bermuda encroachment as the individual siduron treatments.

Plots were established by Dr. Hawes last year in an attempt to find better tee turf for the transition zone. The main emphasis in these studies will be to evaluate the warm-season grasses, Zoysia and bermuda, in combination with the cool season grasses, Kentucky bluegrass and creeping bentgrass. Two variations of the management practices of topdressing and fertilizing will be imposed on these combinations. They will be maintained at a one inch height and traffic will be applied artificially. Hopefully results from these studies will help to make golf course tee management a little easier.

Work conducted by Gregory Richards at the University of Maryland to determine if there is a varietal response to air pollution damage has substantiated that there are, in fact, varietal differences in susceptibility to air pollution injury. Varieties that are exhibiting resistance to air pollution are Newport, Merion, Windsor and Fylking. Varieties extremely susceptible to air pollution are South Dakota Certified and Kenblue.

The University of Maryland turfgrass research program in the Department of Agronomy is continually expanding in an effort to provide you with new information about materials coming on the market. As this turfgrass research program expands its emphasis continues to be directed toward the solution of practical problems affecting the Maryland Turfgrass Industry in hopes that the production of qualty turfgrass throughout the State of Maryland can be achieved.

WHY AND WHEN TO RENOVATE

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The dictionary defines the word "renovate" as "to restore to life and vigor." This word and its definition is especially meaningful when used in connection with turfgrass. Renovation is the technique or procedure used to bring turf back into good condition. Renovating can imply anything from merely removing thatch to complete removal of all vegetation, reworking the soils, and completely reseeding. However, renovation is generally practiced where the stand of living, desirable turfgrass species is so poor that the area cannot be improved readily through routine cultural or management practices but is sufficient to be saved. Renovation often includes some reseeding.

Turfgrass renovation is certainly not a new concept in turfgrass management. It has been practiced for many years, and I feel pretty safe in saying that there will always be a need for renovation practices, especially on older established turf areas. Over the last 50 to 75 years there has been great progress in turf maintenance but perfection and permanency of turfgrasses is still an elusive characteristic. We are still confronted with forms of turfgrass deterioration or failure which call for some method of renovation. It reminds me of the television commercial or advertisement for a certain brand of cigar where the guy says "sooner or later we're going to get you". Sooner or later, on turf areas of any size renovation will be required. On golf courses where turf is heavily used, this is more likely to be sooner, than later.

Light renovation in contrast to extensive renovation implies limited work while leaving the golf course in play as the work is accomplished. Therefore, timing becomes important. The objective is to perform the work as quickly as possible and with as little interference of play as possible. The time must be chosen with consideration for weather factors which would influence the reestablishment of grass; a time when labor is available; a time when play is not too heavy; and at a time when funds are available.

There is widespread agreement that fall is the best time to renovate cool-season grasses. Spring is the next best time. Growing conditions for the reestablishment of the grasses are more favorable in the fall. Seed germination and seedling growth are faster and there is less chance of weed establishment. Also, the cool-season turfgrasses have the advantage of a much longer favorable growing period before having to meet the hot, unfavorable summer-growing period. Fall renovation usually permits a much better distribution of labor. The best time to renovate warm-season grasses is in the spring or early summer when the grass grows more vigorously.

Improperly timed renovation frequently results in weed invasion. The peak *Poa annua* and crabgrass germination periods should be avoided when possible. Poa annua germination is at a peak in the fall when daytime soil temperatures are less than $80^{o}F$ and night temperatures are 50^{o} to $70^{o}F$. Crabgrass generally germinates in the spring anytime after soil temperatures exceed $65^{o}F$. If spring renovation is necessary, the renovation of cool-season grasses should be done early enough to allow the turfgrasses to recover or become established before crabgrass germination begins in late April or early May. Preemergence herbicides should be used to alleviate weed problems following poorly timed or spring renovation of warm-season grasses. Siduron is the only herbicide that we know can be used safely to control crabgrass at the time of seeding of cool-season grasses.

Bentgrass, because it does not respond well to colder weather, should be renovated as soon after the Labor Day weekend as possible. The timing of renovation of Kentucky bluegrass turf is less critical because it responds to cool temperatures better and can, if properly managed, successfully compete with *Poa annua*. However, when Kentucky bluegrass is mowed to 3/4-inch height, annual bluegrass will persist, if established.

The greatest burden on the superintendent faced with a need for improvement is the decision of whether to renovate or not to renovate, and the method and degree of renovation required to produce satisfactory results. Despite scientific effort, the best decisions to these questions still largely remain a part of the ART of turfgrass management. The degree of renovation required is determined by the basic cause(s) of the deterioration of the turf in the first place. If surface soil compaction was the cause of poor turf, light renovation may be all that is necessary. If the grass species is unsatisfactory, then extensive renovation would be required. When demand for use of the turf area is great, such as on greens, collars, and tees, and improvement is needed, light renovation may result in satisfactory results temporarily and more extensive renovation accomplished later.

