PROCEEDINGS

of the

1968

TURF CONFERENCE

Sponsored by the

Midwest Regional Turf Foundation

and

PURDUE UNIVERSITY

LAFAYETTE, INDIANA

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1968

MIDWEST REGIONAL TURF CONFERENCE

The 42 talks included in these Proceedings are condensations of talks by speakers before sections and divisions of the 1968 M.R.T.F. Conference. We appreciated the willingness of the speakers to participate and prepare material for your reading. See Table of Contents next page. Proceedings of each annual Conference since 1948 have been prepared. A limited number of 1962, 1963, 1964, 1965 and 1967 Proceedings are available at price below.

A copy of these Proceedings were mailed to:

1. The 670 attending the 1968 Midwest Turf Conference.

2. One person of each member organization within the Midwest Regional Turf Foundation not represented at the Conference.

3. List of those in educational activities.

Additional copies are available at $ 1.00 each from:

W. H. Daniel, Executive Secretary
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Lafayette, Indiana 47907

Check below for special articles suggested for first reference as based on your major interest:

For LAWNS - first see articles starting on pages [illegible],

11, 12, 15, 18, 20, 33, 55, 73, 76, 77, 79

For SOD PRODUCTION - first see pages

9, 31, 33, 43, 55, 66, 71, 73, 76, 79

For ATHLETIC FIELDS - first see pages

4, 7, 8, 9, 18, 27, 31, 33, 35, 43, 47, 79 - all on soils

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PRESIDENT'S REPORT

Charles Tadge, Supt., Mayfield Country Club,
Cleveland, Ohio

We are taking part in another significant milestone in turfgrass history, the thirtieth Midwest Regional Turfgrass Conference. Attendance has grown from less than 40 in 1937 to almost 700 in 1967. We missed 1942.

In the short decade since attending my first Conference, I have seen the attendance increase by one-third. The physical facilities for our educational sessions are second to none and a far cry from those we were using only a few years ago.

The past thirty years have seen great advances in turfgrass technology. The MRTF has been one of the leaders in this advancement, but we can ill afford to pause for long to indulge in any degree of self-acclaim. We have only opened the door; a multitude of unsolved problems lies within. The scientific world is moving at such a pace today, who can guess what the next thirty years will bring?

The most provoking problem in our immediate future appears to be labor. The most encouraging avenue to alleviation of this dilemma appears to be with the advanced technology of time-saving materials and methods. This knowledge has and should continue to come to us through organizations such as the MRTF.

The success of any organization is the support given to it by its members. A turfgrass foundation is no exception. The MRTF has gained a prominent position because of the participation of members and interested parties. Our Conference attendance continues to climb, but our membership total has been on a plateau for several years. Even with the accelerated turfgrass activities in neighbor states, there is no reason why our membership should not continue to grow. We can well afford to support both a state and a regional turfgrass foundation. I urge you as members to promote the MRTF whenever the opportunity arises.

We extend our most sincere thanks to Dr. Daniel and his staff of Bob Seager, Kaye House and the turf students for their fine work in keeping the MRTF and the Purdue turfgrass programs ever excelling. It has been an honor and a privilege to have served the MRTF as President this past year. I wish to thank all of the Directors and Officers for their capable assistance throughout the year.

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EXECUTIVE SECRETARY'S REPORT

W. H. Daniel, Dept. of Agronomy
Purdue University

Since its inception in 1945, Midwest Regional Turf Foundation has pursued a policy of research with close liaison in problem solving, close contact with individual turf managers, and close association with turf product manufacturers and suppliers. Throughout '67 we continued this program. Although your Executive Secretary made over sixty trips for visits to turf areas, attendance at conferences and speaking at meetings, our prime purpose is conducting research and the resultant exchange and promoting of turf ideas. Many thanks to the numerous people who have assisted in travel and arrangements.

I commend the many members who have maintained long term support of M.R.T.F. It has been the backbone of our program. Numerous new organizations are eligible and we would encourage our old members to seek their support also. This year we have five graduate students, plus over twenty undergraduates active in our program. For more details see Midwest Turf leaflet No. 36, Annual Report.

LEISURE TIME FOR ALL -- BUT US

Frank H. Bunce, Mgr., Bernheim Forest,
Louisville, Kentucky

Don't expect an opening joke as I am heeding my wife's advice:

If you can remember so many jokes
With all the details that mold them,
Why can't you, with equal skill,
Recall the times you've told them.

You and I are caught in a trap - the type the Pennsylvania Dutch imply when they say, "the hurrider I go, the behinder I get," and don't kid yourself that you will escape this trap if you are associated with the business of supplying outdoor recreation. Why?

Too many people, 200,000,000 of us - and growing
Too short work week - and getting shorter
Too long vacation periods - and getting longer
Too many good roads - and growing
Too many cars - and growing

Because so many millions of people are using their leisure as never before, many of us in the outdoor recreation field are having to take a long, hard look in depth, at what may be in our future. We know 90% of our people engaged in some form of outdoor activity in 1960. We are told that outdoor recreation use will increase one and one-half times by the year 1976, and by the year 2000 we can expect a four-fold increase.

Playing outdoor games and sports was fourth most popular activity in 1960. By 1980 will be second, and will hold second in year 2000. In 1960 - 30% of the population participated in playing games or outdoor sports. By 1965 this had increased to 38% of the population.

	1960	1976	2000
Work week	39	36	32
Paid vacations	2	2.8	2.9

The above figures should cheer you up as by 1976 your employees will be on a 36 hour week and the "boss" on a 72-hour week (same as 100 years ago). Reminds me of the French saying - "The more things change, the more they are the same."

Now, let's switch to other problems of ours. If, as a mathematician with the Rand Corporation predicts, that within 25 years 2% of our population will be able to produce all the goods and food the other 98% can possibly consume, where will we find room for all to play?

Each man here has some very personal experience, I am sure, in past years with land being eaten up by subdivisions, shopping centers, industry, airport expansion, highways, and the enormous acreage required for interchanges. Louisville area men, in particular, are very conscious of these very real threats. And, if you have escaped it so far, cross your fingers, your turn is next.

How acute is the space problem? A recent study by the State of Oregon shows that even if the present recreational plans of all agencies are followed to conclu-

sion, and with all state park land fully developed, the opportunity for recreation will decrease by 35% because Oregon expects its own use to increase not one and one-half times by 1976, but by two and one-half times. In other words, Oregon will not be able to accommodate all recreation-seekers even with full planned development.

As a clincher to the probable decrease in opportunity for recreation, we can quote Marion Clauson who has written "that we will have some 600 billion more hours of leisure by the year 2000 than we had in 1950."

One of the very difficult things for me to understand the past few years is "what has happened to leisure?" Some believe, and I fully agree, that the shorter work week, longer vacation, has not increased leisure, but has allowed time for more work.

Let's look at several things some of us here today may do in any week. Just getting to work involves an average of one and one-half hours each day. The do-it-yourself jobs at home add to working time, studying for a better job, or bringing work home adds to work. Moonlighting and overtime are a way of life for many men and women.

Outdoor Activies

Motoring and sightseeing
Picnicking
Camping
Cycling (Honda giving trouble)
Horseback riding
Flying
Hunting and fishing
Winter sports
Drama, concerts, art shows (growing all over our country)
Interpretation (a rapidly growing form of recreation)
Church activities
Community and county activities
Zoos, arboretums, cemeteries
Hiking and walking
Resting, relaxing
Spectator, watching others play
Golf (thousands of new courses)
Physical sports and games
Aquatic sports

People in my section recreate by driving 200 miles or so at fast speeds to outdo their neighbor, arriving at the lake at dark, up at daybreak to fish all day, then a fast trip home after dark, then to work the next day - pooped? Is this recreation? It surely isn't leisure. Leisure, as I understand it, is economic freedom from our daily occupation. Recreation used to mean refreshment of spirit. But, I suppose we must get with it today and accept these new concepts of leisure and recreation. I presume this all stems from our old puritanical tradition that one reaches success and happiness through work; that idleness is a sin, or as the old adage says, "the Devil finds work for idle hands to do."

Quite likely this is the reason we all have hobbies, not for leisure, but to occupy our otherwise free time, and to keep busy. Often I feel as the passenger must have as he asked the pilot - "How are we doing?" "Pretty good," said the pilot, "we are lost but making good time." But, whatever our personal feelings are to these changing conditions, just as we have learned new "work ways" we will have to learn new "play ways."

As you and I think of this increasing leisure time, we immediately visualize worn areas, eroded paths, and trees and turf damaged by compaction. These are the results of increased free time, the inevitable result of usage exactly the same whether golf course, cemetery, park, or whatever type area people visit.

Today we know more about outdoor recreation than we did ten years past, but still not enough for our needs, and very little research is underway. We do know

that the simple forms of recreation are popular. We know that the urgently needed areas are those adjacent to urban centers where better than 60% of our population now live. We know that some recreation is compatible with other land use. Lastly, we know now that leisure-time activities are growing each year. This growth, with all the accompanying problems, stagger the imagination of those of us directly concerned.

Now, let's back up a minute and look at this growing problem from the standpoint of the land manager, and there are many of us in this classification here today. In a recent article the President of the Isaac Walton League says, "you who own land, or are charged with management, whether it is public or private, must devise controls on our recreational use to keep numbers in line with the capacity of the land to provide the experience the seeker for the outdoors expects to find." Can golf course superintendents convince their governing bodies that there is a maximum of use for one acre of ground? Frankly, I doubt it, but we must work toward this objective. Dangers from within may, at times, be as acute as those outside.

This is not a new thought, for a decade we have seen writings in national magazines relative to controls. Some suggest a very high admission charge on the very popular areas. Some suggest the closing of entrance gates when capacity is reached. One writer has suggested that public high density areas be by advance reservation. We will see these controls or modifications of them increasing in the immediate future. Try to visit Grand Canyon in 25 years without a reservation, or paying $ 25.00, which in effect is a rationing of use. I only hope that in future we won't have to buy a reserved ticket for a seat in the woods.

Those of us who manage land, and those charged with the responsibility for land policy, must make personal decisions. Field men know that overuse can ruin a recreational area as thoroughly as a bulldozer. We must learn to live with the land, and not just to live off of it. We must learn, too, that our good earth is not just raw material to be used up.

From what has been said you know my personal feeling that if we, who are in charge of lands, are not conservationists (not preservationists) first, and park, golf, or recreation people secondly, we are in the wrong business. We have the responsibility of insuring that the visitor of today has an enjoyable experience in the outdoors, and the same responsibility for unborn generations.

But, now back to the trap and how or what we can do? I wish I had the answers, but I do know we must live with it for years to come. We do know we will serve more people each year to some saturation point yet unknown. And, in the process we hopefully will have grasses that will take any abuses, equipment guided from a control panel in the office, mowers that will back away from contact with objects without knowledge of the operator, golf carts on a monorail system, maybe just above the turf so it won't be necessary to get out of the cart to play a shot, chemicals and fertilizers that are self-applying in the proper proportions, artificial turf that can be used as inexpensively as sod, trees and shrubs that will take compaction - all these and many more things undreamed of today. We know our job will be accomplished. While we may have a growth of problems, and the problems of growth, it it gets too tough try this -

With areas overcrowded
And laborers very few,
Grounds are in an awful mess,
"What shall we do?"

Just cogitate and ponder,
Then give a joyful shout,
Then build a dam in every place
And flood the public out.

TURFGRASS IS BIG BUSINESS IN PENNSYLVANIA

J. M. Duich, Dept. of Agronomy, Pennsylvania State University
College Park, Pennsylvania

A most valuable precedent was established with the recent completion and publication of the 1966 Pennsylvania Turfgrass Survey[1]. The project represents a first in that the survey was conducted by a state crop reporting service. Aside from the obvious value of the survey to us in Pennsylvania, it is of paramount importance that copies have already been presented to governors, state agricultural secretaries, crop reporting service heads and university administrators in a number of states. We can only hope that this initial state effort will result in a series of similarly conducted and financed studies throughout the country. There is little doubt that a firm and concise documentation of the turfgrass industry is essential to presently justify new and expanded programs of research, teaching and extension activity, as well as associated efforts by all facets of the industry.

A statistical survey has been the prime objective of the Pennsylvania Turfgrass Council for over 12 years. Financing was the obvious limitation until Dr. L. H. Bull, State Secretary of Agriculture, entered the scene. Although data are relatively easy to obtain from organized units, such as state schools, highways and professional groups, such as golf superintendents, the major stumbling block was the 11.5 million people and their 2.25 million home lawns (one-sixth rented and five-sixths home-owned).

With the exception of direct contacts with all golf courses, sod growers, highway and turnpike departments, and plus a few other segments, all sampling was systematic. Questionnaires were prepared by appropriate committees, the state divided into 100 sampling segments drawn with probabilities proportional to dwelling units, enumeration teams were specially trained prior to "pounding the pavements", numerous questionnaires mailed out followed by phone calls or personal visits to non-respondents, data cards were punched and finally the indispensable computers were put to work. The cost of this total effort was approximately $ 28,000.00.

Summary

The survey revealed a total turf area of 963,624 acres out of the total state land area of 28.8 million acres. It was further ascertained that actual turf acreage is associated with 2.47 million acres of land.

Dollar value summary of annual turfgrass production costs and replacement value of equipment totaling $ 498,704,000 is shown in Table 1. Details of the survey are too numerous for publication in these proceedings. Detailed information was acquired on labor, materials, turf types, turf problems, etc. The golf course survey, which was the most detailed and represented nearly a 100 percent reply, revealed such interesting data as 9.4 million annual rounds, 5,963 golf carts, 3,732 persons employed, 10.3 million dollar annual payroll, and average maintenance cost of $ 2,584.00 per hole.

[1]Publication CRS-42, Pennsylvania Crop Reporting Service, D. O. Boster, Head.

Table 1. 1966 Pennsylvania Turfgrass Survey summary of annual turfgrass expenditures expressed in thousands of dollars.

Area	Maintenance	Lawn Service	New Establishment	Equipment Replacement	Total
Home lawns	46,256	4,355	2,560	284,635	337,807
Highways	3,639	-	-	260	3,899
Sod	487	-	-	332	820
Golf	18,465	-	-	12,076	30,541
Schools	3,512	36	638	5,394	9,580
General Type	84,577	56	2	31,130	115,765
Turnpike	210	-	-	80	291
Total	157,149	4,447	3,200	333,909	498,704

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WHAT MY TEAM NEEDS

Key comments from Bob DeMoss, Assistant Coach
Purdue University

Surface firmness is desired for playability. Avoid slick field surfaces. We cannot practice on wet ground. Adequate drainage is essential. Time is of the essence. We have just so many days and so many hours to learn, to train, to coordinate.

80% of the wear is in the center 20 yards of the field. Practice is divided into three phases

Individual - Man
Combination - Opposing men
Team - Play running

During practice we try to change yard lines to distribute wear. It is difficult with up to nine coaches and seventy players to save the turf. Finally, firm surfaces produced by adequate drainage is the first requirement.

(Editor's note). In 1968 all athletic practice areas and fields at Purdue will be vertically trenched above tile lines, then vertically grooved across tile lines with 3 inch deep settings with Aero-blade. Vertical trenches will be backfilled with coarse sand and capped with calcined clay to get water into tile. Vertical grooves will be topdressed with calcined clay to improve water penetration.

Is Your Athletic Area Safe?

A research report from Cal-Turf, 5417 Santa Clara Avenue, Camarillo, California, reported extensive test on resiliency effect. The following table summarizes their extensive work:

	Order of increase in resiliency
Moisture	2.6 to 1
Soil type	2.0 to 1
Amendments	1.9 to 1
Grass variety	1.9 to 1
Cutting height	1.3 to 1

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PROFESSIONAL STADIUM AND TURF USE

George Toma, Supt., Municipal Stadium
Kansas City, Missouri

Today professional sports, such as baseball, football, soccer and a variety of other events, are held in what we call multi-purpose stadiums - those built to house all these events for the sports fans of America. The prime tenant in these stadiums usually are professional teams. The players are the best men available to supply the people who pay their freight with sporting thrills. These men are pros, their employers have invested millions of dollars in them. The athletes have the best doctors, coaches and equipment. Stadium walks are padded for their protection. Usually everything is looked into to prevent injury to these valuable players in order to protect club investments and give everybody concerned a first-rate performance.

The opposite side gives us a different picture. Opposing players become aware of a rough field and they turn gun-shy. When players make such remarks as, "What a rockpile!" - - "Sand-pit." -- "Pavement" -- or "Obstacle course" -- it is a safe bet that the playing of the game will be second rate. So, give the athletes the best possible conditions for performing on.

Here is where the grounds manager comes in. Is he as professional in his field as the athletes are in theirs? Is he trying to give the players professional results also? - The fans a field of which they can be proud? The management a sound, reasonable operation? These are questions which should be answered by the condition of the field.

Where should we start? Care of the field should be provided for right on the drawing board with the architects, engineers, stadium operators, turf consultant, and the grounds keeper, if there is one. Usually in the building of the playing field, the groundskeeper or a turf consultant will have the least to say. There are somethings that everyone seems to know how to run: 1. A newspaper. 2. Coaching. 3. Growing grass.

Still the grass men know of the many problems that will arise with a variety of sports being played on the same field. These are grass-growing problems. What type of grass? - one that will take the wear and tear and respond fast after injury. Drainage - is it adequate? A watering system - does it cover the whole field? Do they know that the turf will be covered at periods of time ranging from hours to days? With all these problems existing many times the architects fail to look into these aspects.

These architect's field men should spend some time with the groundskeeper. During the season, when the field is in use, is the best time. This way they can see for themselves all the obstacles that have to be overcome in the building and maintaining of the field. Three of the major features that are common to all fine playing areas are:

1. Good construction
2. Good soil structure
3. First-class, dedicated maintenance

Constant maintenance without good construction and drainage could end with sloppy playing conditions. On the other hand, a well-constructed field with good drainage, but with poor maintenance, is also inadequate. Any playing field having these three main features in combination has a good chance of staying in excellent playing condition, regardless of heavy traffic.

Proper and constant maintenance is definitely necessary. This must not be neglected even for a short time. The grass could be only as good as the foundation, though, and here is where we should start. Proper drainage, proper soil mix, irrigation, the right grass, and last but not least the right man in management. To my knowledge, only two of all the new stadiums being built have been started on the right track - St. Louis and Anaheim.

A few years ago I was called in by a major league club two months before their first game in their new, near 20 million dollar stadium. Where were their turf plans? In the talking stage? The blueprint stage? Two months before their first game they started to think.

Theyexcavated 45 feet below street level. Drainage was nil, irrigation was primitive for a garden hose, the soil was pure, red clay. I made a few recommendations, such as drainage, a soil mix and automatic irrigation. The stadium authority manager said they did not need it. He won - I lost, along with the players, the fans and the stadium. They tried to put sod on pure, red clay. The sod came in pads. Along came two inches of rain, the sod floated. Last year they spent 78 thousand dollars to correct their problem. The architect won in his fees - the groundskeeper lost. He was fired.

Another new stadium, after 10 football games, had to spend nearly 90 thousand dollars to correct drainage on only three-fourths of the field. Now they are correcting the remainder since baseball will be played in the stadium.

I only wish I had one-tenth of this money to work with in Kansas City. We do not have tile drainage - algae wipes us out each year during the rainy season. Our watering system consists of dragging 1,500 feet of hose to hand-water. We have been trying for years to build up our topsoil by topdressing with mushroom soil. We have the least number of men in the major leagues - even the stadium managers out-number us.

We, perhaps, spend 15 to 30 thousand dollars less than other major league clubs after football to get ready for baseball. We do not use herbicides or fungicides. We finished last season with one crabgrass plant. Oh! yes. We did use some insecticides only because the sod webworms were making a better showing than our lowly Kansas City Athletics. After football we only spot-sod and seed with a cool season mix. In June, we aero-blade and seed with pre-germinated common bermuda. Soak seed for 48 hours, spread on concrete floor 24 hours, mix with organic fertilizer, etc., to spread easier and seed. This is followed by over-seeding in September with a ccol season mixture for football. With all these inadequacies we must work harder.

On the skin areas we do not use sod. We pre-germinate annual rye, soaking 48 hours, changing the water every 12 hours. We then mix with organic fertilizer and Perlite, and seed at a rate of 50 to 60 pounds per 1,000 sq.ft., followed by top-dressing two days after seeding.

Kansas City will overcome many turf problems by building a new dual sports complex with a movable roof. The football stadium will seat 75,000, and baseball will seat 55,000. All seats will be close and excellent. Turf management, if the architects do not forget us, will be truly professional.

These experiences are just part of the game. It is our job to grow grass, so we just hustle and work hard. I try to instill pride in my men. We hope that for you good luck and good fortunes during the year will be as numerous as Blades of Grass.