Before renovation the cause of turf deterioration should be determined; what caused the poor turf in the first place? Some of the most common causes of turf deterioration are: a) poor maintenance practices; b) injury due to insects, diseases, and winterkilling; c) improper soil fertility and unfavorable soil reactions. Once the cause is determined, corrective steps should be made before renovation or during renovation to correct the existing problem and then set up the required maintenance program to prevent its reoccurrence.

Practices such as fertilization, watering, mowing, and control of diseases, insects, and weeds are normally performed in a routine maintenance program. Failure to perform satisfactorily or adequately one or more of these practices will lead to a decline in turf quality. If such is allowed to persist, renovation will eventually be required to restore the turf.

When diagnosing turfgrass difficulties, visual observations will sometimes disclose many obvious problems, but more often do not reveal the basic causes of poor turf. Diseases and weeds may not be basic causes of poor turf. They may result because of poor turf. They often come in as the turfgrass weakens. A renovation program must include other practices in addition to those that control diseases and kill weeds.

Two basic reasons for loss of turf, especially in the Mid-Atlantic Region, are compaction of the soil and an excess thatch layer on the surface of the soil. Either one or both of these conditions can lead to partial or complete loss of turf. These two conditions, either singly or in combination, produce, contribute to, or aggravate the maintenance of good healthy turf. This may sound rather exaggerated, but even a hurried analysis of turf problems occurring from day to day will prove the statement correct. Thatch or compaction when developed beyond an acceptable level, interferes with watering, fertilizing, disease and insect control, and mowing.

Compaction and thatch buildup are gradual developments; therefore, if we can prevent, control, or eliminate them as they develop, we might eliminate the need for renovation later.

Soil Compaction

The adverse effects of soil compaction vs. good physical condition of soil as related to proper drainage and aeration have been emphasized repeatedly in turf conferences, the professional journals, and trade magazines for the past 30 years. Turf grown on compacted soils is shallow rooted and less vigorous. To understand why this is so, perhaps it would be well to reiterate some of the principles involved.

Soil is composed of solid particles and pore spaces. The pore spaces are filled with air and water. It is the relative amount of air and water in pore spaces that is critically important to good plant growth. The relationship between air and water is determined by the size, number, and continuity of pores present. In a soil with good physical structure the small pores adjacent to the soil particles are surrounded by a thin film of capillary water and the remaining larger pores are filled with air. Following a rain or irrigation, water drains from the large pores and air diffuses in. Thus, good drainage and aeration go together; they cannot be separated. In a well-aggregated silt loam soil, after drainage to field capacity, the pore space would contain about 50% water and 50% air.

The amount of space that is filled with air at any one time is referred to as the air porosity. Aeration, the exchange of air in the soil with that in the atmosphere, is necessary to supply the plant roots with oxygen for respiration and the removal of excess carbon dioxide and other potentially toxic gases from the soil. Aeration is brought about by diffusion. Air, containing oxygen, diffuses through the air-filled pores of the soil, oxygen dissolves in water and diffuses through the water to the root. Carbon dioxide, produced by respiration, follows the same general process out of the soil. The diffusion rate of oxygen through the pore spaces is directly proportional to the fraction of soil which is air. In other words, the greater amount of air space, the faster diffusion will be.

Compacted soils differ from non-compacted soils principally in the size, number, and arrangement of pore space. Soil particles are compressed or squeezed together reducing the pore space. As the particles move, the large pore spaces are filled first. Thus the ratio of large pores to small pores is changed. This change in ratio is important because the large pores are responsible for entry of water and air into the soil while the small pores are more related to the water held in the soil. As the degree of compaction increases, soil aeration is decreased inversely to the point where respiration and root growth is restricted. Death of the root system eventually occurs. Severely compacted soils can also mechanically impede root penetration through the soil.

Roots need oxygen for respiration. Equally important, though perhaps not so well recognized, is that oxygen is required for the uptake of mineral nutrients and water from the soil. Without the presence of oxygen the plants suffer from malnutrition or desiccation even though the soil may contain sufficient quantities of water and essential elements for good growth.

Considerable variation exists in values of oxygen reported as being critical for the growth of different grass species; thus, no single value can be given as optimum or minimum. In general, grasses appear to be more tolerant of low oxygen levels than many other agronomic and horticultural crops. This has resulted in the misconception that frequent and light irrigation can supply a sufficient amount of oxygen for root growth. If drainage is excellent, as on well-constructed sand greens, some of the water-tolerating grasses, such as <u>Poa annua</u> and creeping bent, may survive on the oxygen in fresh water. However, in most cases, especially during hot weather, the rate of oxygen diffusion in water may be inadequate to supply sufficient quantities for root growth. Oxygen diffuses about 10,000 times faster in air than in water.