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LOOK AT THAT LAWN!

George J. Koehler, Koehler Bros.,Inc.
Lafayette, Indiana

"Look at that Lawn" is an expression we have heard many times. Undoubtedly we will continue to hear this same expression uttered over and over again, as long as the people with whom we deal desire to surround their homes with beautiful lawns.

The statement, "Look at that Lawn", can carry with it overtones of happiness, proudness, boastfulness, pleading, grief, sadness, indifference, disgust, or others. This depends on each individual's experience with his lawn, and what he has accomplished with it, or how it has baffled or defeated him. It is our experience,while listening to various homeowners who have exclaimed, "Look at that Lawn," to us that I would like to share with you today.

What does the average homeowner desire in a lawn? Many of them jokingly claim they would like a lawn that always stayed green, needed only one or two mowings a year, never needed reseeding or fertilizing, never was attacked by insects or invaded by obnoxious grasses and weeds, never needed watering, and in general presented a beautiful, lush carpet surrounding their home with little or no care on their part. Of course, we realize this cannot be, but we try and steer our customers in the direction needed to achieve the best results with the smallest amount of effort.

The homeowner should be interested in his lawn. It represents, in most cases, the largest single investment in his landscaping. It takes a nice covering of grass to show off and accentuate the rest of the landscaping.

The man that proudly says, "Look at that Lawn," has probably spent many hours with his grass. No doubt he had invested in the proper equipment to fertilize, seed, mow and care for his lawn. He has taken the time to investigate and find out the proper procedures and techniques to use in caring for his grass. He has spent a reasonable amount of money in buying the proper materials for his lawn and has achieved the results he desires.

The next man we hear from says, "Look at that Lawn," in disgust. No matter what he does he cannot seem to get a good lawn. Usually a careful inspection shows that he has been attacking his lawn in a hit or miss fashion. He applies fertilizer and reseeds early in the spring, then loses interest later in the season when he really should be paying more attention to his grass. He allows dry weather, weeds, or insects to take over, and then complains that he cannot grow a good lawn despite the fact that he fertilized and reseeded in the spring. This sort of person is difficult to deal with as it is hard to convince him that he has neglected his lawn just when the lawn needed the most attention. He will try again next spring and probably repeat the cycle all over again. He will eventually give up in disgust, or be swung over to good lawn habits by giving that extra bit of attention to his lawn during the remainder of the season.

Then we hear from the next individual on our list who says, "Look at that Lawn" as though it is a poisonous snake waiting to pounce on him. He is afraid of the lawn and has decided that anything he does will be wrong and to no avail. It is easy to show this type of person that with a little time and effort a lawn can become a lovely object and not something to be avoided at all costs.

When the "don't care" type exclaims - "Look at that Lawn" - he gives the impression that he would just as soon cover it all with concrete and paint it green. To him the lawn is a nuisance, a necessary evil, and he couldn't care less how it looked as long as he doesn't have to do anything with it. He will never be convinced that his lawn is of any value, and his neglect of the lawn is a constant source of annoyance for his family as well as his neighbors. If we could get through to this type we would find improvement in many lawns in each neighborhood.

There are many other ways we have heard - "Look at that Lawn." From the homeowner who is pleading with us to do something about his lawn as he is expecting guests over the weekend and his lawn is in sad shape; from the fraternity or sorority that has neglected its lawn all summer and returned in the fall to find an overgrown lawn full of weeds and crabgrass, and the lawn should look good for the first football weekend, rush week, or a similar occasion; and, of course, we have all heard "Look at that Lawn" in a threatening tone from our wives just as we are ready to go play golf or spend a day fishing.

Each year we find better methods and better materials with which to combat our lawn problems. However, as long as we have lawns and the homeowner who desires a lush carpet of green around his home, we will hear the expression - "Look at that Lawn" with all of its connotations and implications.

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MAINTAINING LARGE TURF AREAS

C. C. Counterman, Supt. of Grounds,
Argonne National Laboratory, Argonne, Illinois

I am privileged to share with you a few of our cost reduction techniques that we employ in managing the grounds of the 3,700 acres Argonne National Laboratory. In the past ten years our areas of responsibility have increased 65%, but we have held the total operating budget of the Grounds Section to a 15% increase over the total budget of 10 years ago; and, at the same time we have reduced our manpower by 20%. Our labor costs, over the past 10 years, have averaged out at 55% of the budget.

Argonne National Laboratory is a major research and development center, located in Southwest suburban Chicagoland, whose basic premise is to work in the programs dealing with the peaceful application of nuclear energy. The Laboratory site is campus-like on 3,700 acres of land. Over 100 buildings, most of which are large, modern and functional, house a wide variety of scientific and engineering programs. Argonne is operated under contract with the U. S. Atomic Energy Commission. Argonne employs 5,500 scientists and suppoerting personnel, and collaborates with all the colleges and universities in the Midwest. The 1966 faculty members from 98 colleges and universities brought in students to use the instructional laboratories.

The Grounds Section employes 21 full-time men. This includes 1 Superintendent, 2 Foremen, 6 Heavy Equipment Operators, and 12 Groundsmen. In late June through August we usually hire 10 additional college students. Our men are all unionized; their average hourly pay is $ 3.60.

The Grounds Section is responsible for the maintenance and development of the Laboratory grounds. This represents 35 miles of roads, 60 acres of paved areas, 8 miles of security fencing, 1,500 acres of forested areas, and 700 acres of developed turf. We are also responsible for snow and ice removal, a sanitary land-fill operation, coal handling, the rail spurs and rail car movements, and truck crane and backhoe services to all groups in the Laboratory. Other work functions include: maintenance of power equipment, such as mowers and small tractors; fabrication and installation of road directional signs, maintenance of storm drainage, and planting and after-care of trees and shrubs. Asphalt paving and the high work on tree trimming is contracted out.

The first,and perhaps the most important step in reducing costs,begins in the planning stages. Each work day, well ahead of the day's 8:00 A.M. starting time, I meet with my two foremen. An actual work schedule is written out and a copy is given to each foreman. On this schedule will be noted the day's weather and the weather outlook, the absentees and the various work locations. Then we list the names of the men, the equipment they will use that day, together with a 1-sentence work description. This meeting makes it possible for all members of supervision to know who is doing what and where; we can re-think the work assignments and we can change our minds and our plans on paper much more efficiently at this time than when the men have actually started to work.

Over 100 work cards are completely written out ahead of time and are ready for assignment - as time and weather permit. Many of these cards are complete enough to enable the men to take to the field and to complete the assignment on their own, with little or no further supervision. I make use of this cardex file to store cards showing the make, model serial number, tire size, capacity, etc., of each of our assigned vehicles, tractors, and their attachments - a great time saver when ordering parts.

Without the use of good equipment well maintained no amount of technical information is going to be of much help in reducing the costs of maintaining turf areas, large or small. We get all turf maintenance equipment refurbished while the snow is falling, and we store enough spare parts in these parts boxes to see us through the season, with the exception of very special parts or items that could not be foreseen that they would be needed.

All engines are equipped with hour meters. If they don't come in originally with an hour meter we install it ourselves. The men fill out operators' cards daily, listing the "in" and "out" hour meter readings, where the equipment was was used, and any needed repairs or adjustments. These hours are logged daily, making it a simple job to schedule correct preventive maintenance.

We have stand-by mowers for most types of mowing. The Groundsmen will bring his ailing mower into the shop, unhook the mower from the parent tractor, hook up

another mower and take off to the field in a matter of minutes. Another invaluable aid in reducing down time of equipment is a well-stocked service truck manned by a very efficient and resourceful mechanic. To minimize the use of hand-propelled rotary mowers, we are presently installing 18 inch circles of turf-free area around trees, poles and signs. A pre-herbicide treated mulch replaces the turf.

Ornamental plantings are not hand-cultivated. Every 2 years we apply a pre-herbicide treated calcined clay mixture on the surface of the entire area that has been set aside for a particular ornamental planting. The pre-mixing of the herbicide in the original mulching materials, or in the calcined clay, saves dragging spraying equipment around, and the mixing and applying work can be done on days when weather or soil conditions are unfavorable for other types of grounds maintenance work. Material yards, substations and the like are treated with a soil sterilant type herbicide in late winter and early spring, once every 3 years.

In 1963 a total of 6,272 man hours were expended at Argonne in moving 600 acres of developed turf areas. In 1967, 2,000 fewer man hours were expended in mowing over 700 acres of developed turf areas.

Improved and more efficient mowing equipment was responsible for some of these fewer mowing man hours, but for road shoulder turf and for some service areas the grass is left to grow until the seed sets, then it is harvested down to a 4 inch cutting height with a flail chopper-trailer combination. The seed laden grass clippings are then spread over recently graded areas, using a common manure spreader. We have used this method for 3 years now to establish a service type turf. At present our shoulder areas receive from 2 to 3 additional mowings to complete the season.

Our goal is to reduce the mowing of road shoulders and service areas to once a year with the establishment of Crown Vetch. It is gradually in 2 to 3 years taking over some of our long-established bluegrass-alta fescue road shoulders. We are establishing this Crown Vetch by again harvesting the seed-laden Crown Vetch plantings that are now present in our fire lane areas down to a 4 inch cutting height with the flail chopper, and then promptly spreading these vetch clippings with a manure spreader right over the existing established grass plants.

We are attempting to minimize the problem of economically and effectively returning turf areas that have been rent asunder by building renovation, utility line repairs and the like, with a simpler method of seeding, fertilizing and mulching. After these torn-up turf areas have been regraded, (no attempt is made to disk, harrow, or to otherwise cultivate the soil), we will mix a measured amount of seed and measured amounts of chopped straw, wood chips and a complete fertilizer all together; then immediately spread this mixture with a manure spreader, or by hand, depending upon the size of the area, over the leveled area. One good watering will normally suffice to get the seed germinated, and the mulch will protect the young seedlings. No attempt is made to remove this mulch later on. The Grounds area around this 12-foot Bubble Chamber Facility will be seeded, on completion, with this method.

We use a 3-gang "Drip-Roller" in applying herbicides to control clover and broadleaf weeds in established turf. The herbicide drips onto the steel roller which, in turn, wets the surface of the weeds and the grass. This drip roller gives us a more accurate dispersal of the herbicide with absolutely no drift.

Summarizing the points outlined: pre-planning, rethinking of every operation, more mechanization with the latest equipment, more attention to scheduled preventive maintenance, more effective records, an adequate supply of spare parts, together with standby equipment, better use of less than perfect weather days, and innovation are points for your consideration in the maintenance of any size of a turf area.

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PROMOTING LAWN CARE

Martin J. "Mike" Maloney, Martin Feed Store & Mill, Inc.,
Elkhart, Indiana

Bill Samuels, a friend of mine who owns and operates an advertising agency, once stated that promotion of a product or service was vital to its successful existence. Take Alka Seltzer, for example -- it could have fizzed and bubbled for years in the secrecy of a laboratory had it not been for millions and millions of dollars spent in promoting its value to Belly-achers. It took years of promotion for the Kleenex people to persuade the population to blow its nose into a piece of paper instead of a handkerchief, and the ladies clothing industry spends no small sum promoting the idea that females should annually discard slightly worn clothing in order to try a new style.

"Make no mistake about it," said Bill. "Promotion is a big business." Perhaps the only thing that doesn't need promoting is sex, and even that has been given a lot of encouragement.

The turf business is no different from all the others when it comes to the matter of furthering its cause. I don't know who it was that coined that old cliche -- "Build a better mousetrap and the world will beat a path to your door." Whoever it was should have added, "If they know about it." The turf industry can produce and offer to sell the finest turf and turf maintenance supplies and equipment imaginable, but if the buying public doesn't know about it and if a desire isn't created in their minds for these products, there will be plenty of grass growing in the path to the door of the turf industry.

Now, I am not saying that the turf industry does not do some promoting. Steve Springer of Elanco Products Company told me the major manufacturer in the turf industry spent $ 23,000,000, and the rest of the turf industry spent another $ 23,000,000 on promotion, for a total of $ 46,000,000. These are no small figures, but realizing they serve the promotional pitch to a nation of nearly 200 million consumers, they look smaller.

Vince Pigors of Ames Company, a division of Miles Laboratories, Inc., told me the soap industry, pharmaceutical, and automobile industries each spends hundreds of millions of dollars on promotion. Procter & Gamble Company alone spent $ 178,000,000 just on TV advertising. What I am saying is that promotion of lawn care has a long way to go before it can be overdone. Let's take a look at this rapidly growing turf industry.

Peeking through the key hole we see research and manufacturing. We see their development and products. If we open the door we see distribution of these products and limited use of turf, such as on athletic fields, parks, cemeteries and public gardens. But, on walking into the room we find ourselves surrounded by nearly 200 million Americans, most of whom are potential users of turf and turf products, users who for the most part are better educated, have more leisure time, and higher incomes than their parents could claim.

These people are the target of the promotions of many industries. For example, 27% of their income is spent for food, 29% of their income goes for housing, 9½% of their income is spent for clothing, and 10½% of their income goes for transportation. The remainder is spent for a variety of smaller needs and luxuries. These are just a few of the industries who are zeroed in on the American consumer. We might wonder what percentage of these incomes are going to be spent on turf and turf products. There are no accurate figures available, but we can estimate the amount the homeowner spends is less than 1% of his income.

Now, may I borrow your imagination for a moment? First of all, imagine you were not vitally interested in turf. You folks are part of this great American population, and I am sure you realize the value of time and money. What would you think if someone tried to sell you on a project which would:

1. Consume 6 hours per week for 30 weeks -- prime daylight hours that could be used for boating, fishing, golfing, or any number of attractive hobbies.

2. Require an initial investment of several hundred dollars for beginning materials.

3. Require an investment of from fifty dollars to several thousand dollars for maintenance equipment.

4. Require storage space (usually the family garage) for equipment.

You would probably quickly, but politely, inform the salesman that you had better things to do with your money. Yet, this is exactly the position you and I are in when we attempt to promote turf and good turf maintenance to the average consumer. And, as if these adverse conditions were not enough, we ask him to plant, grow and maintain a plant which, although he may recognize, he knows little or nothing about its needs.

Promoting this turf industry to the homeowner is quite a task, isn't it? It is sort of like asking a man to give away a sizzling steak and eat mush and milk in its place. And, yet, we in this turf and turf maintenance business continue to promote, sell and reap a profit in an industry that will steadily grow and become more popular.

Now, let's peek at the promotional efforts of Industry and Research. National, regional and local promotion on TV and radio is popular. Magazine and newspaper advertising, as well as direct mail, is used most effectively by several manufacturers. Research organizations, such as Midwest Turf, promote frequently by means of press releases, which are printed in the realm of public service by newspapers and broadcast by radio stations. The Lawn Institute also distributes promotional material. The Merion Bluegrass Association has its promotional program. I am sure there must be other associations who are involved in promoting turf and turf maintenance.

Supplementing this line of promotion is the local or community promotion that can be done by the foot soldiers -- those who sell and service on the retail level. Promotion done by retailers on the community level can be done most effectively and can serve as the catalyst which produces a turf customer from the mixture of buying public and manufactured products, advertising and research. There are many ways in which retailers, landscapers and others, who are in direct contact with the consumers, may promote turf. Unfortunately, most promotions cost money, and it is no secret that promotional budgets on this level are mightly small.

During the twenty years I have been active in this turf business, I have observed and tried various types of promotions directed to the homeowner. Ten years ago I came to the conclusion that my promotional work had to be constant, inexpensive, and designed to accurately meet the mood of the homeowner. The promotional efforts I shall mention are within the reach of almost any individual who is interested in and ambitious enough to promote the turf industry.

The first three suggestions may apply to anyone -- park superintendents, landscapers, golf course manager, or greenskeepers. These may be used to enhance your public image and personal income, as well as to further the turf industry. The

fourth may not be applicable to anyone who does not have a promotion or advertising budget. My suggestions are as follows:

1. Public speaking appearances before service clubs, garden clubs, and any other organization where people gather in groups and are in need of a program.

2. Make the acquaintance of the newspaper editor, radio station manager, TV station manager, and never miss an opportunity to supply them with information, both new and timely, concerning the turf industry

3. Make a point to meet and list among your friends newspaper reporters, photographers, radio and TV announcers. Let them discover that you are a reliable source of turf information

4. With what money you have available begin a long-range promotional program, utilizing radio or newspaper, or TV, or direct mail.

Ten years ago at the suggestion of the local radio station manager, I began a twelve week series of once-a-week, fifteen minute radio programs. These programs were of the interview type, designed to inform the public about turf and turf maintenance. The interviewer (station manager) asked leading questions which allowed me to discuss the fundamentals of lawn building, plant nutrition, disease control and other pertinent material.

At the end of the twelve week period audience response indicated the program should be continued. Summer passed into autumn and the program continued to gain listeners. Because the program was gathering momentum, I decided to continue the program through the winter. It wasn't easy to accumulate interesting material, but by including such subjects as house plant care, wild bird feeding, terrariums, etc., I managed to fill the time and still hold the audience by providing useful information. After two years the station manager was transferred - I changed the format of the program and did it solo.

I am still producing and narrating these programs. Titled, "Down To Earth," the program still deals mainly with turf and turf maintenance. In order to promote interest in turf, I use various methods, one of which is to point out an unusually well-kept lawn and discuss it, and its owner on the air. I try to work closely with realtors and developers in promoting turf Realtors and builders not only make good customers, but their attitude on turf can help promote local turf interest. Frequently I rely upon information from the Midwest Regional Turf Foundation in order to promote turf. Occasionally I am invited to appear on open line or Sound Off radio programs in order to answer questions called in by interested listeners. My experience in the radio field has opened the door to many TV appearances in the interest of turf.

There are various ways of promotion available in this turf field. You may be using methods which work for you in your localities. Perhaps you have thought about starting a promotion program and have not known just where to start. I would suggest anyone start by telling your story to the greatest number of people as many times as you can at the lowest possible cost.

Whatever promotion you do,work at it constantly, plugging away at the turf theme, and it will continue to gather momentum, build greater interest in the minds of the consuming public, and aid you personally, as well as the turf industry in general.

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WHAT IS MAXIMUM LAWN CARE?

L. J. Westermeier, Maschmeyer-Hill Co.,
Columbus, Indiana

The addition of the Green Leaf Garden Center, a retail division of Maschmeyer-Hill in the spring of 1967, has provided the first true diversification of full service landscaping in the Columbus area. Mr. Westermeier joined with Maschmeyer-Hill as the manager of the Green Leaf Garden Center after 45 years of successful lawn supply business in Columbus. He has a background as a buyer and seller of seeds, fertilizers, farm supplies, orchard sprays and general hardware.

In 1954, he set up a retail lawn and garden center. This same year he attended his first fall turf meeting at Purdue University. In 1959 he decided to devote full time to being a retail source of lawn materials, and also a reliable source of information on turfgrasses and their problems. In this same year he decided to hold local lawn clinics. These clinics were held on a spring and fall basis and over 1500 homeowners have attended.

In 1964, Mr. Westermeier was recognized for his efforts in the promotion of lawn and garden sales by national publications.

I have found in my retail sales experience that the type of program needed and wanted by consumers is based upon two factors - the usage of their lawn and the budget they have to spend. A good home lawn is not achieved by "hit and miss" methods - miracle products do not do the job either. Only a consistent program can assure lawn success with less time and money spent. A lawn program means doing the right thing at the right time and the right way. A lawn program is composed of products, application and timing. It is the combination of these that assures lawn success. One without the other will not do the job.

Maximum Lawn Care Program

Promoting Turf Growth	Protecting Turf From Pests
Fertilizing	Broadleaf weeds
Mowing	Crabgrass - preventing
Watering	Crabgrass - killing
Manicuring	Insects, grubs & moles, sod webworm
Overseeding	Disease prevention

Why get rid of the lawn you have? Starting all over isn't always the best answer. Experience proves that Maximum Care pays off in rich green grass beauty ... saves time and dollars. Remember that a new lawn will do no better than the present lawn unless you feed it - weed it - water it - and care for it regularly. There is nothing more effective for chasing away winter blues than prompt greening-up of the lawn. The grass is ready, the roots can grow anytime the ground is not frozen. It needs only proper fertilizing to grow new green leaves, so fertilize early, but first give the lawn a good raking to get up all the debris of winter.

Fertilizer is the key to good lawns. Many experts feed their lawns every month, March through September, with a light application of plant food. However, by using slow release, non-burning types of plant food, I recommend the four periods which will save time, yet give the proper plant food availability.