Water management becomes impossible or extremely difficult on compacted soils. Water infiltration is reduced and the amount of surface runoff is increased. High areas are usually dry. Water must be applied more often to meet the needs of the turf. Low areas are wet, water will not go in, roots become shallow, hot weather arrives, diseases flourish, and the grass stand is partially or completely lost. Some of the effects of soil compaction are summarized in the diagram to follow.

SOIL COMPACTION

REDUCED:	MECHANICAL	REDUCED:
INFILTRATION	IMPEDENCE	AERATION (O_2)
PERCOLATION	ROOT GROWTH	RESPIRATION
DRAINAGE		WATER-NUTRIENT UPTAKE
INCREASED:		INCREASED:
RUN-OFF		CARBON DIOXIDE

SHALLOW ROOTS

UNHEALTHY TURF

DISEASE + WEEDS

RENOVATION

Soils vary greatly in compactibility depending on various soil properties. Soil moisture content has a great influence on compactibility. Water acts as a lubricant and allows the particles to slide together more easily in moist soil than in dry soils. Results of studies on the effects of moisture on soil compactibility indicates that compaction of most soils is greater at field capacity and decreases as moisture level decreases. Therefore, frequent irrigation, or irrigation under a set schedule which keeps the soil relatively wet, would increase compaction.

Soil texture also influences compactibility. Fine-textured soils such as clays are far more prone to compaction than coarse-textured soils. A multicomponent sand composed of several size fractions favors compaction. Maximum compaction occurs when sizes allow tetrahedral packing with films of clay surrounding all particles. Soil modification with coarse-textured sands or similar coarse materials such as calcined clay can reduce the potential of soil compaction. This is the reasoning behind the "Sand Green." If we substitute for a soil a carefully sized sand, compaction is reduced to a minimum and the large particles provide for the large pores necessary for aeration. If irrigation is available, the low water-holding capacity of sands can be overcome. Today, this is the best answer we have to compaction for specialized areas including greens. On larger turfed areas it is not a suitable answer for economical reasons.

Soil compaction on golf courses results from traffic of players and the operation of maintenance machinery. Compaction developes gradually until it reaches a detrimental level. The rate of development is directly related to the amount and intensity of traffic. If steps are taken to prevent or eliminate compaction as it builds up, then perhaps the need for extensive renovation later could be prevented.

What are some of the management practices which will prevent or minimize compaction? Soil modification and water management have already been mentioned as factors which influence compaction. Aerification, especially coring, is a very effective practice to control or relieve compaction when performed at adequate intervals and intensity. Most superintendents are already carrying out aerification on a continuing basis but in many cases the intensity and frequency are inadequate to prevent a serious situation from developing.

The frequency at which different areas of the golf course should be aerified can probably best be governed by the relative amount of traffic on each area. On highly trafficed areas monthly aerification may be necessary. A couple of times a year may be adequate for areas of little or no traffic. Areas around the clubhouse, or approaches to greens and tees should be the most frequently aerified parts of the golf course. Tees and greens would probably be the next, followed by fairways. Aerification can be performed at most any time of the year. However, I would avoid aerifying when the soil is very wet or very dry.

Traffic control is an important factor in minimizing soil compaction. Traffic should be held to a minimum on wet soils, and if possible, measures should be taken to prevent traffic from being concentrated in one area. Traffic can be directed out of wet areas or diverted around excessively used areas through the proper placement of trees, shrubs, traps, walks, and temporarily with fences, chains, posts, and similar objects. Cup setting locations on greens can be planned so that the exit and entrance patterns to the greens are varied. Operating equipment in the same wheel tracks intensifies compaction. Golf carts, if not kept on paths, can cause severe compaction. During the spring thaw when the top inch or so of soil has thawed, compaction potential is greatly increased. During this period traffic should be controlled to a very minimum or the course closed.

Thatch

Thatch, as we know it, is a tightly intermingled layer of living and dead stems, leaves, roots, and stolons of grass which develop between the layer of green vegetation and the soil surface. Basically, thatch is a crop residue problem and will build up any time the rate of production of plant material exceeds the rate of decomposition. Some of the things usually associated with excessive thatch buildup are dry spots, spotted appearances--shades of light and dark green, footprinting, poor response to fertilizers, and a series of disease and insect problems.

A limited amount of thatch is usually considered desirable because it provides some resilience to the turf; protect crown tissues from frost damage; dissipates soil compaction forces, increases wear tolerance, releases some nutrients, conserves moisture, and buffers the soil against extremes in air temperature. It also reduces weed infestation because the thatch layer is not favorable for seed germination. A thin layer of thatch on a golf course putting green produces a better putting surface and helps to hold shots. We don't have to be concerned with not having enough thatch. It is almost impossible to grow a turf completely free of thatch.