Correct mowing procedure - when to mow --. Start mowing as soon as there is anything to mow in the spring. Mow often, every week or less, before the grass

attains a height of 50% greater than the regular cutting height. Sometimes the lawn may get ahead of the homeowner. It becomes tall and out of order. In such cases the extra growth should be removed by steps rather than by trying to do all of it at once. As a rule of thumb, never try to cut off more than one-third of the grass height in a single mowing. The minimum height of cut for most lawns should be 1-3/4 to 2 inches. A tired brownish or grayish cast to the grass is often caused by dull mower blades. So - keep your blades sharp.

An established lawn normally needs watering in most cases from June on through September. Regular artificial watering is beneficial to an established lawn, especially during the hot, dry summer weather. One way to determine whether or not the lawn needs water is to test the soil moisture to a depth of 3 to 4 inches by digging small test holes at various intervals throughout the lawn. Another method of determining water requirements during the dry period is to examine the appearance of the grass during the late afternoon in the cross-sunlight. If the grass is in need of water and drying up, the grass will appear withered and blackish. When your lawn looks like this, water immediately! The watering of an established lawn with a sprinkler is best accomplished by leaving a sprinkler on each section for about one or two hours, depending upon the nature of the soil.

Under manicuring, I feel that the catching of the grass and the removing of the clippings are No. 1 in importance. The clippings are an organic material, and when properly decomposed will improve any soil. Some people follow the practice of leaving the grass clippings on the lawn. They will eventually decompose and become soil. On the other hand, when the grass clippings become heavy as a result of the extra fast growth, or because a mowing has been missed, it would be well to remove them rather than permit them to pile up in clumps and cause smothering of the live grasses.

Spring overseeding - February 25 to March 25, in my opinion, is the second best time of the year to get overseeding done. Then we have the freezing and thawing of the soil, the honeycombing of the ground when the ground warms up - the seed will germinate. Grass seeds usually germinate about April 1 when soil temperatures are averaging in the higher 40's.

I personally recommend a blend of species composed of possibly 50% bluegrass and 50% of: creeping red, chewing, Pennlawn and Illahee fescue. The fescues have a tendency to germinate at a somewhat cooler ground temperature, coming up and making a cover crop for the bluegrasses that take a little longer to germinate. I do feel that in most of our area we can go ahead and seed as late as April and still have a good chance of getting the seed up. However, it may take a watering program to maintain the moisture if we have extra early warm weather and hot sun at that particular time of the year. Fall seeding is Mother Nature's No. 1 time of the year. At that time the soil is warm, giving your grass a quick opportunity to germinate after the proper seed bed is established. The days are getting shorter and the nights longer and we start having dew, and that is when most of the grass seed will germinate very quickly.

Weeds. Weed seeds may remain inactive in the soil for years, and then spring to life under the proper conditions of light and warmth and moisture. These old weeds usually develop when the soil is cultivated, or when bare spots develop. I like to put all the broadleaf weeds in one category and use 2,4-D for control. To control the vining type weeds (chickweed, ground ivy, pursland, clover, etc.) 2,4-D with 2,4,5-T, or 2,4-D with dicamba, have proven very effective. According to the chart we find that the month of May extended into the month of June is really the most preferred time to treat broadleaf weeds as they should be actively growing. We also repeat occasionally in the fall to take care of the late growers at that particular time.

Crabgrass prevention. Back a few years ago this seemed to be the No. 1 problem to control, but in the last six or eight years, with all the pre-emergence chemicals on the market, crabgrass should not be hard to control. We do have a second chance for control by using the post-emergent controls in July in two applications, 5 - 7 days apart.

Grubs, moles. I recommend that the grub and mole control be applied to a yard on a yearly basis so that continued residual toxicity is maintained. Most chemicals last three years; however, light annual touchup is preferred.

Yes, Maximum Lawn Care takes products, and timing and proper application for the best lawns.

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SURVEYING THE PRE-EMERGENT CHEMICALS & IDEAS

Dwight Brown, Geo. W. Hill & Co., Inc.,
Covington, Kentucky

In the entire field of weed control nothing has changed so fast, or has had so much impact on turf people, as pre-emergence control of weeds. Through all of the earlier control methods - from hand-pulling, burning with fire and chemicals, we finally thought we had arrived with the advent of 2,4-D, the forerunner of all post-emergence efforts. Back in about 1945, I well remember the arrival of the first salesman bearing the "great tidings" about 2,4-D, and truly they were great. Such terms as "selectivity" were almost unknown. Its safety, too, was impressed upon us by the salesman's almost willingness to literally drink it, saying it was harmless to all warm-blooded animals.

Much followed swiftly in post-emergence control - potassium cyanate, sodium arsenite, and on up to DSMA, and its further refinements, AMA, etc. While some of these products were being used in suburbia and on golf courses, an entire new approach was being tested, namely, a chemical blanket or barrier on the soil that killed the weeds as they emerged without hurting the grass. This, of course, was the birth of pre-emergence control.

Progress in this new concept moved rapidly. This is the subject matter of our discussion. Let's look into this progress - capabilities - limitations - selection factors and application factors - as told by manufacturers and users alike, as we, in the distribution field, may see it. Early Agronomists back in the 30's and 40's found that arsenicals could be accumulated in the soil, but at that time made no real use of this fact. Finally in the early 50's a combination of arsenic oxide and lead arsenate were tested, Purdue doing a great deal of the basic work.

You in turf work may well remember a commercial product called Pax, a very effective arsenical combination, which gave excellent results for homeowners and turf men as well. At almost the same time, the use of lead was paralleled by some new, non-arsenical materials, all with varying degrees of success and failures. Progress still has come rapidly.

Fortunately many of the chemicals have been found to do many different pre-emergent jobs. So, therefore, let us look and ask ourselves where they fit and what do we want to accomplish?

Most of our broadleaf weeds are easy to control post-emergence, and are no real problem with today's materials. We are, therefore, trying to protect numerous crops, including turfs so that we can get pure stands and clean beds of ornamentals and nursery stock. In the case of these last two categories we want to hold off germination of all weeds, broadleaf and grassy, throughout the blooming season.

Ratings of these chemicals vary from area to area, but in general we can give some ratings and evaluation of usages, according to experimental data, and from first hand usage by you as turf men and landscapers. Let's take some various situations and materials -

Type 1 - for use on established turf that is either too young and not tight enough, or thinned out by disease, verti-cutting, aerification, or lack of proper nutrition and management. Here we find the widest range of products doing a basically good job. Some of these include:

a. Zytron - one of the earliest and best and most effective in early ratings, but now has been taken off the market. Its active carry-over was some 5 to 7 months and gave a full season of protection. Its cost was somewhat higher than other materials and perhaps reduced sales.

b. Dacthal - excellent results with low, reasonable cost at manufacturer's rates - accounts for its popularity.

c. Bandane - at good control rates. Cost here is somewhat higher than average, but still very popular.

d. Benefin, or Balan - although not as tried in our immediate area, it is quite reasonable to use, and in many areas looking good.

e. Tupersan - excellent results, very safe, but not as good on hard crab or goosegrass as others.

f. Calcium arsenate - giving good control, but quite expensive by comparison on initial cost. It, however, has carry-over from season to season and weed prevention can be continued by smaller booster applications each year. The concern, however, must be not to overdose and endanger existing grass growth, or new germination. Widely used for Poa annua control.

g. Chlordane - Long has been and still is a favorite on many golf courses and general turf areas. Even though medium cost, Chlordane still does double duty protecting also against soil insects of all kinds.

In general, the above chemicals range in price from about $ 18.00 to over $ 100.00 per acre. Some recent research has been done on the non-arsenicals which have been showing no soil residues carried over from one season to another. This point deserves real consideration for future research.

Type 2. Secondly, we have another situation where we want to stop weeds and at the same time be able to plant grass seed. Here we have a limited field; about the best qualifiers are:

a. Tupersan has done an excellent job and has been combined by many manufacturers in combination of fertilizer, soil insect control and Tupersan.

b. Chlordane has long been used where immediate seeding is desired.

Type 3. Still another problem has required a pre-emergence material that is safe on bentgrass. Here again there is basically one chemical found in both Pre-san and Betasan. Has been relied on heavily on new bent greens and Northern bent lawns to protect them through early stages of development. It has also been found as a deterrent to germination of Poa annua in the soil.

Type 4 for ornamentals, flower beds and certain commercial crops we find these included:

a. Dacthal - very easy to use and quite effective. It requires no cultivating in, yet covers a wide range of weeds both grass and broadleaf.

b. Treflan - good especially for commercial crops where practical to cultivate into top few inches of soil.

c. Amiben - excellent when used according to directions. No working in by cultivation after original weeding of beds.

d. Eptam - used primarily on commercial crops, but here again a product that requires getting into soil 4 - 6 inches deep by cultivation before it is effective. This really eliminates this product for turf use. Other similar products not practical on turf include: Simazine, Amazine, etc.

In all of these type 4 materials beds must be cleaned weed-free before application. Use exact quantities indicated on label to avoid stunting of the crops they are intended to protect.

Some general Points to Remember about Pre-emergence control

1. Control effectiveness is lost if soil surface is disturbed. Examples of cases which would break the barrier would be:
   a. Moving soil as in replanting
   b. Deep verti-cutting or aerating
   c. Seeds brought to surface in worm casts
   d. Taking divots from tees

2. Heavier rates are generally found necessary on heavy or clay soils, and high organic-matter soils. This is also true on heavily thatched turf.

Up to now we have talked only about chemicals, but we need to remember that there are other methods of fighting weeds, particularly after the chemicals have taken care of the first stages of early development and establishment. These include:

a. New varieties of turfgrasses that start faster and thicken more quickly.
b. Proper management and timely use of fertilizers. For example, there is much evidence recently that high rates of potash are producing heavy, tight stands of bluegrass and fine-leaf fescue turf.
c. Watching seeding rates - not too high - causing weakness and damping-off; not too low causing thin stands taking too long to fill in.

In summing up, I think we might draw a few conclusions. We must carefully -

1. Determine exact control problems.
2. Select the right chemical and consider its limitations
3. Be sure of application timing. Split applications for safety and rate adjustment
4. Check labels for manufacturer's rates for your job
5. Use the right equipment for most efficient application

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CAREFUL WITH CHEMICALS!

Paul Mechling, Supt., Sylvania Country Club
Sylvania, Ohio

In this era of high-speed travel, hippies, etc., we are constantly "bombed" with precautions against non-use of seat belts, the dangers of the side effects of certain helpful drugs, the dangers of excessive smoking, etc. What about the precautions needed with the everyday chemicals that you and I use in the pursuit of our duties around the golf course? Why not a little "Caution with Chemicals?" Maybe the incidents set forth below will point out the need for more "Caution with Chemicals."

Incident #1

During the summer of 1965, I had the misfortune of having a man almost lose both eyes from chemicals. The chemicals were Thiram (Tetramethylthiuram disulfide - 75%) and PMA (Phenyl mercury acetate solution - 10%). The young man's name was Dean Siler and this was his first and last time to handle these chemicals. He had handled other chemicals, i.e., 2,4-D and Dicamba without any ill effects.

On this day Dean's supervisor sent him out to spray the greens with a mixture of Thiram and PMA. The mixture was such that we were attempting to apply 2 ounces of Thiram and 1/2 ounce PMA per 1,000 sq.ft. on a "prevent" schedule. It was a warm day with a wind gusting from all directions and it was impossible to work upwind from the spray mist. There was safety equipment available somewhere, and, since this was a municipal operation, there were written orders to use the safety equipment whenever danger was imminent. However, in the past no one had ever had any adverse effects from the above chemicals, so NO ONE was enforcing the regulations.

At lunchtime Dean complained of a burning sensation in his eyes and nose, and on his skin. Since all of us had experienced this sensation when handling Thiram and PMA, we dismissed his complaint as "normal" reaction. The next morning when Dean showed up for work we realized how "normal" was his complaint. Dean's eyes were swollen almost shut, he couldn't breathe through his nose, and his face was puffed up like a chipmunk's carrying nuts. The doctor's diagnosis was a mild allergy to the chemicals being used. The net result of this experience was the loss of a good man for two weeks and a concerted program of safety in handling and using chemicals.

Incident #2

During the second week of August, 1967, while in the process of treating timbers for a bridge that we were repairing, I had a young man get a face full of wood treating chemicals - (Pentachlorophenyl - 5%). In an effort to increase efficiency and reduce employee fatigue, I decided to use a small, compressed air-type sprayer to apply the Penta-treat material. My foreman and I checked the sprayer to be sure that it worked properly; that the lid sealed properly, and that the connections were all properly secured. We even checked the hose and decided that, although it was getting along in years, it would be O.K. for this material.

The man using the sprayer was dressed in protective clothing, including rubber boots, rubber pants and gloves, but NO face protection. We felt that face protection was unnecessary since the operator would be working at nearly arm's length and around his feet with a relatively low pressure and a coarse spray mist that would not drift appreciably.

Everything was fine until the hose ruptured and the materials hit the operator in the face. Had he been wearing a face protector or goggles the worst that

could have happened would have been a few blisters on the skin. He had NO face or eye protectors. Consequently, both eyes were filled with Pentachlorophenol. Fortunately I had the presence of mind to put him in the shower and flush his face with clear water before taking him to the hospital for further treatment, otherwise, he might have lost one or both of his eyes. The young man was fortunate that he did not lose his eyes, or that they were not permanently damaged. However, I lost the services of one of my best men for three days during the busiest week of the year.

Incident #3

At another time early in 1967, I was attempting to transfer some PMA from a 55 gal. drum into a gallon jug. The valve in the barrel opened faster than I expected and the material gushed out, hit the funnel and splattered. I jumped back quickly so that it missed my face, but it still splashed on my hands and arms. I shut the valve and washed immediately with soap and water. The total time lapse could not have been more than two minutes. However, I still had several blisters where the PMA hit the bare skin.

So! What's all the fuss? No one was seriously injured. The "So! What-" is this: It is unnecessary for anyone to suffer the discomfort of an injury when safety equipment is available. If the necessary precautions are taken and safety equipment is worn or used, everyone will live longer, live happier, and you will get more work done. Using chemicals without safety equipment is like walking in fire - if the burn isn't too bad there won't be any scars.

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CAUTION WITH CHEMICALS

Paul Burdett, Burdett's Inc.,
Lombard, Illinois

This chemical racket is getting more complex. I keep telling myself this, but I can never forget when I was initiated into the complexities of golf course maintenance. I was fertilizing a green with sulphate of ammonia. In those days we put the stuff into a barrel on the green, filled the barrel with water, stirred it with a paddle, then while still stirring it, dipped the solution out with buckets, splashing it as evenly as possible over the green. Then one man was set to water it in for an hour, going over and over the green, and the rest of us went on. I grabbed the wheelbarrow with the buckets and sulphate in it. Three days later the boss took me over to the rough and showed me a two inch trail burned clear to the ground from one green to the next. When I realized that my carelessness had caused this burn I exclaimed, "They should not be able to sell a material as dangerous as that stuff." I have heard that comment many times.

The newer chemicals are, for the most part, far less caustic than were the older ones, and the application rates for the old ones are far less than they used to be. Calomel and corrosive sublimate mixtures used to be applied at 3 ounces per 1,000 sq.ft.. Mercury burn on turf was sometimes disconcerting and often verged on the disastrous. Our bosses in those days had one real good cure though - when a green went bad, for whatever reason, we had a topdressing session and maybe put it on a little heavy. By the time the greens grew out they came back clean, even and beautiful. Of course, the weather had changed too.

Our modern fungicides rarely cause additional discoloration on turf. With the

numbers of chemicals that are available, the numbers that are sold, it is a wonder that human error does not cause more difficulty. Twice in the last two years I have found myself delivering the wrong material - once I caught the error, and once the superintendent noticed it.

We have an example, (this happened many years ago) of the superintendent who told his spray man to clean and drain the spray tank. The job did not get done, and the material used and remaining in the tank was a weed killer that would eliminate plant growth for three years. When the sprayer was used again for spraying the greens, the material first out of the sprayer killed the grass on the green. The soil was later removed to a depth of four inches, replaced with new soil and sodded.

A few years ago an employee of a good friend of mine was told to add Chlordane to the greens mixture. He got hold of a bottle of Garlon, a grass and weed killer material. He got six greens treated before the error was discovered. The treated greens were washed thoroughly and, fortunately, the dosage was so mild that only slight discoloration resulted, but we spent many anxious weeks till the bent recovered.

Last year I sold some Dowpon, a material that kills grass and cattails. The superintendent sprayed the cattails at the edge of the pond alright and they died, but he neglected to clean out the sprayer. We both found out that the Dowpon is an excellent grass killer. A strip on the edge of the green, some 5 ft. wide by 40 long, is still brown, killed by the Dowpon that remained in the pump and hose. It is a good idea to flush out the tank and pump it out through the pump, hose and gun.

I get worried about multiple dosages where some superintendents mix as many as five materials in a tank at one time. These sometimes include a fertilizer, two insecticides and two fungicides, all to be put on in one application. Usually the application is successful, but two years ago I had a complaint that the greens looked worse a few days after treatment than they did before. The superintendent, a close friend of mine, and I sat for two hours mixing the materials together and found that if we added the chemicals together in one sequence they curddled. If we used another sequence it made a usable, smooth, although horrible looking mixture. Of course, I argue that good chemicals are worthy of individual application, but my friend had had more experience than I have had. Time was precious, he knew it could be done and he saved time. As the time of stress passed he was able to drop out some of the materials. He thoroughly cleans the tank and flushes out the hose and pump after each use. If that mixture ever settled in the pump between use, the pump would have had to be taken apart and cleaned before it would run again.

All mistakes are not disastrous. Sometimes we learn a new way to do a job better. Some years ago a friend wanted to clean the weeds out of his watering pond, and sent a man for the usual sodium arsenite liquid. I learned later that the man had put 2,4,5-T in the pond. The pond had no weeds in it for years after that. When I learned of this error I watched the beautiful trees surrounding the pond for years. He never lost a leaf, nor was there any sign of injury. Later one of the companies got an aquatic weed label.

We sometimes have a call for a material to use under fences so bind weeds and other weeds would not grow and climb up the chain link fences. For this purpose we use an 8G Atrazine, and suggest its application with a little horn seeder. Used as lightly as possible, it will still sterilize the soil and give the full year protection. One day a favorite customer took me to the fence where the man had come down the hill with the material. Then we got a gully-washer rain and he had a spot about 20 x 20 feet where no grass or weeds grew for a long time. Fortunately, the shrubs destroyed had little value.

I delivered some ammonium nitrate once; the bags were in poor condition, and there was considerable material left in the truck. I backed up to the edge of the warehouse lawn, swept it off onto the grass. It has taken two years before even the quackgrass is re-establishing itself. Last year I busted a bag of Nu-green in the warehouse. I cleaned up the mess, swept the remainder in a shovel and used the old topdressing sweep on the grass. We all know it is harmless and won't burn. I noticed during the January thaw that some grass was growing there again, and it sure was bright green.

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WOULD YOU BELIEVE?

R. C. Meier, Jr., Turf Equipment Sales
Cincinnati, Ohio

It is my pleasure to promote, discuss, deliver, collect for and see the results of modern chemicals for Turf Management. Like other distributors, the problems and the successes both provide education.

I am keenly interested in what is published for it gives clues to better understanding. A golfer had bad eczema during the summer for three years. He noticed it became worse after walking past workers spraying greens. In checking it was found the fungicide containing Thiram was causing his sensitivity, and Thiram is put into many things, including artgum erasers.

We can expect continued FTC, USDA and other agency regulations attempting to restrict mismanagement and reduce potential hazard. Obviously such restrictions should be based on practicality as well as theoretical concerns.

An excellent article appeared in the June, 1966, Golf Superintendent. It gave three recommendations -

a. Label all poisonous materials
b. Know symptoms and antidotes for materials used
c. Destroy materials you cannot identify.

The article rates chemicals from 1 (non-toxic) to 6 (super-toxic)

Insecticides

Chlorinated hydro-carbons	3, 4 and 5;	thus moderate to extreme toxic
Organic phosphates	3 - 6	moderate to super-toxic

Fungicides		Herbicides	
Mercuries	5	2,4-D	4
Thiram	4	2,4,5-T	3
PMAS	5	Arsenicals	6
Cadmium salts	5	DSMA	4
Acti-dione	5		

One way to reduce damage to individuals is to change clothes, including socks and shoes, immediately after using materials. This alone can reduce the absorption through the skin, the subsequent forgetting to be careful about contact with the skin, etc.

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FAIRWAY DISEASE CONTROL

Robert E. Scobee, The Upjohn Company
Kalamazoo, Michigan

During the past few years there have been considerable changes in golf course maintenance practices. Our goals and plans have been revised many times to include ideas we thought were impossible just a few short years ago. Twenty years ago if a golf course superintendent could successfully maintain 18 putting greens, both he and his club were well satisfied. But, this was not enough! Next, the interests and demands of golf, plus the desire of the golf course superintendent to maintain better turf, brought concern for the fine maintenance of tees.