When thatch accumulation becomes excessive, i.e., over approximately 1/4-inch on greens and 1/2-inch on higher mowed turf, it becomes undesirable. Excessive thatch accumulation intercepts and retards the downward movement of fertilizers and pesticides. The interception of nutrient elements often results in erratic response to fertilization. Thatch provides an excellent habitat for turf diseases and insects and reduces the effectiveness of fungicides and insecticides; thus pest control becomes more difficult. Heavily thatched turf turns brown quicker following cold weather, and remains brown longer than thinner turf due to the insulating effect of thatch.

Thatch restricts the movement of water and air to the soil. When it becomes dry, it's hydrophobic and sheds water causing dry spots and uneven turf growth. Saturated thatch is slow to dry, thus enhancing disease problems. Turfgrass roots grow on the soil surface or in the thatch layer itself because this is where the nutrients and moisture are located. Thatch interfers with overseeding. If overseeding is desired, thatch must be removed to allow contact of the seed with soil for good germination. Thatch accumulation eventually results in fluffy, spongy, uneven turf that is difficult to mow without scalping.

The overall effect of thatch buildup is a turf low in vigor, easily subject to drought, and often infested by disease and other pests. The weakened turfgrass plant is easily injured by any stress condition which may develop as a result of adverse environmental conditions. So if we are going to produce high quality turf with a minimum of effort and expense, we must be alert to potential thatch related problems and consider the effects that any mangement practice may have on thatch buildup.

Thatch accumulation is affected by many factors all operating simultaneously. Some of these factors are under the turf manager's control, others such as temperature are not. Any condition that upsets the organic matter production-decomposition balance favors thatch development. Thus, anything that increases vegetative production and subdequent death of plant parts, or anything that slows down the rate of decomposition favors thatch accumulation.

Let us take a look at some of the factors usually associated with excessive thatch accumulation. Excessive rates of fertilization produce more dry weight which must decay or produce thatch. A fertilization program that releases nutrients, especially nitrogen, at a rate that results in good but not excessive growth aids in preventing thatch buildup. High and infrequent mowing, especially of stoloniferous grasses, such as bermuda and zoysia, favor thatch buildup. If the creeping bentgrasses are not mowed short enough they form thatch rapidly. Some of the newer vigorous turf varieties of high density are believed to contribute to the thatch problem.

Microorganisms that decay organic matter must have oxygen. Therefore, thatch accumulation would be enhanced by poor soil aeration resulting from excessive applications of water, poor drainage or from soil compaction. Also, the microorganisms require near neutral conditions. So acid soils, or thatch layers that are acid, may enhance thatching. The use of certain pesticides that destroy microorganisms have been reported associated with thatch buildup. Chlordane, dieldrin, and tricalcium arsenate are three such materials.

If thatch accumulates rapidly the turf manager should review these factors to see which may be causing the thatch to accumulate. He should change those practices over which he has control to slow the rate of accumulation and incorporate preventive thatch practices into the turfgrass management program. Although thatch management practices such as cultivation and topdressing are a necessary part of every turfgrass management program, I feel that under many conditions the modification of nutrition, mowing, and irrigation programs, will reduce the frequency at which these practices are necessary. Once thatch has accumulated to a detrimental level, it takes pretty drastic steps to remove it. Curative practices are expensive, time-consuming, and extensive injury to the existing turf will likely result. For these reasons, the turf manager should think in terms of thatch prevention or control and not thatch eradication.

The most effective and desirable control practices have been those that encourage microbial decomposition. The most effective means to accomplish this is to get soil in contact with the thatch layer. On closely mowed turfs, such as greens, topdressing with a soil mixture, or topdressing combined with coring, is generally considered the most effective in encouraging thatch decomposition. Most superintendents have been doing this for years. However, topdressing is expensive and good materials are hard to locate so it is usually practiced only on small areas like greens. On larger areas thatch can be controlled to varying degrees by aerification (coring), spiking, slicing, and vertical mowing, or combinations of these. Coring has been more effective where the cores are not removed and the soil from them worked back into the thatch.

I would like to briefly report results obtained from a thatch study started by Dr. Juska at Beltsville in 1963. Although this study was oriented toward the homeowner or home lawn conditions, I expect the results would be applicable under some conditions found on the golf course as well. The objective of this study was to determine the effectiveness of several management practices alone, and in various combinations, on preventing thatch accumulation in Kentucky bluegrass.