We are now at the point of progressing one more step in golf course maintenance. The golf course superintendent and the golfers, in general, are no longer satisfied with high level maintenance on greens and tees alone. Golf course fairways must now be dense, soft green carpets of turf comparable to that of putting greens and tees. In order to maintain the so-called "perfect fairway turf," there are six essential factors:

1. Wise CULTURAL PRACTICES
2. Adequate FERTILIZATION
3. Needed IRRIGATION
4. Prompt WEED CONTROL
5. Restrictive INSECT CONTROL
6. Sufficient DISEASE CONTROL

All of these must be incorporated into a sound program. Each factor can be considered a piece of the "maintenance puzzle." If any one piece is missing, the picture cannot be completed.

For the next few minutes I would like to discuss with you the part of the puzzle called disease control. In the midwestern part of the United States, the major fairway diseases are caused by the leaf blight organisms. These include such diseases as leafspot and melting-out caused by Helminthosporium; fading-out caused by Curvularia and Sclerotinia dollarspot. It is generally recognized that the Helminthosporium complex poses one of the most serious threats to the successful production of quality turfgrass in the Midwest. The reasons for this belief can best be explained by reviewing the growth habits of the causal organism.

Leafspot or melting-out, in its many and varied forms, is at best a sneaky disease. The damage caused by leafspot is best likened to the common cold. The initial infection may not constitute much of the problem, but, if left unchecked and encouraged by the environment, it may develop into an extremely serious problem. Disease infection may occur at various times of the year, usually under cool, moist conditions. Turf may also be infected with the disease for a long period of time before definite visual damage is observed - all the while the turf is being weakened.

Melting-out or leafspot cause turf loss either by direct infection and death of the crowns of the plants, or it can merely infect the foliar portions of the plants, weakening them to such a point that the turf is extremely susceptible to drouth, wear and other diseases. In many cases by the time visual damage is observed and the organism has been controlled, the turf has been thinned to a point that recovery is a lengthy process at best. For this reason, it has become necessary to spray for this disease in a regular preventative schedule.

The development of a practical fairway disease control schedule requires considerable attention be given to the demands of each golf course. Many of these demands vary in some degree from one golf course to another. The following six areas should be carefully evaluated:

1. Limitations in BUDGET
2. Level of total MAINTENANCE
3. Susceptibility of GRASSES used
4. Damaging of major DISEASES
5. Extent of disease CONTROL expected
6. Disease favoring ENVIRONMENT

Once you have determined the needs and goals of your club, you must then select a fungicide that will do the job you desire. When considering the proper fungicide, again there are a number of factors of prime importance:

1. Must be effective on the leaf blight organisms, such as melting-out, fading-out and dollarspot.
2. Must have a long residual
3. Must be easy to apply
4. Must be safe to both turf and user, and
5. Must be economical

There are a number of fungicides on the market that meet part of or all of the above requirements. Careful attention must be given to the product that best fits the above requirements. Before making a final decision on any fungicide, I would very strongly suggest contacting your local supplier, or the sales representative of the respective manufacturer and discuss the characteristics of the fungicide.

During the next few minutes I would like to briefly review with you the approach we at TUCO have taken in establishing a fairway spray schedule with our products. We have placed primary emphasis on the early-season control of Helminthosporium for the reasons I discussed earlier. We feel very strongly that effective control of this organism in the early part of the year is extremely vital in protecting the turf during the entire growing period. Control of this early-season disease will give healthier plants that are more capable of resisting drouth, wear and other diseases.

Acti-dione RZ is the basis of our fairway spray programs, and we suggest it be used at the rate of 1.5 pounds per acre. In cases of severe disease infection we also recommend supplementing the Acti-dione RZ with Acti-dione Ferrated at the rate of one unit per acre. Under most conditions this will not be necessary.

We suggest that the first fungicide application be applied as close after the first mowing as possible, preferably within 7 - 10 days. At the first mowing the weather is usually sufficient for this disease to attack new plants, and there is an abundance of disease spores present that have overwintered in infected plant crowns and in the soil. Also, the first mowing is normally a relatively severe clipping which makes a natural avenue for disease invasion. This first treatment is designed to control the disease before it has a chance to spread to new plants.

Our next three to four applications of Acti-dione RZ are spaced every 21 - 30 days throughout the spring and early summer months. These are preventative sprays; again primarily for the control of Helminthosporium complex. It is during these months of the year that Helminthosporium is most active and destructive. It will normally take three to four sprays to give protection throughout this period. The remaining three to four applications of Acti-dione RZ are primarily for the prevention of dollarspot, although under proper conditions, cool, moist periods, melting-out and fading-out can be troublesome.

In summary, it is our feeling that in order to control diseases in fairway turf, whether the turf is bent, bluegrass or Poa annua, a program of this nature is essential. Some of the timings will vary according to the growing season in your area, but the basic objectives will still apply. The ultimate goal is to control fairway disease sufficient to conserve and utilize all greenness possible.

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RENOVATION TOWARD BENTGRASS

Ted Woehrle, Supt., Oakland Hills Country Club
Birmingham, Michigan

Why renovate in the first place? After several failures during the past ten years on the fairway turf at Beverly Country Club, Chicago, Illinois, it was decided to attempt a permanent change in the grass population. The fairways until two seasons ago were continually deteriorating. The percentage of Poa annua was on the increase, and the extent of potential failure was also on the increase. There were several good reasons for this worsening condition. Some of these were:

1. Poor tight soil, causing poor drainage
2. Poor water management caused by an over-designed irrigation system, indirectly related to poor soil.
3. Poor cultural practices throughout the years. Turf over-managed for good looks instead of good health, causing an over-stimulation and a severe "thatch" problem - again indirectly related to poor soil condition.

Beverly had become addicted to management of Poa annua. We were trying to live with our problem instead of curing the problem. After much thought it was felt that we could eliminate the Poa annua by a complete renovation. If this could be accomplished we could once more maintain a desirable turf as we know it should be maintained. We could theoretically use less water; therefore, there would be less compaction,and better soil and air relationship would result. All of this would lead to less thatch and a healthier turf.

Now, how does one go about controlling Poa annua on fairways at a private club without causing much alarm and resentment by the membership? Could we do this without making the place look like the Sahara Desert?

I knew that Poa annua could be selectively controlled in areas containing some desirable grasses. Once the Poa was weakened, how do we replace it with the more permanent grasses? Can we expect germination of bluegrass or bentgrass seed in treated soil? I knew from experience learned while at student at Purdue, that we could expect germination and survival of the desirable grasses seeded into soils treated with arsenicals. This is why we decided in the late summer of 1966 that we would attempt Poa annua eradication and the product used was Tri-calcium arsenate.

RATES to be used and the TIMING of the program were still quite vague. Several reports of success, as well as several reports of failures in similar programs, had been reported. The secret seemed to be in soil analysis. The soil was thoroughly analyzed by a competent soils laboratory and the results were studied. After consulting with Dr. Danial, it was decided to begin our program with a treatment of four pounds 80% Tri-calcium arsenate powder suspended in water per 1,000 sq.ft., or a little over 150 lbs. per acre of material.

One week later we seeded a mixture of bluegrasses at the rate of 20 pounds per acre with an alfalfa drill seeded into the thatch. We saw a good germination, but poor survival.

The next application of Tri-calcium arsenate was about one month later. By now the Poa was pretty sick. It was either dead or dying. A second seeding was made one week later. This time we decided to abandon the drill seeder. We felt that very little seed was actualy coming in contact with the soil because of the heavy thatch problem; that survival would be much better if the seed could make contact with the soil. It was decided to try the tractor mounted Aero-blade and seed

after this operation, and drag the seed into the open furrows left by the Aero-blade by dragging a piece of chainlink fence around. As it turned out, we had good germination and good survival.

A strange thing was happening throughout this entire period of renovation. Even though there was only a small population of bentgrass in the old fairway turf, we began to notice that the small patches of creepingbent grass were beginning to grow now that competition for space was lessened by the thinning of the Poa annua. We were actually gaining bentgrass faster than bluegrass. As it turned out, by the end of 1967, we have about 80% bentgrass, 10% bluegrass, and about 10% Poa annua.

For all intents and purposes this ended the program for 1966. As winter approached, we continued to hand-seed a mixture of seed and soil into the thin areas. By now we realized that the bluegrass was not doing as well as the bentgrass so we began to use Seaside bentgrass in our seed mixture.

The spring of 1967 came on with a bang and the Poa was still weak, so it was decided not to apply additional arsenate. We were also concerned about the Western Open which was to be held at Beverly in August. If at all possible we wanted to have as much turf cover as normal whether it be Poa annua, or some type of permanent grass.

In early June, we ran into a short hot spell and the Poa was under stress, and it began to die quicker than anticipated. We were ready with several types of liquid phosphates that could be sprayed on the leaves of the weakened Poa to help sustain the plants through this period. True, we were interested in killing the Poa, but at the same time we wanted some grass for the tournament. For the remainder of the season we were able to control the death of the Poa almost at will. A light application of foliar spray with a liquid phosphate would revive the plant for a week or ten days without destroying the program by applying too much into the soil and disturbing the relationship of arsenate and phosphate.

A third application of Tri-calcium arsenate at the rate of 2-1/4 lbs. per 1,000 sq.ft. was applied this past fall in October. The Aero-blade was once more used to advantage. Very little seeding was done. Seaside bent was used in some of the thin areas usually found in slight depressions where water stood for short periods of time. More of the chemical seems to be broken down when under water, therefore causing a more toxic effect in a shorter period of time. In some cases it almost appeared that complete sterilization took place when areas remained under water for any length of time. Good drainage is a must. Slit trenches proved very valuable under these conditions.

If anyone is contemplating such a program as I described this afternoon, please heed this advice. Try several areas with different rates for a year or two before jumping into a complete program. Soils do vary and the amount of material needed will vary. There is still some doubt in my mind about the procedure. Do we attempt to establish our permanent grasses in the existing Poa before applying the chemical, or do we apply the chemical to weaken the more vigorous growth of Poa annua before we seed so the permanent grasses will have a better chance to compete for space? What is the proper timing?

Above all I feel that the most important point to consider in the entire program is the ground work that is necessary in informing the membership. You must make them understand there will be some pretty sorry looking grass for a short period of time. Things will look worse before they look better.

Once you have completed the renovation program it will be much easier to maintain the fairway turf because you will not be fighting to keep Poa annua and therefore you will not be forced to manage turf the way we know is not correct.

There have been enough successful programs in fairway renovation that we can have a little more confidence in our programs, and they should also be a little easier to sell to your membership. So, start now and experiment with several of the chemicals available on the market and be ready to go into a program as soon as the proper time presents itself, or as soon as you are tired of living with Poa annua.

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MACHINERY AND TIMING IN RENOVATION - BLUEGRASS

Charles H. Tadge, Supt., Mayfield Country Club
Cleveland, Ohio

At this time I will try to avoid repetition of details reported to you last year of our experience in converting from Poa annua to bluegrass fairways at the Miami Valley Golf Club. It is hoped that this can be somewhat of a critique of the approaches we considered and tried before our program was finally successful.

A turfgrass renovation program is basically a conversion from an undesirable plant cover to a desirable turfgrass cover. Two general steps are involved; first, to get the new grass planted and growing, and second, to reduce competition for the new seedlings. Under these, come methods and machines for preparing the soil, seeding, and applying chemicals to reduce competition. To compound all of these problems, we must consider correct timing for each operation.

Reduction of competition from weeds should never be overlooked in a renovation program. Complete kill of all plant cover might be the most agronomically sound approach, but is usually not the most practical on a golf course fairway. The typical golfer response to our renovation plans is usually, "Do anything necessary as long as it doesn't interfere with play." We all know this is impossible, but we must try to choose the procedures which will least inconvenience the golfer.

After determination of what weeds make up the undesirable portion of the turf, we have to decide what herbicides will best effect a control. Broadleaf weeds can be eliminated when actively growing with one of several chemicals. However, seeding must be delayed three or four weeks to prevent injury to young seedlings. Poa annua is not as easy to control selectively.

In considering the proper time for seeding, we knew that bluegrass and bentgrass seed would germinate and grow from March through October in the Midwest. Germination and growth is best in late summer when soil temperatures are the highest. Care of new seedlings is easier as fall approaches with the shorter and sometimes cooler days. Unfortunately, this is also the natural germination and growth period for Poa annua. Therefore, we must seed as early as possible to get the jump on the Poa annua, but late enough to be past the crabgrass season and to reduce inconvenience during the height of the golf season.

Soil preparations could vary from complete plowing to vertical slitting and aerification. The more important reasons for preparing the soil are to get the seed into the soil and to relieve compaction. Complete plowing or cultivation might be considered to bury all undesirable plants and seeds, if golfer reaction were not adverse. However, we might uncover as many problems as we bury.

The many types of machines used for soil preparation and seed application would include: core-type aerifiers, rotary hoes, disk harrows, grass seed drills

and vertical slicing or slitting machines. The slitting machines leave a lot of thatch or plant debris on the surface, which must be removed. This entails using a sweeper in the operation.

Seed may be applied with the seed drill, a cyclone type spreader, a drop-type spreader, or even in water suspension with a hydro-seeder. The grass seed drills are very good, but had been out of production and difficult to obtain until recently.

If Poa annua is to be eliminated, chemicals such as calcium arsenate might be applied in dry pellet form with cyclone or drop-type spreaders, or with a sprayer as a powder in suspension. Timing is also essential here so that desired seedlings are not inhibited along with the weeds.

Our renovation program initially started back in 1960 with some plots to test various chemicals for pre-emergence control of Poa annua and crabgrass. Since calcium arsenate performed best there, it was selected in 1964. In 1960 our fairway turf was about 80% Poa annua, and other weeds with bluegrass and bentgrass making up the remaining 20%.

For several frustrating seasons, the Poa annua turf would fail and be replaced by crabgrass, goosegrass, knotweed, clover and finally more Poa annua. Throughout this period we made various unsuccessful attempts at renovation. Failure was possibly due to our inability to reduce the competition through poor timing and inadequate methods.

From August, 1960, to August, 1964, we treated with various herbicides for broadleaf weeds with relatively good results. We seeded each year about the middle of September with from 20 to 100 pounds of bentgrass seed per acre. Soil was prepared by various methods. The agricultural rotary hoe was tried, but results were unsatisfactory. We aerified until we were terrified. We used a vertical slitting machine both alone and in conjunction with an aerification. This was a very satisfactory procedure, except on shallow-rooted turf where the aerification step caused too much surface disturbance. All seed was broadcast with a cyclone type spreader, except for some limited trials with a hydro-seeder. The broadcast method was fine as long as wind was not excessive. This must be followed with a chain link fence drag-mat, or similar device, to get the seed into the soil. Results with the hydro-seeder were about the same, but required more labor.

In August, 1964, after a very difficult summer, we estimated our fairway turf at about 70% Poa annua, crabgrass and knotweed. The other 30% was bluegrass and bentgrass. By this time we had cleaned up most of the broadleaf weeds.

Our renovation to date had gained us only about 10% more bluegrass and bentgrass. We felt our failure had been due to competition to the young seedlings. It was suggested that this competition could be reduced by proper timing of seeding and chemical control of the Poa annua.

At this time, we decided to try to establish a bluegrass blend, since turf maintenance of bluegrass appeared to be more economical and less troublesome. Perhaps our mid-September seedings had been a little late, so we decided to try late August to get the jump on Poa annua germination. We would have preferred early August, but once again desires of the golfer took first priority.

On August 31, 1964, we overseeded with 68 pounds bluegrass blend per acre. The fairways were opened up with an Aero-blade machine, making vertical slits two inches apart from 1/2 to 3/4 inch deep. Thatch accumulation was removed with a Mulch-Vac sweeper, starting in the center of the fairways and working out to scatter the material in the rough. This eliminated costly handling and disposal problems with the thatch.

Seed and fertilizer were broadcast with a Lely spreader and incorporated with a clain-link fence drag. When seedlings were up to mowing height, calcium arsenate applications were started. At this time the Poa annua could be inhibited without danger to the young bluegrass.

Calcium arsenate in the 85% wettable powder form was applied through a boom sprayer. It was necessary to use 50 gallons per acre nozzles to reduce clogging difficulties. Solution rate varied from 1 pound to 1.4 pounds calcium arsenate per gallon of water, with about 1.3 pounds applied per 1,000 sq.ft. per application. Several applications were made a few weeks apart to keep a fresh layer of arsenic on the soil surface. Also, the arsenic burn effect on the mature Poa annua weakened its competition to the bluegrass.

The seeding process was repeated again in late August of 1965 and 1966. The calcium arsenate treatments were continued spring and fall during 1965 and 1966 at reduced rates.

In September, 1966, we estimated Poa annua to be only 10% of our fairway turf. The remainder being divided at about 70% bluegrass and 20% bentgrass.

The key to our later successful renovation, as opposed to the earlier failures, I feel lies both in timing of the seeding, and most of all in chemical control of Poa annua. The methods of soil preparation and seeding remained about the same. We were also fortunate in having good advice as to the proper timing for the calcium arsenate applications. I hope that some of you will be able to benefit from this brief account of our trials and tribulations.

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FINESSE IN WEED CONTROL

Cecil F. Kerr, Chipman Chemical Company, Inc.
Kalamazoo, Michigan

Weeds are often defined as "any plant out of place." Recently many useful products have been developed which make weed control much easier, and much has been learned about control of weedy grasses, such as crabgrass and Poa annua.

Pre-emergence crabgrass killers must be applied early in the spring before crabgrass germinates. This date varies with different areas. Poa annua may be removed gradually by repeated light applications of tri-calcium arsenate to avoid unsightly bare areas. After arsenical toxicity is once achieved and Poa annua is removed, toxicity may be maintained with light annual applications.

Dicamba is an effective weed killer if used properly. Only light rates of Dicamba should be used above the roots of desirable trees and shrubs as the chemical may be picked up by their root systems.

2(MCPP) is a useful broadleaf weed killer. It is the safest selective herbicide that can be used on bentgrass. It is even safe to use on bentgrass greens. It is a slow-acting chemical which gradually removes weeds and allows desirable grasses to fill in without leaving unsightly bare areas. 2-(MCPP) combined with 2,4-D amine provides an excellent broadleaf killer for bluegrass fairways. This combination even kills knotweed effectively, as does Dicamba and 2,4-D mixtures.

There are many useful spray hints for efficient weed control. Apply between 20 and 40 gallons of water per acre. Operate pump at a pressure between 30 and 40 pounds per square inch. Replace worn nozzle tips. Never use metal of any kind to clean plugged tips. Every sprayer should be cleaned immediately after using.

It would be advisable to hang a useful information table of weights and measurements in your office. This table should include information such as:

1 acre equals 43,560 square feet
1 pound equals 16 ozs.
1 ounce per 1,000 sq.ft. equals 2.72 lbs. per acre
1 ounce per 1,000 sq.ft. equals 2.72 pints per acre
1 gallon equals 128 ozs.

It is extremely important that your weed sprayer be calibrated before using. Today's turf managers are applying sophisticated chemicals that require exact application. Application techniques are often more important than the choice of chemical.

Two useful calibration formulas are as follows:

(Gallons per minute) $G.P.M. = \frac{G.P.A. \times M.P.H. \times Width}{5,940}$ (nozzle spacing in")

(Gallons per acre) $G.P.A. = \frac{5,940 \times G.P.M.}{M.P.H. \times W}$

A spreader sticker should be added to every gallon of MCPP and 2,4-D applied to fine turf. The addition of a good quality wetting agent that both spreads and sticks makes sprays better, last longer, and keeps the spray from "beading" on foliage. This insures better penetration and coverage which affords more economical and effective control of weeds.

The biological effectiveness of any herbicide is vitally dependent upon the absorption of the chemical by the plant. This is demonstrated by Freed and Montgomery, who showed that 24 hours after application of Amitrol alone, 13% of the Amitrol was absorbed by the weed, while by addition of a surfactant - alkylaryl polyoxyethelene glycol in isopropanol - 77% of the Amitrol was absorbed.

All herbicides are subject to drift. Ester formulations of 2,4-D are volatile (pass off as a gas or evaporate) and drift for miles. Only safe amine formulations should be used on turf. All herbicides should be preferably sprayed with a covered boom to avoid physical drift. This is most important around trees and shrubs.

New weed killers are being developed that will make our job easier and more effective. Our Company is testing two compounds, Bromoxynil and Ioxonil. These chemicals effectively control weeds on newly seeded turf without injury to bluegrass seedlings. This will solve another problem in our turf management - another useful tool.

The control of weeds is a necessary component of a successful turf maintenance program. The control of weeds requires finesse in selection of the right chemical for a specific job and scientific application techniques.