The three sets of treatments arranged in a split-split plot design were:

A: Whole-plot treatments
   1) clippings removed
   2) clippings not removed

B: Sub-plot treatments
   1) lime applied to maintain pH 7
   2) lime applied in spring and fall - 10-15 lb/1000 ft^2 of agricultural limestone (pH 6.8)
   3) check - no lime applied (pH 5.4)

C: Sub-sub-plot treatments
   1) aerified (coring) - removing 3/8 inch cores approximately 2 inches deep on a 2-inch centers. Cores were broken up with a verticut machine and left on the plot.
   2) verticut - using a vertical mower with blades spaced 1 inch apart to mechanically remove thatch. Thatch brought to surface was raked from the plots.
   3) handraking - using hand thatch rakes which are used frequently on home lawns.
   4) wetting agent (Aqua-Gro) - applied at 8 oz. of A.I. in 10 gal water/1000 $ft.^2$.
   5) additions of organic matter (milorganite) - at 5 lb/1000 ft^2.
   6) check - no treatment

Sub-sub-plot treatments, except the wetting agent, were applied twice a year: in the spring, the last of March or first of April, and in the fall, the first of October. Applications of the wetting agent were made four times a year--the first of April, June, August, and October.

Uniform fertilization, irrigation, and height of mowing were applied to all plots. Ammonium nitrate was applied at 1 lb of N/1000 ft^2 as needed to maintain a moderate growth rate. This resulted in the application of 4 to 5 pounds annually. Phosphorus and potassium was added according to soil test recommendations. Plots were mowed once a week at 2-1/4 inches. The area was irrigated two to four times each year until 1973. The summer and fall of 1973 were drier than normal and water was applied five times. Thatch measurements were made in December or January each year.

Thatch accumulation increased from year to year for the first 5 years of the study, but accumulation was not excessive on any plots and there was no significant difference among the treatments or between any treatment and the check. Thatch is usually not a problem in Kentucky bluegrass turf until 3 to 4 years after seeding. The last 4 years, certain treatments have resulted in somewhat stable thatch levels and differences between treatments have been significant.

Permitting clippings to remain on turf contributed to thatch buildup on all plots the last 3 years except those that were aerified or verticut. There seems to be a critical thatch level at which clippings do not decay very rapidly and become a contributing factor to thatch buildup. The critical level in this study was approximately 1/2 inch. At this level curative measures become necessary. Below this level, clippings either come in contact with the soil, or they are close to the soil, in an environment conducive to microbial decay and contribute very little to the thatch layer.

Turf quality was increased by leaving clippings on the plots, especially during high temperature and moisture stress periods. This is probably due to the plant material acting somewhat as a buffer against soil temperature buildup and moisture conservation. Added nutrients from decay may have also been a contributing factor.

Maintaining a pH 7 and biannual lime applications (av. soil pH 6.0) significantly reduced thatch accumulation when compared with the check with an average pH of 5.4. The smallest amount of thatch buildup was on plots receiving lime twice a year. This indicates the importance of maintaining favorable conditions for the microorganisms responsible for decomposition. Turf quality was increased and leaf spot and snow mold were reduced by maintaining a favorable pH.

In 1970 aerification significantly reduced thatch when compared with the check, and in 1971 and 1972 aerification, verticutting, and handraking reduced thatch. The use of a wetting agent was not effective in reducing thatch during any sampling year, and the addition or organic matter as milorganite increased thatch formation in 1970 and 1972. Now, if we average the last 3 years, aerification resulted in the least amount of thatch followed by verticutting and handraking. The prevention of thatch accumulation on plots aerified is probably the result of increasing favorable conditions for microorganisms. The theory behind the use of a wetting agent is that it reduces the surface tension between thatch and water, thus allowing the thatch to become wet quicker and thereby increase decomposition. But, the thatch not only wets quicker, it also dries quicker. It is believed this frequent wetting and drying interrupts the decaying process. The increase in thatch formation on plots receiving milorganite might be explained by the greater total growth of the turf, although the added organic matter itself may have been responsible to some extent.

The best combination of treatments in this study was liming twice a year and aerification, although an excessive level of thatch buildup was prevented by vertical mowing or handraking to remove the thatch. There are so many variable factors that influence thatch accumulation that it is impossible to design a program of thatch prevention for all turfgrass areas. Practices which are effective on one area may not be effective on an adjacent area. Each turf manager must adjust his program to utilize the practices which best fit his particular set of circumstances.

RENOVATION CHEMICALS

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Webster defines renovate as "to make new, to renew, make over or repair, to restore to life, vigor or activity". The choice of turfgrass renovation chemicals will be primarily dependent upon the degree of renovation to be undertaken and the species of grass and weeds involved. Renovation can vary from a minimum of selected weed control of a few species in an established turf of desirable species to a maximum of complete vegetation control followed by establishment of desirable grasses through reseeding.

In the category of minimum renovation through the elimination of a limited number of broadleaf weeds 2,4-D, MCPP and dicamba are useful tools either alone or in combinations. However, if overseeding is to follow weed control the use of 2,4-D, MCPP or a 2,4-D - MCPP combination will require considerable less waiting time prior to reseeding than will dicamba or dicamba combination applications. The choice of material again will be primarily dependent upon the weed species involved although the desirable grass species present must also be taken into consideration. If 2,4-D alone will control all weed problems in a given situation it certainly would be the material to use. If clover, knotweed, chickweed, or similar weeds are the problem it will be necessary to use MCPP, dicamba or 2,4-D - MCPP, or 2,4-D - dicamba combination for adequate control. None of these materials will give control of any grass weeds.