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HERBICIDE RESEARCH AND FINESSE

Hayden Watkins, Graduate Student
Purdue University

Selective chemicals will control most broadleaf weeds. We are less fortunate in the area of grassy weeds. New chemicals for post-emergence use in turf are few, so we use the old standards that have served us so well.

Recently our interest has been directed at the improvement of the performance of these herbicides. Just the deposit of a herbicide on a plant is not quite enough. It must be taken into the plant and translocated to sites where its presence interferes with normal plant functions, resulting in the death of the plant. Most of these herbicides would be deposited on the leaf surface and taken into the plant through the leaf. Stem and root uptake is probably small in post-emergence herbicides.

Let me mention a few things that may alter herbicide performance. The STRUCTURE of the leaf is not very condusive to absorption of herbicides. Many leaves are covered with HAIRS. They prevent good contact with the spray droplet and the leaf surface. The CUTICLE, a waxy layer over the entire plant leaf surface of many plants, is a formidable barrier to many compounds. The STOMATA are considered by many to be an important means of herbicide entry. As you remember, the stomata are small openings in the leaf surface permitting exchange of carbon dioxide, oxygen and water from the inside of the leaf to the atmosphere surrounding the leaf. The individual CELL wall, composed mainly of cellulose, present the next barrier to herbicides. After all this there remains the problem of DISTRIBUTION through the plant.

Some herbicides seem able to penetrate the CUTICLE readily - others cannot. Surfactants probably aid in cuticular penetration by providing a larger deposit of the herbicide spray on the leaf, and also may actually aid in penetration through the cuticle. Water alone, if very coarse drops, tends to bounce off very waxy leaves. Surfactants aid in making this water stick to the leaf surface.

STOMATA are present on all aerial portions of the plant, but they are most abundant on leaves. Stomata frequency varies greatly on different parts of the same leaf and on different leaves of the same plant. Stomata may occur on both sides of leaves, or mostly on one side, usually the lower. The use of surfactants in spray solutions is believed to aid in penetration of herbicides through the stomata.

Temperature also influences absorption of herbicides. Absorption is considerably greater at higher temperatures, 70°-80° than at 50°-60°. Direct sunlight also increases absorption of herbicides, especially at lower temperatures. High humidity aids in absorption by keeping herbicides in the liquid state longer and reducing evaporation. The soil moisture is important to herbicide action by keeping plants growing vigorously. Temperature, sunlight and moisture all aid indirectly in herbicidal action by keeping leaves turgid, opening stomates and producing a vigorously growing plant.

It has been shown that 2,4-D is translocated from the leaf with natural food assimilates. Probably other compounds behave similarly. Any condition then favoring phytosynthesis and food translocation would also aid in 2,4-D absorption and translocation. This would result in better herbicide action.

Growth regulatory herbicides like 2,4-D should be applied at the recommended rates, not only for economic reasons, but also because too high rates tend to produce a localized kill in the plant leaf. This dead leaf then does not manufacture food and translocate it, and the herbicide does not move with the food. This pre-

vents translocation of the herbicide to other parts of the plant to kill the entire plant.

The amount of water used per acre does not seem to be critical, except good coverage is required. Young plants are more susceptible to herbicides than are older plants.

Now, I can summarize by giving the nearly ideal conditions for treating weeds for maximum herbicide effectiveness:

1. A clear day with sunshine
2. Warm temperatures (70-80°)
3. High humidity
4. Weeds young, small and growing vigorously
5. Little wind - to prevent drift and fast evaporation of spray solution
6. Soil moisture high
7. Last, but not least, select the herbicide carefully. Some are more effective than others on a specific weed problem or in certain situations. Consider the possibility of a mixture of herbicides for broader weed control, but be sure the herbicides are right - and used right - for the job.

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THE CHEMICAL CONTROL OF SOME AQUATIC PLANTS

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Most people have at some time observed a body of water heavily infested with aquatic plants and have wondered what can be done. Three general types of control techniques which have been employed are:

1. Mechanical
2. Biological
3. Chemical

Mechanical methods include the use of chains, mowers, and various other types of mechanical devices for the cutting and removal of the aquatic plant infestations. In general, these methods are costly and do not give much in the way of lasting control. In some situations the mechanical methods have aided in the spreading of aquatic plant infestations.

Biological methods include the use of bottom-rooting fishes, such as the carp and the use of fertilizer to produce turbid water conditions. These have been used in the past, but without great success. However, research on biological methods is continuing and in the future some biological methods may become available.

The remainder of the discussion will concern the use of chemicals for the control of aquatic plants. The procedures for the use of chemicals can be divided into three general steps:

1. Identification of the plant that needs to be controlled
2. Selection of an effective herbicide
3. Determination of rate and method of application.

On the following pages is a summary of the rates of herbicides which have been found effective on many aquatic plants common in the Midwest. The rates are listed under each aquatic plant, and the plants have been divided into six different groups based on the leaf attachment and their distribution in bodies of water. These are:

1. Emergent plants with roots in the pond bottom but with foliage extending above the water surface
2. Submersed plants with alternate leaf attachment
3. Submersed plants with either whorled or opposite leaf attachment
4. Floating-leaved plants with roots in pond bottom, but with leaves floating on the water surface
5. Free-floating plants, which may have roots but float freely on the water surface
6. Algae.

Many of the herbicides listed are relatively toxic to fish, but when used according to the recommended rate, these herbicides will not kill the fish. Use only those herbicides listed for each aquatic species. Do not increase the rate to obtain better control. Read the label carefully. Use ONLY those registered for aquatic use.

Most of the herbicides listed are for post-emergent application. Fenac and dichlobenil are for pre-emergent application. Dichlobenil is effective when applied either to the exposed pond bottom or through the water, but when it is applied through the water the rate of application must be increased. Fenac must be applied to the exposed pond bottom, as it is not effective as a pre-emergent herbicide when applied through the water. Applications of pre-emergent herbicides are recommended in March.

Many bodies of water have multiple uses, and there are restrictions on water use after the application of aquatic herbicides. Since this information is needed when an application of a herbicide is being considered, the time requirements for water uses have been summarized. These restrictions were assembled from the labels of the aquatic herbicides registered for use by the Department of Agriculture.

Casoron - Do not apply to water which will be used for crop irrigation, for livestock watering, or for human consumption. Do not use fish from treated waters for food or feed for a period of 60 days after application. Do not use in commercial fish or shellfish waters.

Fenac - Do not contaminate water used for irrigation or domestic purposes.

Ortho Diquat - Do not use treated water for human or animal consumption, swimming, spraying, or overhead and furrow irrigation within 10 days after application.

Granular 2,4-D - Do not apply to waters used for irrigation, agricultural sprays, domestic water supply, or watering dairy animals.

Aquathol - Treated water may be used for watering turf immediately. Water may be used for swimming and recreational purposes 24 hours after treatment. Seven days after treatment water may be used for irrigation, agricultural sprays, watering of livestock and domestic purposes. Do not use fish from treated water for food or feed within 3 days of treatment.

Aquathol-Plus - Treated water may be used for swimming and recreational purposes after 24 hours. To avoid the possibility of injury to crops and contamination of water and food for man and animals, do not apply to waters used for irrigation, agricultural sprays, domestic water supply, or for watering dairy animals, or animals being finished for slaughter.

Hydrothol-47 - Do not use fish from treated water for food or feed within 3 days after treatment. Do not use treated water for irrigation or for agricultural sprays on food crops for watering livestock or domestic purposes within the following periods:

up to 0.3 ppm -- 7 days after application
0.3 to 0.8ppm --14 " " "

Treated water may be used for watering turf.

Potassium Endothal - Do not use treated water for irrigation, or for agricultural sprays on food crops, or for domestic purposes within 7 days of treatment. Treated water can be used for sprinkling bentgrass immediately. Do not use fish from treated water for food or feed within 3 days of treatment.

Aqua-Vex (Potassium salt of Silvex) - To avoid the possibility of injury to crops and contamination of water and food for man and animals, do not apply to waters used for irrigation, agricultural sprays, domestic water supply or for watering livestock. Treated water may be used for swimming immediately after treatment.

Kuron (Ester formulation of Silvex) - To avoid injury, do not use Kuron where pond water is being used for irrigation (including rice production), for agricultural sprays, domestic water supply, or for watering livestock.

Group and species	Chemical, active ingredient or free acid equivalent	Rate of application	Remarks
EMERGENT PLANTS			
Arrowhead (Sagittaria spp.)	Use one of following:		
	2,4-D		
	ester (20% G)	1 lb/440 sq.ft.	Spread on water
	ester (4 lb./gal.)	1/4 cup/2 gal.	Wet foliage
	amine (4 lb./gal.)	1/4 cup/2 gal.	" "
	Silvex		
	ester 4 lb./gal)	1/4 cup/2 gal.	" "
	potassium salt (6 lb./gal.)	1/4 cup/2 gal.	" "
	potassium salt (20% G)	1 lb./440 sq.ft.	Spread on water
	Diquat cation	1/4 cup/gal.	Wet foliage

Group and species	Chemical, active ingredient or free acid equivalent	Rate of application	Remarks
Bulrush (*Scirpus acutus*)	Use one of following:		
	2,4-D		
	ester (20% G)	1 lb./440 sq.ft.	Wet stems
	ester (4 lb./gal.)	1/2 cup/2 gal.	" "
	Diquat cation	2 T/3 gal, and 1 tsp. non-ionic wetting agent	Wet foliage to the point of runoff
	Dichlobenil (aquatic granules)	11 lb./A.	Apply in March to exposed bottom soil
Cattails (*Typha spp.*)	Use one of following:		
	Dalapon	4 oz./gal. and 3 caps detergent	Wet foliage
	Amino triazole	2 oz./gal and 3 caps detergent	" "
	2,4-D ester (4 lb./gal.)	1/2 cup/gal. and 3 caps detergent	" "
	Diquat cation	2 T./3 gal. and 1 tsp. non-ionic wetting agent	" "
Creeping water primrose (*Jussiaea repens* var. *glabrescens*)	Use one of following:		
	2,4-D		
	ester (20% G)	1 lb./440 sq.ft.	Spread on water
	ester (4 lb./gal.)	1/4 cup/2 gal.	Wet foliage
	amine (4 lb./gal.)	1/4 cup/2 gal.	" "
	Silvex		
	ester (4 lb./gal.)	1/4 cup/2 gal.	" "
	potassium salt (6 lb./gal.)	1/4 cup/2 gal.	" "
	potassium salt (20% G)	2 lb./440 sq.ft.	" "
	Diquat cation	1/4 cup/2 gal.	" "
Waterwillow (*Justicia americana*)	Use one of following:		
	2,4-D		
	ester (20% G)	1 lb./440 sq.ft.	Spread on water
	ester (4 lb./gal)	1/4 cup/2 gal.	Wet foliage
	amine (4 lb./gal)	1/4 cup/2 gal.	" "
	Silvex		
	ester (4 lb./gal.)	1/4 cup/2 gal.	" "
	potassium salt (6 lb./gal.)	1/4 cup/2 gal.	" "
	potassium salt (20% G)	1 lb./440 sq.ft.	" "

Group and species	Chemical, active ingredient or free acid equivalent	Rate of application	Remarks
SUBMERSED PLANTS WITH ALTERNATE LEAF ATTACHMENT			
Curlyleaf pondweed (*Potamogeton crispus*)	Use one of following:		
	Endothal (2 lb. sodium salt/gal. or 10% G)	1 ppm	Apply on or below surface
	Diquat cation	0.5 ppm or 1 gal/surface A	Same as above
	Dichlobenil (aquatic granules	200 lb./A	Pre-emergent application
	Fenac	See manufacturer's directions	Must be applied to exposed pond bottom
Leafy pondweed (*P. foliosus*)	Same as for curlyleaf pondweed or use one of following:		
	Dichlobenil (aquatic granules)	400 lb./A	Pre-emergent application
	Fenac (sodium salt of 2,3,6-trichlorophenyl-acetic acid or 10% G)	See manufacturer's directions	Must be applied to exposed pond bottom
Sago pondweed (*P. pectinatus*)	Same as for curlyleaf pondweed, or use one of following:		
	Dichlobenil (aquatic granules)	100 lb./A	Pre-emergent application
	Fenac (10% G)	See manufacturer's directions	Must be applied to exposed pond bottom
Small pondweed (*P. pusillus*)	Same as curlyleaf pondweed		
SUBMERSED PLANTS WITH WHORLED OR OPPOSITE LEAF ATTACHMENT			
Buttercup (*Ranunculus* spp.)	Diquat cation	0.5 ppm	Apply below water surface
Cabomba (*Cabomba caroliniana*)	Hydrothal-47 (di(N,N dimethylalkylamine) salt of endothl; L or G)	2 ppm	Same as above

Group and species	Chemical, active ingredient or free acid equivalent	Rate of application	Remarks
Coontail (Ceratophyllum spp.)	Use one of following:		
	Endothal (potassium salt)	2 ppm	Spread on water
	2,4-D ester (20% G)	2 ppm	" "
	Silvex ester (4 lb./gal.)	2 ppm	Apply below water surface
	Diquat cation	1 ppm or 2 gal/ surface A.	
Slender naiad (Najas flexilis)	Diquat cation	1 ppm or 1.5 gal/surface A	Same as above
	Dichlobenil (aquatic granules)	200 lb./A	Pre-emergent application
Southern naiad (N. guadalupensis)	Diquat cation	1 ppm or 1.5 gal/surface A	Apply below water surface
	Dichlobenil (aquatic granules)	200 lb./A	Pre-emergent application
Watermilfoil (Myriophyllum spp.)	2,4-D ester (20% G)	2 ppm	Spread on water
	Silvex ester (4 lb./gal)	2 ppm)	Apply below
	potassium salt (6 lb./gal)	2 ppm)	water surface
	potassium salt (20% G)	2 ppm	Spread on water
	Endothal		
	sodium salt (2 lb./gal.)	3 ppm	Apply below water surface
	potassium salt	3 ppm	Spread on water
	Diquat cation	1 ppm	Apply below water surface
	Dichlobenil (4% aquatic granules)	240-375 lb.A or 2.5-3.8 lb./ 440 sq.ft.	
	Fenac (sodium salt of 2,3,6-trichlorophenyl acetic acid or 10% G)	See manufacturer's directions	Must be applied to exposed pond bottom
FLOATING LEAVED AQUATIC PLANTS			
American pondweed (Potamogeton nodosus)	Use one of following:		
	Endothal (10% G)	1 ppm	Spread on water
	Endothal (2 lb. sodium salt/gal)	1/2 cup/gal	Apply to leaves
	Dichlobenil (aquatic gran.)	2 lb./440 sq.ft., or 200 lb/A	Pre-emergent application only
FREE-FLOATING AQUATIC PLANTS			
Duckweed (Lemna minor)	Use one of following:		
	Endothal (2 lb. sodium salt/gal.	1 cup/4 gal.	Apply to water surface
	Diquat cation	1 cup/4 gal.	do
ALGAE THAT RESEMBLE TRUE PLANTS			
Chara (Chara spp.)	Use one of following:		
	Dichlobenil (Aquatic gran.)	100 lb.A.	Preemerg.app. only
	Coppersulfate	1 ppm	Post-emergent
	Hydrothol-47	0.2 ppm	do
Filamentous algae	Copper sulfate	1 ppm	Post-emergent
	Hydrothol-47	0.2 ppm	do

GETTING AND USING INFORMATION ON WORK APPLICANTS

Robert Feindt, Supt., Otter Creek Golf Course
Columbus, Indiana

No matter what our titles may be, Golf Course Superintendent or Superintendent of Grounds, we are also, in a sense, a personnel interviewer and personnel manager. Certainly we don't have the need for a full-time personnel department on the golf course as would be in the case with a large company. But, each time we hire someone we interview them and we obtain information about this person.

Usually when a person applies for a job or position with a large company, he will fill out an application for employment form - this is just standard procedure. The applicant is asked to give a personal resume of himself, such as age, height, weight, address, phone number, etc. Also, he will give a resume of his education, military background, past employment or experiences. He will be asked to list personal references (people who have known him), and also to give a brief medical history. He may be required to take a physical and even a written examination. Now, this information gives the employer or interviewer some picture of the applicant. This information will be reviewed, and if the applicant can fill the needs, he usually is hired.

A very simple job application form can well fit the needs of the Golf Course Superintendent. Instead of just conducting a verbal interview and not being able to retain all the information, have the information written down. I don't mean that a verbal interview is not important - it certainly is. You can learn a lot about a person by talking to him. Many a person has talked himself out of a job by being outspoken, or by being self-centered. I feel you need both a verbal interview and written information. Then, after you have a number of applicants, analyze this information, check with past employers as to general conduct, initiative, dependability, honesty, and most important how does he get along with other people. One agitator can disrupt the harmony of a good maintenance crew.

Put yourself in your employees place - would I want to work along side this individual? As you well know, there are many unpleasant tasks on the golf course that are a must. These jobs will get done more efficiently if there is harmony among the men. You as a supervisor or employer can see that each man is pulling his fair share of the work load when you are present, but what happens when you are not present!

Obtaining basic information from a job application form and using this information could prevent you from hiring the wrong person and disrupting your maintenance program. Heaven only knows how some of our programs are disrupted by weather conditions, equipment breakdowns and from heavy play.

If your crew is made up of high school or college students and they do not have a previous work record, you can obtain information from their school principal, or guidance counselor. These young people can do a real fine job on the golf course and many of them need summer work. But, they must be screened the same as people seeking full-time employment.

Usually on a job application form when a person lists references, he will list someone that is a good friend, and usually a good friend will give the applicant a good recommendation. You wouldn't want to rely on this source of information alone, but it can be weighed with information from other sources and help you make a decision on who to hire.

In our line of work there are periods when we only need people for a limited

time or to complete a project, or we are in a hurry to get certain jobs done before the big tournament, or before weather gets bad. You don't have time to obtain past work information, or you can't contact former employers. If the individual looks questionable, check with your local or state police, and if he has been in trouble they will have a record of it. I have made it a practice never to hire anyone on our first meeting without first getting some information about the person. If you are not sure check somewhere or with someone - you might be saving yourself or your club some money.

Having the medical history of employees is very important. You certainly don't want to be involved with an insurance loss resulting from an old injury. A physical examination can usually detect injuries or problems.

We had a good example of this at our Club. A young man applied for a job and on his application form he stated a medical history of a disformed disc in the lower back. He was turned down from various factories and had trouble getting a job. After talking with him I found it was a childhood defect. I then discussed the matter with my board members and we decided to have him re-examined by a local industrial physician. He was given a complete physical, X-rays were taken and upon the doctor's recommendation we hired him, and he has been doing a fine job. The doctor didn't even charge us for this service when he found out that we were interested in hiring him.

The job applicant form can serve as a reference. Go back and review this information of your employees. One of them may have some hidden talents. You may have someone with the ability to do carpentry work or concrete work. He may be the quite type that doesn't volunteer. By checking through your information you may be able to use this man in a key role to complete a certain project using your own people.

Conclusion

The golf course labor is usually the largest expenditure in the budget, but do we spend as much time analyzing and planning this phase of our budget as we do working out a fertilizer or spraying program? We need to take plenty of time for interviewing the people we plan to hire each season. We need to take the time to obtain basic information about these people if we are going to utilize our labor budget efficiently.

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FORCING SOD DEVELOPMENT

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Sod production has become the fastest growing agricultural industry in Michigan with well over 20,000 acres in production in 1967. Other states have also noted a marked growth in the industry. This expansion has come in response to the demand for sod by the public. There are large numbers of new growers as well as expansion among the established producers. Some of the new growers will develop successful enterprises, others will not.

A successful sod farming enterprise is based on several key requirements, which can be listed in several ways, but contain elements of each of the following:

1. Availability of CAPITAL - for land, water, equipment, labor and marketing
2. Good SOIL that is suitable for sod production
3. Adequate TECHNOLOGY - to establish, maintain and harvest the crop
4. Adequate MANAGEMENT - to efficiently organize
5. Development of a MARKET for your product

In our discussion today we shall consider certain aspects of the first three items.

The title assigned to me, "Forcing Sod Development," suggests there are special techniques for encouraging rapid sod development. For example, what management practices make it possible to harvest and sell a crop in three months from seeding? And if this can be done with consistency, is this kind of management practical? Certainly producing a crop in three months is forcing sod development. This has been accomplished on organic soil with a spring seeding.

But, let us consider the cultural practices which contribute to rapid sod development. These will be discussed briefly from a general production point of view with more detail as it applies to the individual factors.

Soil Selection.

Perhaps the most important question facing the grower, after market development, is the kind of soil on which he chooses to grow sod. In Michigan, most of the sod acreage is on organic soil, while in many other states mineral soils predominate. From a grower's standpoint, organic soils require more drainage and more flotation equipment but produce lighter weight sod and generally can grow the crop in less time.

From the consumer's point of view, the organic soil sod is lighter weight and easier to lay. And, contrary to some suggestions from other parts of the country, the organic soil sod establishes at least as rapidly as mineral soil sod. King and Beard(2) have reported that in 15 tests over 2 years the rooting capabilities of organic grown sod were equal to or superior to that of mineral soil sod. Careful consideration was given to controlling the quality and age of sod used, thickness of cutting, laying techniques and collection of data.

In addition the soil should be uniform, relatively free of stones, roots and other debris, and free of undesirable grasses as bentgrass, quackgrass, bermudagrass, or nutgrass. The soil should be deep enough to allow for drainage and continued production. If sod is cut thin, as should be the case, 1/4 to 1/2 inch of soil should be removed with each crop.

Some soils, especially organic soils, will require artificial drainage and water control. In many cases, the drainage water will have to be lifted by pumping into the drainage outlet. It is possible to use such a system to advantage, controlling the water table depth (at 2 - 3 feet) in the field. This is accomplished through the tile system with use of adjustable sluice gates. This helps to reduce subsidence of organic soils and can decrease frequency of irrigation.

Special flotation equipment as balloon tires or extension rims are common on sod equipment and are especially needed when soils are wet. Accessibility of the site to highways and markets should be considered. Expensive roads may be needed to accommodate loaded sod trucks.

Adequate water

A source of good quality irrigation water is almost essential for forcing sod development. This means light and frequent applications during establishment,

followed by adequate water to supplement rainfall while the soil develops. Consider both quantity and quality of water. Watch for salt content in deep wells.

Soil preparation

From the cultural standpoint, soil preparation and seedling establishment are essential for rapid soil development. In a few cases, sod has been re-established from rhizomes left in the field and light overseeding. But, for most successful and rapid establishment, tillage is practiced, including plowing, settling, and levelling operations. The latter is extremely important for good establishment and efficient sod cutting.

Lime and seedbed fertilizer should be applied on the basis of soil test (2) and worked into the soil before the final levelling operation. Do not place fertilizer on the soil surface with the seed as this may reduce germination. Lime to raise soil pH to 5.5 to 6.0 on organic soils, and 6.0 to 6.5 on mineral soils. Bluegrasses prefer the higher pH ranges.

Seeding

Most sod produced in Michigan is 100 percent Merion bluegrass. There is increased interest in blends of Merion with other bluegrasses. This provides a broader base for disease resistance and adaptation. There is limited demand for bluegrass-red fescue mixtures. Any appreciable decrease in the component of Merion will increase the time to harvest. Present seeding rates recommended in Michigan are:(2)

Kentucky bluegrasses	25 - 40 pounds per acre
Red fescues	60 -100 " " "
Mixed bluegrasses and red fescue	35 - 65 " " "

Seeding rates will be affected by seed quality, seedbed condition, season of year, irrigation, and personal preference. Excessive rates usually lead to slower sod development. Be sure to purchase good quality, clean seed.

For seeding, the Brillion-type seeders are most widely used, although a cyclone seeder, followed by a cultipacker, can also be used effectively. It is essential to get the seed uniformly distributed for rapid sod development. Wind and wet soil interfere with seeding operations. On organic or any soil subject to blowing, irrigation is helpful in preventing seed blowing and loss of young seedlings.

The most favorable seeding time in Michigan is August 15 to September 15. Later seedings will often frost heave. Spring seedings are often less uniform and weed competition interferes with development of harvestable sod. Dormant fall seedings, from mid-November on, are often successful if the land is not subject to overflow. Irrigation allows seeding at almost any time during the growing season except late fall.

Maintenance fertilization

Assuming phosphorus and potassium are mixed into the seedbed, subsequent fertilization will be for nitrogen. It is important to feed the new seedling sufficient nitrogen so it will grow vigorously and fill in the open areas. But, grass fertilization is often based upon the most attractive top growth. The above ground portion of the grass plant is needed only for appearance (to sell the sod), and for producing food for the roots and rhizomes. The latter hold the sod together and determine how soon the sod is marketable.

Heavy nitrogen fertilization forces top growth at the expense of roots and rhizomes. Satari[5] found rhizome growth decreased with high nitrogen rates in the greenhouse. The percentage of total available carboyhydrates also decreased. These serve as energy sources for new roots and rhizomes.

On organic soil in the field, 15 pounds of nitrogen per month appears adequate for rapid sod development. This was determined by measuring sod strength of the weight to tear a sod piece. Higher rates of nitrogen did not increase sod strength in spite of visual response in terms of color.

Kurtz[4] found that sod strength, and numbers and lengths of rhizomes increased with increasing nitrogen rates on a mineral soil. This points out that importance of knowing the nitrogen status of your soil. Our current nitrogen guidelines (in pounds nitrogen annually per acre) for sod are:[2]

	Merion	Common Ky.	Red fescues
Organic soils	90 - 150	60 - 100	40 - 75
Mineral soils	150 - 250	80 - 160	60 -100

Factors such as appearance of grass, time of year, amount of rainfall, and irrigation (leaching), nitrogen status of the soil, and soil type should be considered as well. The soluble nitrogen carriers are most commonly used at 4 - 6 week intervals. Based on our work, not more than 30 pounds per acre should be applied per application on organic soils unless the grass is very young or deficient in nitrogen. The frequency and rate of application will be higher for mineral soils. Lower rates should be used during summer months.

Fertilizer application through irrigation systems or by plane may provide labor savings.

Mowing

A height of 1½ to 2 inches is preferred. Frequency depends on grass growth -- up to 3 times weekly. If excessive growth takes place between mowing, clippings may have to be removed to maintain quality. As a general rule, never remove more than 1/3 of the top growth. Before harvest it may be necessary to thin and remove clippings,especially for older sod.

Disease control

Incidence of disease varies from year to year. Fusarium blight has been observed in several sod fields in Michigan. Several of these were plowed down. The incidence was higher on older sod. This problem could become very serious. Stripe smut has not been reported as a problem in sod fields to date in Michigan.

Insect Control

More stringent controls on insect tolerance in sod may be coming. Plan to clean early.

Harvesting

The harvesting operations are being increasingly mechanized with new innovations in sod cutters, rollers, palletization and handling. An interesting study by Aylsworth[1] pinpoints labor and machine cost of sod harvesting methods.

Sod growers will become more efficient and more technical in forcing sod development. An annual crop from each field will be the rule and some crops will be

produced in 3 to 4 months. However, each grower will be forced to decide how this fits his soil management, production, labor and marketing programs. Research should aid in understanding improveed management practices, as well as providing new varieties which will hasten development of quality marketable sod in this highly specialized, modern agricultural business.

[1]Aylsworth, J. Q. Pinpoint your sod harvesting costs. Weeds, Trees and Turf. Feb., 1968, pp. 8,9, 41.
[2]Beard, J.B., and P.E. Rieke. Sod Production in Michigan. AES mimeo. 1968. Michigan State University. pp. 1-7-.
[3]King, J. W., and J. B. Beard. Soil and management factors affecting the rooting capability of organic and mineral sod. 1967 Agronomy Abstracts, p. 51.
[4]Kurtz, K. W. Effect of nitrogen fertilization on the establishment, density and strength of Merion Kentucky bluegrass sod grown on a mineral soil. 1967. M.S. Thesis, Western Michigan University
[5]Satari, A. M. Effects of various rates and combinations of nitrogen, phosphorus, potassium and cutting height on the development of rhizome, root, total available carbohydrate and foliage composition of Poa pratensis L. Merion grown on Houghton muck. Ph.D. Thesis, Michigan State University.

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WHAT AN ARCHITECT NEEDS TO KNOW

Edmund B. Ault, Golf Course Architect
Bethesda, Maryland

(His educational background is in construction engineering and he spent some time in South America in this field. He has been an ardent golfer all of his life, and at one time was a scratch player. His work on golf courses numbers nearly 200 and range from the Alps of Switzerland (Zurich) to the desert at Las Vegas, and to the islands - San Juan, the British West Indies, and Okinawa.)

I attend and participate seriously in these conferences for an exchange of knowledge, which willkeep me abreast of the modern progress in this fast expanding field - the golf industry. I would like to believe that in the not too distant future, before construction is started, a permit will be issued by the regulatory people in the county or municipality in which the golf course is being built. In order to obtain a permit for construction of the golf course, the owners must submit plans and specifications which naturally will have to have been prepared by a qualified, registered professional person.

I am assuming that these plans and specifications will be checked by a qualified person before such a permit is used. Certain basic requirements can be established which may help to eliminate some of the many pitfalls which golf courses have gotten into in the past.

As far back as 1957, I discussed this with Herb Graffis. In September, 1960, with M. F. McCarthy, J. C. Dey, and several other members of USGA, I expressed the need of complete construction specifications for golf courses. I made it very clear that construction specifications for a golf course would interfere in no way with the architecture. I thought it may be possible for the USGA to have a Review Committee to which a club, or anyone considering building a golf course, could send the plans and specifications the architect had furnished them for approval.

I made the same appeal to the President of the G.C.S.A. to also have that organization establish a committee in each section of the country so that an owner considering building a golf course could submit plans and specifications for approval.

I went through the same procedure with several representatives of the PGA where they, too, could have an opportunity to review plans and specifications, especially for the design and layout of the clubhouse area. My paramount purpose in having these various committees available to review plans and construction specifications for a new golf course was in the hope that the latest findings of research and experiments in turf could be put into practice. It is my personal belief that in the not too distant future such a service will be available for the approval of plans and specifications.

Let me return now to the immediate subject and go through a quick step-by-step procedure taken by the architect in developing the golf course from plans to play.

1. TYPE OF COURSE DESIRED. The initial meeting with the group, or owners, may get an answer immediately, especially when it is to be a municipal course, a course that may be being developed for a profit, a course being built with government financing, or a golf course encompassing a homesite complex. On the other hand, leading questions must be asked by the architect as to whether the group expects at a later date to hold a sectional or title tournament on the course, the number of members it eventually plans to have, and other related facilities that may be proposed for a later date.

2. SITE ANALYSIS AND SITE PLANNING.

A. Past land use (productive farm, type of farm, pasture land, virgin soil (never under cultivation).
B. Major drainage. Effects of the site being considered as related to off-site drainage.
C. Availability of state and federal soils maps.
D. Test borings on certain areas of the site for exploration of drainage problems. Clay layer of impermeable material close to the surface which may impede good drainage.

Site planning must include not only the design or layout of the golf course, but also determine the most advantageous location for clubhouse and other support facilities such as tennis, swimming, cart storage, pool, parking, etc. In considering the clubhouse location, the availability of existing utilities that may be used economically must be considered.

3. SEWAGE DISPOSAL AND TREATMENT. As a rule the volume of disposal from a country club cannot be handled through a normal septic field. Small treatment plants or local disposal systems must be considered.

4. SPECIFICATIONS AND CONSTRUCTION DRAWINGS. To prepare proper specifications for the construction of a golf course, it requires three distinct professions:

1. The architect
2. The agronomist
3. The engineer

The architect must be knowledgeable about the second two professions, but must rely on them for technical and positive decisions in agronomy and engineering. At times it is very trying and frustrating to the modern golf architect to make a decision as to what standards of green construction he should incorporate in the specifications.

Types of Grasses

Architects who design courses in all sections of the United States and different parts of the world must be in areas which are borderline to both the cool and

warm season grasses. The architect must rely on the recommendations of available agronomist, and seek out the type of bentgrass, bermudas, etc., that have been proven successful within this area for tees, fairways and greens.

Irrigation

The source of water may dictate its cost and sufficiency and the type of grasses that can be supported. Three major types of irrigation systems are generalized 1968 for 18 holes -

1. Fully automatic - approximately $ 120,000
2. Semi-Automatic system - between $ 75,000 and $ 85,000
3. Manual control system - about $ 65,000

The agronomist and architect should now recommend to the club the type of system which should be installed, taking into consideration the following important factors:

A. Construction budget for the golf course
B. Type of grasses being used
C. Volume of play expected on the course
D. Level of maintenance expected
E. How much is system needed in a year

If a golf course is being built in an area where it is only irrigated between rains during the months of July, August and September, it is rather difficult to recommend the same type of system which may be designed for a course that needs irrigation 12 months a year. Existing old clubs, who install a complete automatic system covering greens, tees and fairways, assume that, with the installation of such a complete automatic system, many of their problems will be solved. It is easy to mislead the owners as to what they can expect because of the physical analysis of the greens construction.

My advice to a great many clubs, who have consulted me regarding automatic irrigation for the greens, is to first rebuild the greens to accept this modern watering method. I believe this is better advice than installing an irrigation system that can do far more damage than good on small, compacted, impermeable greens that have no sub-drainage and inadequate surface drainage.

Putting the Plans, Specifications and Construction Drawings Into Effect

A good golf course cannot be built with plans and specifications alone. Beginning about 12 years ago, I recommended to all owners that they place a qualified golf course superintendent on the job the day construction started. I still insist that this practice be followed. You can readily see the advantages to everyone - architect, owners, builders and the superintendent himself.

The contract will then read that the contractor will be released as soon as he has completed the planting of the course in full accordance with the plans and specifications. The golf course superintendent, who has been on the job from the start, has his crew organized and takes over the establishment of the turf after planting.

What is the difference if the contractor is bidding to establish the turf (because he certainly will include a figure in his initial bid), or whether the superintendent spends an equal sum in a better manner to accomplish the same end? He has interest, experience and is qualified to manage and complete this important end of the contract.

Finally, when one attends the majority of turf conferences and hears the reports and findings on new materials and practices that are acceptable and progressive to modern golf course construction, how are these findings placed in the hands of those who are responsible and can bring them into practice? That is why I'm here this year.

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SOILS - THEIR DEVELOPMENT AND ADAPTION TO SUBURBAN USES

Harry M. Galloway and Joseph E. Yahner, Extension Agronomists
Purdue University

Soils and their position in the landscape are related to their drainage and underlying material. A knowledge of soils and some of their characteristics can help those interested in urban land uses understand and predict soil behavior. Common soil factors affecting uses -

1. Water absorption properties
2. Load supporting properties for foundations
3. Support of foot traffic and light vehicles
4. Workability due to soil texture and period when dry
5. Ease of seeding, sodding and landscaping after completion of projects.

Major urban land uses include:

1. House lots with septic systems
2. House lots without septic systems
3. Recreational areas including football fields, golf courses, and landscaped areas around factories, schools and other large buildings.

Three common Central Indiana soils developed from and on the same kind of underlying materials on varying slopes -

RUSSELL SILT LOAM - a SLOPING, well drained soil with brown, moderately permeable, well-structured clay loam subsoils. Water movement through the soil is slow, but drainage is not impeded.

FINCASTLE SILT LOAM - a nearly LEVEL, somewhat poorly drained soil with yellowish brown subsoil spotted with rusty brown mottles and having blocky structure. Water movement is very slow and drainage is impeded in wet seasons.

BROOKSTON SILTY CLAY LOAM - a flat or DEPRESSED dark colored soil with gray subsoils that are splotched with rust colored spots and streaks. The surface soil has a tendency to shrink and swell with changes in moisture. Water moves in from surrounding high ground and drainage is slow. High water tables are common during wet seasons.

Soils with long seasonal wetness problems:

BLOUNT SILT LOAM. It is a common east central Indiana soil from north of Fort Wayne to south to Winchester and west to Peru. It is also common in Lake County. Properties are very similar to Fincastle, but the subsoil

is much higher in clay. This soil has a wetness problem for long periods of the year. Water tables remain high in wet seasons and poor absorption of septic effluent is an especially serious problem. (Subsoils are used for making clay tile). Load supporting ability is adequate as long as the soil can be kept dry, but strength is lost when wet due to shrinking and swelling, or to freeze-thaw in winter. Foot traffic is limited due to stickiness in wet seasons. COMPACTION prior to seeding or sodding, even when select material is topdressed, inhibits root penetration into subsoil materials.

Southern Indiana soils with similar problems include MONTGOMERY SILTY CLAY LOAM on the heavy clay lake beds. Others like AVONBURG, CLERMONT and VIGO SILT LOAM have compact subsoil layers, not high in clay, but causing a similar behavior.

Outwash from the front of receding glaciers gave extensive well-drained soils underlaid with sand and gravel. These soils are found along nearly every major river valley side and on former outwash areas of north central Indiana.

WARSAW SILT LOAM is darker for it had prairie grasses on it. RUSSELL SILT LOAM is lighter for it had forest cover.

These soils can be worked most of the time and excess water seldom stands on their surfaces. Septic systems usually work well as the open sand and gravel acts as an underdrain. Load supporting ability is good either wet or dry when the sand and gravel is well tamped during construction.

Revegetation is subject to fewer problems than the more clayey soils, but they lack water supplying power. A thick blanket of good topdressing would facilitate turf establishment.

Caution: Well water supplies can be polluted by concentrated dumping of sewage into these soils.

Other soils behaving similarly include: PLAINFIELD SAND, CHELSEA LOAMY SAND, and PRINCETON AND TRACY SANDY LOAMS. The true sands have very low water holding capacity and low nutrient content. Irrigation will be essential to develop really good turf and shrubbery. They can be hard to vegetate and manage.

Further understanding of the soils of a particular area can be gained by consulting soil survey reports, printed bulletins, or the local Soil Conservation Service representative. Wise soil use, through zoning and area planning, can save money and develop better communities.

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PARTICLE SIZE AND DENSITY - A REVIEW

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The inherent interest in physical properties of soils has been based on structure, the arrangement of individual particles into aggregates. It has long been recognized that soil structure could be managed to maintain or increase aggregates during more conventional cropping practices. However, progressively heavier use demands and construction techniques have far exceeded the ability of natural

aggregate structure to resist compaction under turfgrass use.

Table 1. Effect of compaction on a well-aggregated soil at several depths as determined by aeration porosity and volume weight (bulk density). Penna.

Depth	% Porosity Aeration	% Porosity Total	Vol. Wt.
0-1"	6.1	32.1	1.80
1-3	24.4	43.4	1.50
3-6	33.7	52.5	1.26

Physical measurements of total porosity, aeration porosity (large pores) and volume weight (weight of soil ÷ volume of soil) clearly demonstrate the detrimental aspects of the compactive force. Effects are greatest in the 0 to one inch depth as anticipated.

Table 2. Effect of two levels of foot compaction on a well-aggregated soil as determined by aeration porosity and water infiltration rate. Pennsylvania

Level of Compaction	Aeration Porosity	Inches/Hour Infiltration	Structure
0	33.1	1.5+	+
xx	19.2	0.6	↓
xxxx	6.1	0.3	-

Varying the intensity of foot traffic on a turf sod resulted in additive compaction effects as determined by aeration porosity and water infiltration rate.

Table 3. Analysis of well-aggregated soil under field and laboratory conditions (following shredding and handling). Pennsylvania

	% Porosity Aeration	% Porosity Total	Inches/Hour Infiltration
Field	33.1	51.2	1.5+
Lab	12.6	56.2	0.3

The Lab determination in question represents the counterpart of the same soil undisturbed under sod in the field. The soil was "handled" to the point of being stripped off the original site by heavy equipment and shredded while in a dry condition. It is not difficult to conceive considerably more severe handling during "routine construction."

The above effects have been recognized for many years without the benefit of soil physical measurements. The earliest references to choice of soil types for recreational use have leaned toward a loam or sandy loam type soil. The textural value of the coarser particle sands as a supplement to soil aggregates thus entered the picture, followed by sand additions and peat to modify heavier native soils. However, it has been predominantly in the last decade that the common objective in modification has been toward a definite sand matrix (basic skeletal framework) opposed to a soil matrix with reliance on aggregate structure. Thus we have evolved to a point of "substituting the coarser textured sand and sand-sized materials for aggregate structure" to obtain a bridging effect which will permit compaction.

However, results could be termed moderately successful at best for many construction efforts. There has been a gross generalization on both the quantity and

quality of ingredients. This factor is more apparent in reviewing many specifications and noting the absence of necessary specifications for textured materials. Particle sizes and their distribution are the key factor regardless of the quantity of materials to be used. Visual examination of particle sizes and their distribution must be replaced by standard sieve analyses and specified as such.

The key to achieving a bridging effect of coarser textured particles and what's left in the voids (soil, organic matter, water and air space) is dictated by intermeshing of the materials involved. Many do not appreciate that sand particles vary 40-fold in size from .05 to 2.0 mm, to say nothing of appreciably larger sized gravel and smaller silt, clay and colloidal particles. All studies to date relating to particle sizes conclusively show that -

1. There is a minimum threshold value of coarser particles (sand size) necessary to achieve bridging
2. A segment of particle sizes must be omitted to leave voids for other purposes
3. Satisfactory results can be gained through different combinations of various particle size ranges.