To most of us the term renovation probably is more commonly considered as the elimination of all vegetation in the treated area followed by re-establishment. At the present time there are a number of materials that are being used for this purpose although some of them are still EPA labelled for experimental use only.

Paraquat is formulated as a water soluble, dichloride salt of bipyridinium containing 2 pounds active ingredient per gallon. It is a non-volatile material with some formulations corrosive to aluminum and galvanized steel but non-corrosive to mild steel and stainless steel.

Paraquat has an LD50 of 150 milligrams per kilogram for rats and must be handled with extreme precaution. (LD50 is the number of milligrams required per kilogram of body weight by oral ingestion to kill 50% of a given rat population). It can be harmful if inhaled or absorbed through the skin. Oral ingestion may be fatal. A face shield, rubber gloves and waterproof clothing should be worn when using Paraquat.

Paraquat is a contact herbicide that is quickly absorbed by the above ground parts of the plants. Uptake by the plant has been detected within 30 seconds of application. This rapid uptake minimizes the effect of rainfall following application. Under sunny, warm conditions discoloration of the plant tissue can be observed within 2 hours with severe wilting occurring in 24 to 48 hours.

Paraquat is presently registered for use on non-crop areas. When used on the golf course it should be kept in mind that this material is toxic to many types of wildlife, especially birds, and, therefore, should not be used when weather conditions favor drift into wooded or non-use areas.

Paraquat is absorbed immediately on contact with the soil and, therefore, is inactivated permitting immediate reseeding of the treated area. It is a cationic material and should not be mixed with anionic wetting agents, liquid fertilizers or similar materials as tie-up or precipitation may occur.

Paraquat will give good control of chickweed, knotweed, lambsquarters, pigweed, purslane, red clover, sheperdspurseu, thistle, wild mustard, bluegrasses, crabgrass, and some bentgrasses. It does not give effective kill of dandelion, plantains, or white clover. When these weeds are present an application of a translocated material such as 2,4-D, MCPP or dicamba (depending on the specific broadleaf problem) should be made several days prior to the Paraquat application. Grasses such as Johnsongrass and Bermudagrass will be top-killed and suppressed but will recover. Paraquat is most effective on immature weeds. Control effectiveness decreases with weed maturity.

A rate of 2 pounds active ingredient per acre is recommended when complete kill (of those weeds Paraquat will control) is desired. In some cases it may be desirable to suppress but not kill turfgrasses in order to introduce new varieties or species of grass into the area. Spring applications of 0.24 to 0.5 pound active ingredient per acre, for example, will provide approximately 30 days suppression of 75% of the Kentucky bluegrass population, 1 pound active ingredient per acre will suppress 95% of the Kentucky bluegrass for the same period. Fall applications for suppression should be reduced to 1/4 pound active ingredient per acre. Apparently fall applications will weaken the Kentucky bluegrass making it more susceptible to winter kill.

Roundup, commonly known as glyphosate, is a water soluble formulation of the isopropylamine salt of N-phosphonomethyl glycine. Glyphosate for turf renovation work is available only under experimental label. Formulations used for experimental purposes contain 3 pounds acid equivalent per gallon. It is recommended for postemergence control of many annual and perennial grasses and broadleaf weeds.

Glyphosate is classified as slightly toxic by oral ingestion with an LD50 of 4320 milligrams per kilogram. In comparison Paraquat has an LD50 of 150 milligrams per kilogram. Although glyphosate produces no apparent skin irritation to humans it is a severe eye irritant to some animals and consequently goggles should be worn for eye protection when using this material.

Glyphosate is translocated from vegetative parts to the roots or rhizomes of most perennial weeds. Dr. Ray Freeborg, Purdue University, reports that glyphosate was found in the roots and rhizomes of quackgrass within 48 hours following application. The appearance of visual effects of herbicide activity may range from two to four days for annual weeds and up to ten days or longer for perennial weeds. Herbicidal activity is first observed as a gradual wilting and overall yellowing of the plant followed by complete browing and deterioration of the plant tissue.

Rainfall occurring within six hours of application may reduce effectiveness of the material. Rainfall within two hours after application will probably necessitate re-treatment. Treatments applied in the shade or during periods of overcast weather conditions will reduce the rapidity of visual effects but do not seem to affect the ultimate control. As with most herbicides maximum control is obtained under conditions favorable to good growth of the treated vegetation.

Annual weeds are quite susceptible to glyphosate during early stages of growth but perennial broadleaf weeds and grasses are most susceptible during and just following flowering stage. Susceptibility of perennials at full maturity is still quite good.