The majority of the associated presentations on this program will emphasize the details related to particle size and density.

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SOIL PORES IN GOLF GREENS

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Any material in which grass grows, be it soil, sand or some artificial substance, has pores for the roots to anchor and feed. These pores take up from 30 to 70% of the total space. This amount depends first of all on whether the soil is made up of individual solid grains, or of aggregates or porous, spongy material. Pore space in sand is between 30 and 40%; ordinary mineral soil has between 40 and 50, muck between 50 and 60, peat between 60 anf 70, and calcined aggregates may exceed 70%.

At any given moment the pores are either filled with air or water. Plant roots need both. How much of the pore space is filled with either depends on the pore size and on the moisture tension. Since the attraction of the soil to water is greater than the attraction from water molecule to water molecule, it is the small pores that remain full of water the longest. This tells us that the plant needs large pores for aeration and small pores for water supply. There are two main factors that determine the size boundary between the pores filled with water and those filled with air - the effective drainage depth and the evapotranspiration. The deeper the drainage is effective, or the deeper is the ground water table, the drier is the soil.

It is obvious that a soil has to have enough water to support plant growth. Plants use up to three tenths of an inch of water during a hot dry summer day. To supply this a soil that has 10% by volume of available water would dry out 3 inches every day. Very frequent sprinkling would be necessary to keep the plants alive. And, this has the disadvantage that the pores would contain too little air. The conclusion is that the pore conditions should be such that the roots can penetrate at least a foot into the soil.

So, the question is - how do we get enough large pores (diameter greater than 0.06 mm) to a depth of two feet. Most soils in their natural structure are made up of small aggregates with a substantial portion of large pores between the aggregates. But pressure, especially when the soil is wet and plastic, will squeeze these aggregates together. Consequently, much of the large pore space is lost. This is the typical case for a golf green that has recently been wetted by rain or irrigation.

A sand is made up of individual sand grains. It is not plastic and pressure will scarcely compress its pores. So, it seems all we have to do is to select sand of grain sizes that will give the right pore sizes. In a well graded sand the effective pore diameter is about ONE-THIRD OF THE PARTICLE DIAMETER. In a less graded sand there is a wider range of pore diameters. The pores will have a diameter between one-third and one-fifth of the mean particle size (mean on weight basis). Such a condition can be obtained by using a mixture of fine sand (0.1-0.25 mm diameter) and of medium sand (0.25-0.5 mm diameter). The resulting pores are mostly between 0.05 and 0.1 mm diameter, depending on the percentage of fine and medium sand in the mixture. Since sand has little capacity to hold onto plant nutrients of peat, calcined aggregates or exchange resins should be added. If such a mixture is used the rate of infiltration will be ample and will be no problem.

A problem is whether overhead sprinklers or subirrigation should be used. In a sand mixture, as previously described, the rate of capillary climb of water can be as high as an inch per day, if the ground water level is at 1-1/2 feet below the surface. Subsurface irrigation has several advantages. Not so much water is wasted by evaporation and runoff. Since less water is lost, much less irrigation water is needed. The surface soil stays moist, yet not wet, and consequently aeration is satisfactory.

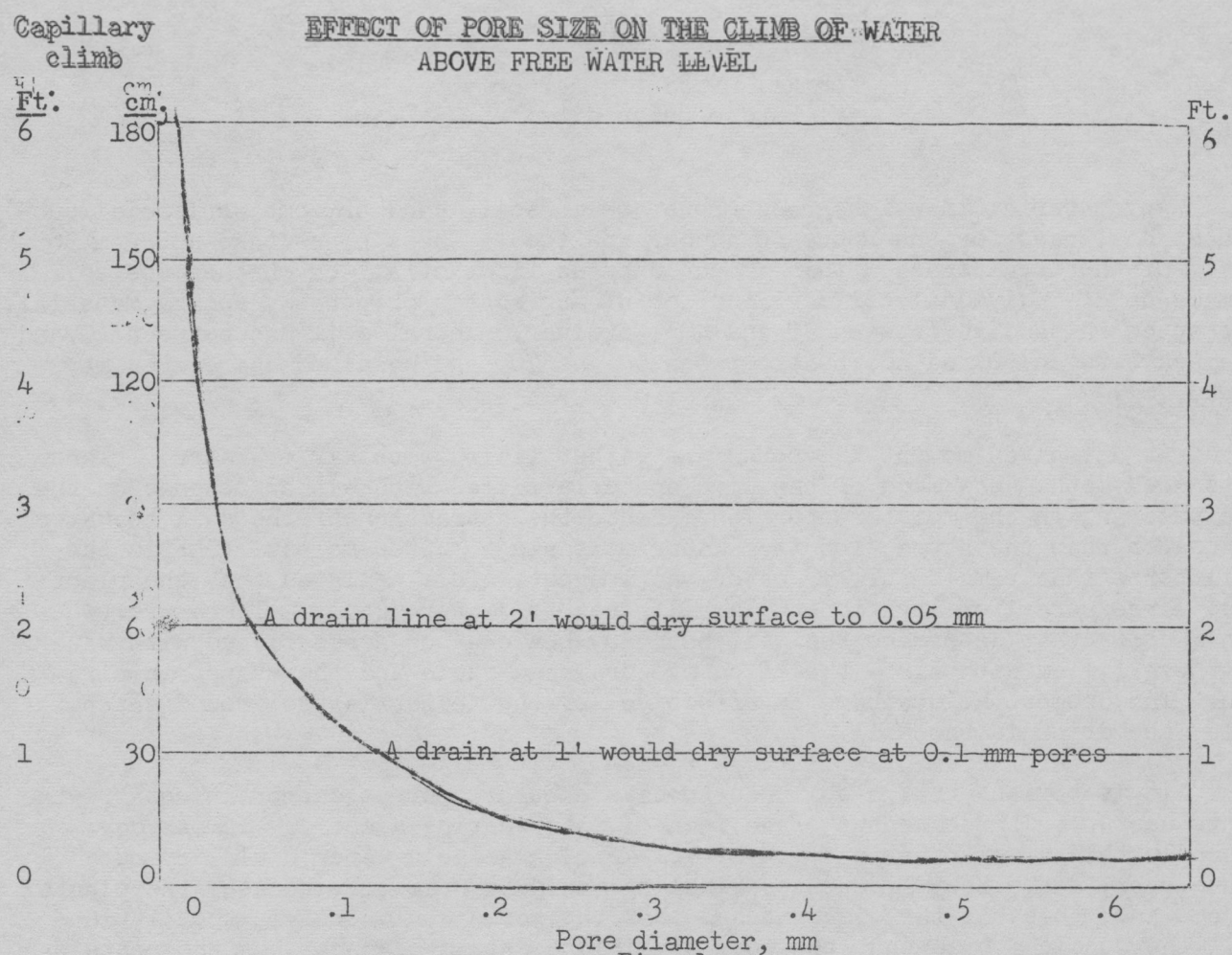

Fig. 1

PEAT AND ORGANIC ADDITIVES

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Turfgrass areas, especially new golf courses, are located on sites with many and varied soil conditions. The terrain may be hilly, flat, swampy,and the soil gravelly, sandy,heavy clay or peat - in some cases there may be little or no soil. Organic matter is the most readily available material that may be used to improve the physical properties of most of these soils. Organic matter will increase the water holding capacity of sandy soils and improve the air-water relationships of heavy clay types of soil.

Examples of organic materials useful as soil amendments are: peat, sawdust, cocoa hulls, gin trash, bagasse, sewerage sludge, manures and compost. Leaves, grass clippings, straw and other similar materials may be used in the compost. Local availability is frequently the determining factor in choice of organic amendment. Choice should always be cased on an understanding of the characteristics and behavior of the material.

Organic additives may be classified on basis of rate of decomposition as dynamic and static forms. Static types, like peat and sawdust requiring a much longer time to decompose than the dynamic types like manure, spent mushroom soil and compost. Sawdust and peat are two of the more widely used organic additives for golf course soils. Both are satisfactory materials when used in accordance with their known properties.

Sawdust

Among others, Burton and Associates at Tifton, Georgia, and Waddington and Associates of Massachusetts, have shown the value and limitations of sawdust. The desirability of using material that has undergone partial decomposition is generally recognized. Sawdust from hardwoods decomposes more rapidly than that of softwoods, thus nitrogen tie-up; and, therefore, need for supplemental nitrogen is greater with hardwood sawdust.

Waddington reported germination and seedling growth were suppressed by some fresh sawdust materials. Ash and red oak sawdust produced the more severe toxic effects. Abnormal seedlings and stunted roots occurred when extracts from these were used. Nitrogen added to the mix did not overcome these deleterious effects. Merion bluegrass was more susceptible than Pennlawn fescue, Highland and Seaside bentgrasses. These adverse effects were not apparent in sawdust weathered for 2 to 7 months. When fresh sawdust must be used, incorporate well in advance of planting when possible. Also, Waddington suggests seeding a sample and comparing germination with untreated to confirm survival.

Peat

Peat is probably the most widely available of all organic materials. It is an easily obtainable, usually uniform source of stable organic matter. Frequently there is confusion with regards to peat terminology and classification. Problems associated with peat use may be avoided if the characteristics of the various kinds of peat are known.

Peat is the remains of plants that have accumulated and undergone partial or incomplete decomposition in water or excessively wet areas, such as swamps and bogs.

Among the more important differences in physical and chemical properties are botanical composition, water-holding capacity, stage of decomposition, organic matter content, nitrogen content and chemical reaction (pH) Peat is brown, reddish brown or black, depending on its state of decomposition and moisture. It may be fibrous or non-fibrous, depending on its botanical composition and its state of decomposition. Criteria for purchasing peat are given in the table.

Classification

A number of classification schemes for peat and for organic soils have been devised. They vary in accordance with the classification objective and the author's special field of study; for example, geology, botany, or any one of several branches of agronomy. Thus, terms such as "marine marshes," and "fresh water swamps" with their various subdivisions are used by Shaler (1890), a geologist.

Further contributing causes to diversity of classification are the various features used as a basis for establishing classes. For example, geographical and topographical features, surface vegetation, botanical origin and composition, chemical properties and others. Terms like "low moor," "transitional moor" and "high moor" describe surface configuration of bogs. Low moor refers to the lower levels (below soil line) and would compare to the "sedimentary" classification discussed later. High moor refers to the raised portion of the bog and is synonymous with the term "raised bogs" used by Barry (1954) to describe the peat bogs of central Ireland. Add to this the use of different terms for similar criteria and the lack of quantitative definition for terms describing a wide range of conditions, and it is easy to understand why confusion exists with regard to peat terminology and classification.

Classification schemes based on botanical composition - the kind of original parent material - stage of decomposition and combinations of the two are most interesting to turfgrass managers. Details of three schemes are discussed in the article entitled: "Peat Classifications," by Dr. J. R. Watson, Jr., in the Proceedings of the 38th National Turfgrass Conference and Show; February, 1967; Washington, D.C. The key terms and a brief description of each is summarized.

Sedimentary Peat accumulates on the bottom of the comparatively deep water zones. These peats are derived from algae, plankton, water lilies and various other pond weeds. Tissue from these plants decomposes rather completely. This, along with the type of decay, produces a highly colloidal, almost black, rubberlike peat. Because it accumulates on the lake bottom, this material often contains large quantities of mineral matter, such as marl, silt and clay. Such material has very poor physical properties and is undesirable as a soil conditioner. Musser points out that this material is sometimes used in golf course construction with disastrous results.

Moss Peat is formed principally from sphagnum, hypnum and other mosses. It is sometimes called "peat moss." It is derived mostly from sphagnum moss and is light tan to brown in color, light-weight, porous, high in moisture-holding capacity and highly acid. Hypnum moss peat is darker brown and its physical properties are similar to reed-sedge peat. When incorporated into soil and lime is added, moss peat will decompose at a moderate rate.

Sphagnum moss or "top moss" is the young residue or live portion of the plant and should not be confused with the partially decomposed moss peat. Top moss is marketed for packing, for use as a mulch and for starting cuttings rather than for soil improvement.

Reed-Sedge Peat is formed principally from reeds, sedges, cattails and similar plants. Commercial lots of this peat differ in their degree of decomposition, acidity and organic matter content. Partially decomposed lots are reddish brown to black

and are somewhat fibrous. Those in a more advanced stage of decompcsition are darker in color. They are intermediate in their moisture-holding capacity and nitrogen content.

Peat Humus - Peat that is of an advanced stage of decomposition - none of the original plant remains are identifiable - is called peat humus by Lucas, et al. This compares to the cultivated peat classification used by Musser. It is dark brown to black, low in moisture-holding capacity and has a medium to high nitrogen content. Peat humus has a high lignin content and is more resistant to further breakdown than moss or reed-sedge peats.

Organic Soil - Lucas, et al. place other peat-like soils that are high in organic matter and that are offered for sale in a general category of organic soil. They include sedimentary peat, "black dirt," (muck) soil, topsoil and black humus. The authors caution against the use of such materials for soil improvement unless they have been tested for and have acceptable levels of acidity and mineral content. Muck has undergone extensive decomposition and in comparison with peat is low in organic matter.

Additional Characteristics

Peats with a (pH) below 5.0 are called "low lime;" above 5.0, "high lime." Very acid peats have a (pH) of 4.2 or lower. Many local peat deposits are often quite acid, may be high in salt if the bog is located in marshy sea coast areas, and before they are used on golf course soil they should be tested.

Reed-sedge and peat humus deposits may sometimes contain weed seed. The surface layers of such deposits, especially if they have been under cultivation, may be heavily infested. Care should be exercised to avoid bringing in such materials to a golf course. Subsoil peat and moss peat are usually free of weed seed.

Range in Analyses of Common Horticultural Peats

	pH	Water Absorbing Capacity %	Oven dry weight lbs./cu.ft.	Nitrogen %
Sphagnum Moss	3.0-4.0	1500-3000	4.5-7.0	0.6-1.4
Hypnum Moss	5.0-7.0	1200-1800	5.0-10.0	2.0-3.5
Reed-Sedge (Low Lime)	4.0-5.0	500-1200	10.0-15.0	1.5-3.5
Reed-Sedge (High Lime)	5.1-7.5	400-1200	10.0-18.0	2.0-3.5
Peat humus (Decomposed)	5.0-7.5	150- 500	20.0-40.0	2.0-3.5

(After Lucas et al.)

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WHERE DO THE FINES COME FROM

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The dreams, the plans, the specs, the contract, the construction, the planting are finally achieved. Now play golf - on what! Fines! How did the poor infiltration, sliding ball mark, surface wetness, diseaae, difficulty in watering, localized dry spots and hard crust surface develop? Assuming that greens were properly con-

structed and established, they are subject to constant addition of fines at and near the surface.

Re-arranging on site occurs

A. When worked big particles tend to surface, so - lumps of soil being diluted with sand will rake, work, end up on surface - look good but flatten out - these extra fines at surface are normal for mix. Remedy - be alert, add extra (1/4" peat, calcined clay and sand) in final raking to dilute soil.

B. When wet finest particles tend to surface. So, wetness, irrigation, ponding, flooding tend to sort fines onto top.

C. When walked on, mowed, pressure pushes bigger particles down. So, as fine gravel and sand press down, the fines surround and stay above them. (Example, push a rock into a soil in spring).

D. A few fines can predominate - maybe 5% inbetween - 95% other can make a big difference under compaction. And, less than 1/4 inch will control the surface effects.

Fines Come Onto Site

Dust, actually silt and clay, are airborne many days of the year. Cars parked for a few days illustrate this as dust collects. The dirty snow, the dirty rain when dust storms occur are peak periods. Yet, a putting green receives and traps 365 days a year. In Oklahoma we estimate 0 - 1 inch per year as normal accretion.

Beyond this organic matter accumulates as thatch, mat and humus. Partially decomposed colloids are extremely fine, and besides organic matter support bacteria and fungi, which add to their fine texture.

Slowly soluble fungicides, fertilizer fractions and dusts add specifically to the fines and persist near the surface. We may add more ounces of slowly soluble Tersan than soluble potash in a season.

Fines Are Brought In

So, sand is ordered. The fines and clay may be above 1%. And, very fine sand is "sand." So, mistakes in understanding, with a little soil and organic slime accumulated, is it any wonder permeability may become nil?

What to Do?

Fortunately, the modern tools available permit surface modification. Aerification, grooving, spiking, vertical cutting permit opening and dilution.

Topdressing can be anything - if one knows what is needed - to reduce the problem or modify toward what is needed. Will a sandier topdressing help? Will more peat in topdressing soften the green? Will calcined aggregates dilute the soil and thatch? Will weed seed problems be reduced or increased? How often and how much?

The certainty is that textured character is being utilized to improve compacted areas. Dilution towards the desired, rebuilding to the desired, improving the existing, offer the turf manager and user better turf.

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EXPERIMENTS AND EXPERIENCE WITH SOIL MIXES
A REVIEW AND EVALUATION

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College Station, Texas

The first serious efforts to determine optimum physical characteristics of soils for putting greens were undertaken by the USGA Green Section in 1947. Through arrangements with Saratoga Laboratories of New York, studies were made of the textural composition of "good" and "bad" greens from numerous golf courses. Unfortunately, the studies provided few clues as to why one green supported better turf than another.

In 1951, the author had the opportunity of working with a group of civil engineers engaged in paving work, and became acquainted with some of the criteria upon which they judged the suitability of base material for the support of pavement. Their aim was density and stability. The aim in a putting green soil is to achieve a degree of stability but certainly not density. One of the measurements used by the engineer is called the plasticity index. Obviously, plasticity of base material is inimical to support of pavement. Charts are available which indicate the amount of granular aggregate material necessary to stabilize soils of any given plasticity index. It occurred to us that a similar chart might be constructed which would show the percentage of a given soil which could be used if sand and organic matter were of a specified type.

In 1953, Raymond Kunze, during graduate study at Texas A&M, chose this subject for thesis work. As might be expected, the problem turned out to be more complex than it appeared.

At the outset, Kunze collected cores from putting greens, determined density, made textural analyses and recompacted the material to its original density. Kunze studied the particle sizes of sands and their influence on turf growth and compactibility. He found that sand particles of fairly uniform size in the range of .5 mm. to 1 mm. were preferable, but were considered too expensive to be practical. Concrete sand, or mason's sand, was not ideal but it did serve the purpose satisfactorily.

Kunze also worked with different types of clay. He found that much more kaolinite clay could be used than montmorillonite. Montmorillonite is a highly plastic clay that tends to envelope and cement the sand particles.

A great many mixtures were made up and studied with respect to their ability to support growth under conditions of close mowing and compaction. One interesting observation was that the mixtures containing the least sand and the most soil supported the most vigorous turf at the outset. However, as compaction was imposed, the response became completely reversed, and those mixtures containing the greatest amount of sand and least soil were most vigorous.

In 1956, Leon Howard, working towards the Master's degree, used many different soils and sands in field plots and in the laboratory. He found that variations in sand or in soil could be tolerated so long as the mixture produced some common measurable physical qualities in the end product. He found that in general after compaction, the non-capillary pore space should amount to 12 to 18% of the volume. Capillary pore space should range between 18-27%. Hydraulic conductivity, according to Howard, should range between .5 and 1.5 inches per hour. (Note: It has been found that in practice the upper range is preferable.)

In the meantime, other workers had contributed to the literature and attempts were made to incorporate these findings into the work Kunze and Howard had done.

Garman, working in Oklahoma, had observed that about 20% of peat, by volume, was the maximum desirable amount. Davis at Purdue and Lunt at UCLA had found that most compaction occurred very near the surface of the soil. Lunt had tried building some greens, using a pure fine sand about 4 inches thick over the existing soil. Such greens were satisfactory, but watering had to be done very carefully.

At about this time Reese Coltrane, Superintendent of Lakewood Country Club in New Orleans, built a green using a porous soil mixture on a base of muck from Lake Pontchartrain. The green was almost impossible to keep because of the fact that the muck pulled moisture from the porous soil mixture very rapidly. Obviously, some way of interrupting this capillary attraction was necessary.

We also learned at some point during this period that Willie Tucker, who was one of the pioneer golf architects in America, used a layer of gravel and manure at a depth of about 9 or 10 inches in greens he built at the University of New Mexico in Albuquerque. We assumed the gravel was for drainage, but could not understand the purpose of the manure until Mr. Tucker told us that the layers were not necessarily for drainage. They simply broke up the capillary pathway whereby salts from the caliche subsoil crept to the surface. The manure layer above the gravel was Mr. Tucker's way of preventing soil particles from migrating downward and filling the spaces between gravel particles.