The absence of any preemergence effect and no soil residual is one of the most encouraging characteristics of glyphosate. Reseeding or vegetative planting of treated areas is possible within a few days after treatment. Work at Purdue University indicates that germination and survival of Kentucky bluegrasses and Manhattan ryegrasses seedings were satisfactory three days after application of 2, 3, and 4 pound per acre rates of glyphosate.

Monsanto recommends a 2 pound active ingredient per acre rate for experimental work on turfgrass renovation provided the area does not include heavy rhizomatous weed grasses such as quackgrass. Duich at Penn State obtained complete control of a broadleaf weed infested Kentucky bluegrass turf with a 2 pound active ingredient per acre application rate. He also reports that rates of 3 pounds active ingredient per acre gave good but not complete control of quackgrass. Increasing the rate to 6 pounds of active ingredient per acre did not give increaseased quackgrass control. Black at Illinois did not get complete control of creeping bentgrass when two applications were applied at a 1 pound active ingredient rate per acre per application. In other work he found greater reduction in bentgrass population when areas were sprayed and seeded with a Rogers Aero-Blade using Kentucky bluegrass as compared with seeding with a Rogers Aero-Blade and then spraying with the glyphosate. Apparently the Aero-Blade cut many of the stolons and rhizomes and reduced the amount of translocation of the herbicide, thus reducing the effectiveness of control.

Results of the Monsanto trials would indicate that at rates of .6 pound of active ingredient to 2.5 pounds of active ingredient per acre control of the following common turfgrass and weeds will be obtained: Creeping bentgrass, Colonial bentgrass, pigweed, ragweed, chamomile, mustards, bromegrass, lambsquarter, bull thistle, orchardgrass, wild carrot, large crabgrass, barnyardgrass, leafy spurge, fescues, bedstraw, ground ivy, morningglory, ryegrasses, carpetweed, Panicums, dallisgrass, buckhorn plantain, bluegrasses, knotweed, smartweed, purslane, creeping buttercup, red sorrel, curly dock, foxtails, nightshade, johnsongrass, chickweed, clover, and some species of Veronica. At higher rates of 3 to 5 pounds of active ingredients per acre partial to complete control can be obtained of quackgrass, wild onion, Canada thistle, bindweed, bermudagrass, nutsedge, cinquefoil, poison ivy, and broadleaf dock.

Glyphosate presently is registered only for use in soybean production. Hopefully EPA registration for other uses including non-crop use will be granted within the next few months.

Methyl bromide is an excellent renovation chemical where relatively small areas are involved. It is a colorless, odorless gas which is liquefied under pressure. It is available in one pound cans and in larger size cylinders.

Methyl bromide is extremely poisonous. Human exposure to 2000 ppm for one hour will cause serious injury or death. Two percent chloropicrin is normally added to methyl bromide as a warning agent.

Upon release from its pressurized container methyl bromide volatilizes immediately. It is, therefore, necessary to release the material under a gas proof tarp or polyethylene cover.

Prior to application the soil should be tilled to obtain maximum aeration for penetration of the gas into the soil. Soil temperatures must be above 60°F. for effective control. The gas proof cover should be left in place for 48 hours before removal. An additional 48 hour aeration period is recommended prior to reseeding.

Methyl bromide will control all vegetation in the treated area as well as most weed seeds. It will also greatly reduce the micro-organism population of the soil including nematodes and disease organisms.

A rate of 10 pounds per thousand square feet is recommended. Its greatest drawback is the inconvenience and cost of placing and removing the gas proof cover and the cost of the material itself. Commercial concerns presently offering methyl bromide service for large areas currently are charging approximately $600 to $700 dollars per acre.

There is one other material that should be mentioned although like glyphosate it is still in the testing stage and has not received an EPA label other than for experimental use. This material, bentazon, was developed by the BASF laboratories in Rhein, Germany and will be marketed under the trade name of Basagran.

Experimentally Basagran is being formulated as a 4 pound active ingredient per gallon water soluble salt, a 5% granule and a 26% wettable powder. Toxicity studies, especially in regard to wildlife are presently being made. The LD50 for rats is 1100 milligrams per kilogram. Basagran is of primary interest to turf growers as a control for nutsedge. Jagsschitz at Rhode Island University reports good nutsedge control as does Hawf at the University of Delaware. Hawf, in preliminary studies, obtained good control of nutsedge with no damage to Kentucky bluegrass at a rate of 1.5 pounds active ingredient per acre applied in early September. Injury was observed to Kentucky 31 tall fescue at this rate. No injury to Kentucky bluegrass was observed at a 3 pound active ingredient per acre rate. Daniels and Freeborg at Purdue report good control of nutsedge with a combination of bentazon at 0.5 pound active ingredient per acre and 2,4-D at 0.5 pound active ingredient per acre.

RENOVATION EQUIPMENT

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Equipment and techniques used to improve existing turf vary according to desired results. One may be renovating to introduce improved species or varieties into an unacceptable turf or renovating to introduce good grasses or even temporary grasses into a predominate weed patch. Most often one is using seed but may be attempting to introduce vegetative materials. This discussion will center upon seeding methods.

It is a well known fact that broadcasting seed on the surface without necessary soil preparation is unsuccessful. Even if it is accomplished during the winter, there is not enough mixing (freezing and thawing) to satisfactorily incorporate the seed. Soil that is completely settled or compacted and has any type of mature vegetation will not expand and contract to the point that a friable surface can be obtained. This is especially true if the soil surface is covered with thatch or dead vegetation.

Soil-Seed Contact

The key is soil-seed contact. Whatever the problem and the existing condition of the turf, the seed must come into complete contact with the soil. If laying on top of thatch, dead vegetation or compacted or crusted soil, it is not likely to obtain enough water to germinate; and if it did, the small root that first protrudes would not have an available or continuous water supply.

Competition

Even with good soil-seed contact, the existing competition must often be reduced. If a fairly good turf exists, one can lower the mowing height until the seeded turf has germinated and can itself compete for light and moisture. A small amount of existing weeds (or turf) can be beneficial. For example, when seeding into crabgrass during the fall, the slow growing or even dying crabgrass can act as a mulch to protect the seed or young seedlings from the daily moisture and temperature extremes. Growth regulators have also been used to some extent in reducing the growth of existing vegetation. However, one must be sure that the specific growth regulator does not also control the growth of the new seedlings or permanently injure the existing vegetation.

Equipment and Techniques

The above discussion has set the stage for choosing the proper equipment and technique for the job. Thatch and competition must be reduced and soil-seed contact must be obtained. Therefore, seeding equipment designed for prepared seedbeds are usually unsatisfactory. The overseeding technique involves seedbed preparations.

Complete Renovation Machines

At least two specialized renovation machines have been developed. These provide a slicing operation in combination with a seed hopper which drops seed through tubes directly into slits cut by free rotation coulters. In simpler terms, this is no-till planting. The slicing operation cuts through thatch and penetrates the soil surface. Seed is metered from the seed hopper through seed tubes and onto the coulters which deliver the seed into the slits. This is then followed by either a drag mat or a free-rotation roller to further incorporate the seed and level the surface.

At a time when seed costs are rapidly increasing, this equipment can be very economical. This is surely the most seed-efficient way of overseeding. A conscientious operator can soon learn to properly adjust the equipment even when traversing hilly terrain. When the soil surface is very uneven, there is a tendency to deposit the seed on top of the soil surface in low spots and incorporate the seed too deeply on high spots.

This equipment has many other uses. Thatch can be removed in good turf, some leveling or surface smoothing can be accomplished and they can be very effectively used to seed prepared seedbeds. They can be used to improve fairways, tees and lawn type areas. The larger more efficient models are not designed for green renovation.

Other so-called renovation equipment is based on a spiking principle wherein the seed from a hopper is dropped evenly over the soil surface. Some of this seed drops into shallow depressions left by front running spikes. It is not as efficient as the above type and a lack of soil moisture or too much thatch or compaction may render this method ineffective.

The same is true when using equipment designed for pasture renovation. Many advances are being made and the main drawback is either the spacing of seed or the extent to which the surface is distribed. In situations where thatch is not a problem, do not discount the use of pasture renovation equipment.

Combination Use of Available Equipment

When complete renovation equipment is not available, overseeding can be accomplished for small areas and even greens by using one or more pieces of equipment designed for special use. Vertical mowers (dethatching equipment) can be used to remove thatch and actually penetrate the soil surface. The remaining shallow slits offer an improved microenvironment for at least some seed that is broadcast on the surface. The same is true when using coring machines. Even the small amount of soil that is removed and redeposited on the surface offers a degree of soil-seed contact. However, to be effective, the area may need to be traversed several times in order to disturb the soil sufficiently. With both the vertical mowing and coring methods, it is best to follow the seeding with a rake or drag mat. This helps to settle the seed to the soil surface and move some of the loose soil for better soil-seed contact. By using a combination of the vertical mowing and coring machines, overseeding can be quite successful.

Another recently introduced machine was designed to break up compaction and remove thatch with a slicing-vibration action, thereby providing slits for seed incorporation. Such special and heavy built equipment may be necessary to getsuccessful overseeding in seriously compacted areas.

Summary

New advances in renovation equipment and techniques are continuously being made. Due to the temporary nature of some of the species being overseeded and increased traffic pressure on manicured turf areas, the need for such equipment is increasing. For a continuous quality turf on areas such as tees, semiannual or annual overseeding may be the only answer. With this in mind, renovation equipment can easily be justified as a labor-efficient and necessary additive to a superintendent's equipment inventory.