We had long been aware of the detrimental effects of texturally different layers near the soil surface, and it had become apparent from the observations cited that layers could be made to serve useful purposes if they were placed deeper in the soil profile. This thinking was reinforced when Charles Wilson brought to our attention some of the demonstrations of Walter Gardner at Washington State University. Gardner had shown in a dramatic way the effect of layering upon water movement through the soil.

The many bits of information from various sources finally began fitting together into a concept of putting green construction. In 1957 and 1958, Leon Howard rebuilt the greens at Texarkana Country Club using the method we had devised. In 1958, he rebuilt the greens at Albuquerque Country Club. None of these greens have ever experienced serious trouble. They have been relatively easy to keep, and they continue to be in good condition.

By 1960, we felt we had enough information to publish an article entitled "Specifications for a Method of Putting Green Construction." This method is described in detail in the September 1960 issue of the USGA Journal and Turf Management. An article outlining progress and redefining these specifications appeared in the USGA Green Section Record in November 1965.

The articles were controversial. It is our feeling that time has justified our position. The method has proven to be workable under almost any condition where it has been tried. Furthermore, the very fact that the recommendations were controversial has stimulated a great deal of research.

There have been some problems with greens which were purportedly built by these specifications. Most of the problems came as a result of failure to follow directions and obvious mistakes. One club did no mixing, but simply placed the various components in layers, one on top of another. One builder used tile in the subgrade base - glazed tile with the bell joints cemented. Obviously, this person lacked an understanding of the manner in which tile works. A third club built the greens correctly, but sodded them with bentgrass sod grown on a muck soil.

Less obvious mistakes like borrowing a neighbor's formula and applying it to soil materials that may be quite different, failure to include a buffer layer to keep soil from migrating into the gravel, leaving out the gravel layer, leaving out

the tile, or otherwise taking a short cut may negate the entire concept.

There are sometimes problems concerned with learning to water adequately, and learning to fertilize. There are some legitimate complaints of hard greens when they are first constructed, and grass is more difficult to establish on a sandy soil.

There is still much to learn about putting green construction, and it is gratifying to see a great deal of research effort being expended on the matter. As new information becomes available we shall be able to more nearly approach a trouble-free putting green. It is an evolutionary process that will come about through the piecing together of many bits of knowledge.

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SOIL MODIFICATION RESEARCH

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The soil modification research study being conducted at The Pennsylvania State University was started in 1960. One of the objectives in this study is to determine the effectiveness of various amendments in modifying soil physical properties. The physical condition of compacted and uncompacted soil mixture is being evaluated by measuring various soil physical properties.

Table 1. The particle size distribution (percent by weight)

		SANDS					
Material	Fine gravel	Very coarse	Coarse	Medium	Fine	Very fine	Silt
millimeter	+2.0	2 - .1	1 - .5	.5 - .25	.25 - .1	.1 - .05	.05 - .002
Coarse sand	0	14.7	80.7	4.4	0.2	0	0
Concrete sand	14.3	6.3	18.4	43.2	14.8	2.1	0.6
Mortar sand	0.1	4.3	22.5	50.4	19.6	2.8	0.3
USS B.F. Slag	5.4	26.1	39.1	19	6.3	3.4	0.8
Wunderley Slag	6	38.2	36.6	10	3.2	2.4	3.6
Perl-lome	23	37.1	13.2	7.1	8.7	7.5	3.3
Turface	5.3	35.4	37.2	20.2	1.7	0.2	0
Hagerstown silt loam	0	1.2	2	1.5	3.6	14.3	58.8 Clay - 18.2

The coarse sand is a sharp quartz sand, and the mortar and concrete sands are washed river sand. USS B.F. Slag is water quenched blast furnace slag, and the Wunderley Slat is a blast furnace slag which has been treated with pickling liquor. Perl-lome is a porous material obtained by heating a siliceous volcanic rock called perlite. The perlite expands when heated and light-weight, porous, and relatively fragile particles are formed. Turface is a calcined clay material. The Hagerstown soil found at the experimental site was used as the soil source. The peat used in the mixtures was a reed-sedge peat.

Extensive laboratory tests included determinations of moisture retention, percolation rate, bulk density, particle density, total porosity, and aeration porosity. The data obtained from 132 laboratory mixtures were used to select 81 mixtures for field evaluation.

Preparation for the field study was started in the summer of 1960. The topsoil was stripped from the site and a 0.5% slope was established on the subsoil. A six-inch layer of one-half inch limestone chips was placed on the area, and in July 1961 the 81 mixtures were mixed off-site and then placed on the stone layer. The mixtures were allowed to settle until the spring of 1962. The settled depth was ten inches. The plots were seeded with Penncross creeping bentgrass in June-July, 1962. Starting in 1963, a compaction treatment was applied to half of each plot. A compacting machine which utilizes a water filled roller is used to compact the plots. Golf shoe soles are attached to the roller and a footprint effect is obtained. An aeration treatment was started in 1964, giving four subplots for each mixture.

Samples from each of the 81 mixtures were used for laboratory testing. The results of laboratory tests are being correlated with the field results. Percolation rates, which designate the rate of downward movement of water through a saturated soil, were determined on compacted and uncompacted samples. These results are being compared with infiltration rate data obtained in the field, using a double ring infiltrometer. Infiltration is the movement of water into the soil.

Table 2. Compacted mixture responses - selected from 81 tested

Mixture by volume	peat	soil	Lab. Percolation in./hr.	Infiltration in./hr 1963	'64	'65	'66	'67	Available moisture in./ft.	pH
No sand	2	8	0	1.2	0	0.5	0.3	0.1	3.6	6.7
8 mortar sand	1	1	6	4.4	3.4	1.9	1.5	0.7	3.3	7.0
8 concrete "	1	1	8	12	8	4	2	1.1	3.2	6.9
8 coarse "	1	1	24	24	16	14	6	9	1.4	6.9
6 slag, 2 C.sand	1	1	60+	23	16	21	9	4	3.1	8.2
4 slag, 2 sand	1	3	5	6	3	7	1.1	1.0	3.2	8.1
4 Turface, 2 sand uncompacted	1	3	7	13	13	11	2.4	2.4	3.0	6.6
4 Turface, 2 sand	1	3	8	23	20	22	13	12	2.4	6.6

The effects of compaction on water movement were quite apparent. The values are the extremes for what might be expected with a particular mix if used on an actual playing area such as a putting green. Cupping areas would have a high amount of compaction, while some areas would have very little traffic due to the size or design of the green. The increasein infiltration and percolation with increasing sand or coarse material content was definite. Approximately 40 to 50 percent coarse amendment had to be added before a definite beneficial effect could be noticed. Enough of these materials must be added to get bridging of the particles. This bridging gives larger and more stable pores. Sands have varied in their effect on modification. Contrasting results can be seen by comparing coarse sand results with mortar sand results with mortar sand data.

A trend toward decreased infiltration from 1963 to 1967 is apparent on both the compacted and uncompacted plots. Some seem to have come to a relatively uniform

rate, while others show decreases each year. Some mixtures, which were considered satisfactory early in the experiment, now have very low infiltration rates. The frequency of compaction was less in 1965 than in other years, and the less severe compaction no doubt is the cause of slightly higher infiltration rates on certain compacted mixtures that year.

As the permeability of a mixture is increased by addition of coarse amendments, the available moisture held by the mixture decreases. The available moisture data in Table 2 show this relationship. The values shown indicate the available moisture at a moisture depth of 25 cm H_2O, and are expressed as inches of water per 12-inch depth of mixture. Available moisture was decreased by additions of the sands, slags and turface. A differential effect of the sands is apparent as it was with the infiltration results.

Aeration porosity values have correlated closely with infiltration and percolation rates. High aeration porosity values are associated with these mixes having a high permeability. Those mixtures with high aeration porosity and permeability have low moisture holding capacities, and more frequent watering is necessary to keep the plant supplied with adequate moisture.

All acid soil mixtures were limed according to a lime requirement test when the plots were established in 1962. The pH values for the mixtures are shown in Table 2. The pH values for the slag plots are very high due to the alkaline nature of the slag. The alkaline effect was less with the Wunderley Slag which was treated with acid pickling liquor. The values were still high, being in the range of 7.5 to 7.6.

Other determinations being made on the soil modification plots include root weight and distribution, oxygen diffusion, nutrient accumulation in the grass, nutrient content and cation exchange capacity of the scil, and particle breakdown. This paper has included only certain phases of the entire study.

The most often asked question concerning our work is: "Which is <u>the</u> best mixture?" We are not looking for a single "best" mixture. Our objective is to characterize the various materials and mixtures so that they can be utilized and maintained in the best possible way. A good mixture should satisfy the needs for moisture retention as well as for permeability. The ratios of sand, soil, peat, and other amendments in a mixture should depend on the kind of sand, soil type, and the combined characteristics of all amendments used. To depend upon some magical ratio indicates a lack of appreciation for the soil physical property relationships mentioned earlier in this paper. More than one ratio, or combination of materials, certainly should satisfy the objective of obtaining a mixture which gives a playable turfgrass area with a minimum of maintenance problems. Your choice of a mixture may be dependent on the cost and availability of materials, your management program, and your personal preferences and judgment.

(More elaborate reports are available from author).

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MODIFIED ROOTZONE RESEARCH

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What is a "Modified Rootzone?" Burt Musser in his famous "What is Soil?" lecture maintained that the moment you added anything to a soil, it was no longer soil. We are concerned with more radical and costly modifications, some of which exclude any soil.

Research on growing mediums for bentgrass at Kansas Agr. Experiment Station was initiated to reconcile the problem posed by the "answers" from California and Texas that indicated high-silt, prairie soils were going to give us troubles. Lunt, in California, used fine dune or beach sand, and plastic "adobe" clays. Ferguson, Howard and Kunze in Texas used a coarser, commercial sand, and clay loams in their mixtures. Both agreed that the silt-size particles were undesirable because they clogged the soil mix rather than coating the sand particles.

Excellent silicon sands are available in a wide range of sizes along the Arkansas and Republican - Kaw River valleys that rise in the Rocky Mountains or outwash plains. Other areas have indifferent or no sands - in the Southeast they are better called "chat" of chert or flint origin.

What do you call sand? Sands vary enormously from place to place. Particle size alone is a poor index. Physical and chemical characteristics are at least of equal importance. Particle size distribution, degree of wear or angularity, pH range, rate of decomposition and raction with added chemicals are unknown factors. Is your sand wind-blown and sorted, water deposited and washed, clean, dirty, limey, etc., etc.? What do they deliver to you as "sand?"

We used a fine, washed silicon sand from the Kaw River that is waste from one sand plant. Variously called Kaw Blow (KB)," "Wash back" or "Quick"sand with a particle size of .25 - .5 mm for our fine sand mixed. The particles are nearly round, our closest approach to the California sands.

Our coarse sand was of glacial origin, angular, with most particles around 1 mm. in diameter. It is mostly silicon, but less pure, from the Blue River, sold as mason's (BM) sand. These were mixed to give 65%, 75%, 85%, 90% and 100% sand, with the balance hypnum peat and Geary silt loam soil. These were randomized in 3 ft. x 90 ft. strips in 3 replications. Across these strips at right angles five grasses at two replications were planted.

The green was given excellent care and management with medium traffic from golf classes, and Grounds Maintenance crews over noon hour, and the public during evenings and weekends. At the end of two years, the stolonized grasses, Springfield and Cohansey (C-7) out-performed the seeded grasses, Seaside, Penncross and the stolonized Carey Park in that order. There were significant differences in the grasses X percent of sand interactions. Ratings were on a 1 - 10 scale with increasing percent cover up to 7, and improved turf or "putting quality" to an idealized perfect turf as 10.

In rating the rootzone mixed, the problem of turf quality vs. root development was a compromise at about 80% sand on the coarse B.M., and 85% on the fine K.B. sands. The higher sand percentages had better roots, but loss of turf occurred on high coarse sands. Root survival in summer was poorer on the 65% and 75% coarse B.M. sand. Winter desiccation killed the grass on 90% and 100% B.M. sand.

The fine K.B. sand mixtures had more latitude and gave more roots with better playing surface than the coarser B.M. sand mixtures.

In following the U.S.G.A. Green Section mixtures, our results would suggest that fine sands may be preferred to coarse, and that the amount of soil added should be held to the minimum rather than the maximum side of tolerance. In areas of high dust fall the addition of fines from dust, topdressing, fertilizer, crop residue, etc., should be realized and guarded against to avoid sealing of the surface of the sandy modified rootzone.

In observing many greens from the finest of beach sands, both here and abroad, to the pea gravel construction in vogue around World War II, it would appear that a uniform profile of fine sand, with a minimum of soil and plant residues, is performing best. The playability of the surface is governed by management practices of the surface including: height of mowing, watering practices, cultivation, topdressing and thatch control.

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VARIABLE DEPTH OF ROOTZONE MATERIALS

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How deep should a rootzone be built for a putting green? What materials should be used? Is any soil needed in the mix? How far apart should the drain lines be placed? The answers to these and related questions are being sought in current research on the experimental green.

Many materials are available which can be used as growth mediums for turfgrass. A partial list would include: soil, sand, peat, calcined clay, sawdust and slag, plus an infinite number of possible mixes. All of these materials have one property in common, that is, it requires a certain amount of tension or suction to pull water out of the pores. The amount of suction needed depends on the pore size. Water held in relatively large pores is easily drained, little tension is needed. However, water held in small pores is tightly held and it requires a very high tension for removal. A balance between large and small pores is desirable for plant growth; the large pores provide air passages, and the small pores retain water for plant needs.

The amount of tension at any given point in a profile is measured from the point in question to the water table or the first coarser layer, whichever comes first. In fairways, the tension on water in pores near the surface may be 3 to 4 feet, depending on the depth of the water table. In greens, however, the amount of tension on water in pores near the surface may only be 10 to 12 inches. If the soil mix is compacted near the surface by foot traffic, and the resulting pores are small enough to support, by capillarity, water to a height of 10 inches, no water will drain from the soil. The green can dry down only through evaporation or transpiration.

If plants need water, why should we be interested in removing water from the rootzone? The reason is that too much water can be detrimental to the growth of grass roots. Roots need oxygen for respiration. Therefore, the direct aim of drainage would be to lower the moisture content in the rootzone so that air can penetrate into the soil more easily and become available to plant roots. At the

same time, CO_2 can diffuse from the roots through the air filled pores to the surface. When the soil is compacted and water is held in the small pores near the surface, oxygen cannot diffuse to the deeper roots. This causes a shallow rooted turf which is subject to drouth and disease attack.

There are some definite advantages for using soil in a greens mix, such as high exchange capacity for nutrient retention, buffer capacity, and less injury by winter desiccation. However, the fines in soil, which include fine sand, silt and clay, can predominate and create many small pores which are difficult to drain. Soil aggregates are subject to compaction, especially when pressure is applied to the aggregates when in a wet condition. The result is an impermeable material which will not drain and can become very hard, like cement, when permitted to dry out. Therefore, our research work at Purdue has been with mixes which do not include soil. The mixes are compacted when built to standardize that factor.

An experiment was initiated August 1, 1967, to study the effect of the depth of material, type of material, and drain line spacing on bentgrass quality. One part of the experiment was devoted to variation in depth to the subsoil,and overall depth to the drain line. The experimental design was split plot with two replications. The four depths to the subsoil were 4, 6, 8 and 10 inches, and the four depths to the drain lines were 10, 13, 16, and 19 inches. Rigid plastic pipe, $1\frac{1}{2}$ inches diameter, was used for the drain lines. Narrow slits (.020") were cut (with coping saw) every 3 inches on alternate sides of the pipe to permit water entry.

The existing sod was removed and the soil was excavated to a depth of 8 inches. The subgrade was then shaped so that the desired depth would be attained and trenches were dug for the drain lines. The drain pipes were laid on $\frac{1}{2}$ inch of coarse sand, and the trenches were backfilled with coarse sand. Mortar sand was then spread over the subgrade to within 2 inches of the final grade. The sand was compacted as it was put into the plots. One inch of a calcined material, diatomaceous earth, was spread over the sand and mixed to a depth of 4 inches. Then 1 inch of peat was spread and mixed to 4 inches. Plots were tamped, water settled, and seeded to Penncross bent on August 30.

A second experimental area was devoted to studying the variation in drain line spacing and type of material. The four drain line spacings were: 6, 8, 10 and 12 feet. Each main plot consisted of four sub-plots in which two mixtures, two replications each, were located. The mixtures included a 2-1-1 mix of mortar sand, calcined clay, and peat, and a 3 - 1 mix of mortar sand and peat. The materials were mixed off site and compacted as they were put into the plots. The depth to the subsoil was 6 inches and overall depth of the drain line was 13 inches for all plots.

Experimental measurements, which will be made this summer, include infiltration rate (double ring infiltrometer), moisture status (surface neutron meter), root depth, and oxygen diffusion rate.

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PLANTING TECHNIQUES, CONTINUING ESTABLISHMENT, AND EARLY MAINTENANCE

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Let's look at a new facility in terms of three distinct phases of turf development. The contractor works according to the specifications which call for him to prepare a seedbed, apply the indicated lime and fertilizer, plant the grass and

"maintain" it until it has been mowed once. At this point the contractor-builder has done that which was required of him and is released. But, is the grass ready for early maintenance? No! It is not yet well established. Right here we have the most critical period in the development of the new turf - the ESTABLISHMENT of turf ready to use.

The term PLANTING TECHNIQUE includes not only the methods of presenting the seeds and vegetative materials to the seedbed, but the preparation of the seedbed with the incorporation of materials, which can have a tremendous effect in carrying the new grass over the Establishment Period into the phase we term Early Maintenance.

First, let's look at planting techniques. We've come a long way since the Darmil planter, the wheelbarrow seeder and Cyclone spreader. These were commonplace thirty years ago. Today the BRILLION represents nearly the ultimate in planting grass seeds on golf courses and many other large areas. The word is "Precision." The seed is metered at a pre-determined rate, dropped on a prepared seedbed and covered at the depth best suited to the grass in question. The ADT and the Viking grades the seedbed as it drops the seed.

The Gill seeder is favored for replanting and overseeding on areas already established. It employs the principle of "Punch Planting" wherein the seeds fall on the surface <u>after</u> many holes have been punched into which the seeds collect. When we overseed following the aerifier, the new grass comes up only in the holes.

Disc drills on the market drop seeds in a shallow trench made by a curved disc that opens the trench. New revolving toothed blades saw shallow grooves into the surface and deposit seed into grooves. The grass comes up in rows but eventually it spreads.

HYDRAULIC SEEDERS have developed from a crude device engineered by Keyser and Grau for the initial seeding of slopes on the Pennsylvania Turnpike about 30 years ago. In this GUNITE adaptation the grass seed was mixed with screened soil, limestone, fertilizer and organic matter (Floss). As the dry mixture was expelled by air pressure through a hose, a spray of water engaged the soil at point of discharge, covering the slope with a thin mud that found its way into every crevice. From this crude but highly successful beginning, we have had three major hydraulic seeders developed - Bowie, Finn and Reinco. These machines employ up to 1,000 gallon tanks with impellers to mix the ingredients and powerful pumps to propel the slurry onto the slopes. The principle is to blend water, lime fertilizer and seed (plus legume inoculant) and wood cellulose pulp as mulch, and apply it as a "one shot" deal. The "one shot" idea is giving way to the "two-step" plan in the interests of better results. When seeds are imbedded in the wood cellulose pulp they tend to be held away from the soil surface. The initial moisture in the pulp may be sufficient to germinate the seeds. Subsequent drying may cause the pulp to lift away from the soil before roots are caught. The result often is disaster unless there is ample continuous moisture to insure rooting in the soil.

The "two-step" method is gaining advocates because it virtually eliminates the danger of drying. The seed, lime, fertilizer and inoculant, where legumes are involved, are mixed in the slurry and applied to the surface. Immediately a mulch is applied (straw or wood cellulose) to cover the seeds and to keep the surface cool and moist. This plan is especially important when vegetative material is applied hydraulically. Where legumes are involved one can add additional inoculant with step No. 2.

The seedbed merits particular attention whether seeds are applied conventionally or hydraulically. MOISTURE should be ample and continuous from surface to subsoil. This is especially important for tees and greens where irrigation can be used to supply the needed moisture and to SETTLE the loose soil before planting.

A FIRM seedbed is most important when dealing with small seeds.

Seedbed fertilizer is an item that can bridge the gap between planting and "Open for Play" if the proper choice is made and there is an understanding among architect, owner and builder. It has become all too evident that the contractor-builder prefers to use one simple,uncomplicated,inexpensive fertilizer that will just get the grass up so that it can be mowed once and let him pick up and leave. Ideally the seedbed can be prepared with enough slow-release, non-leaching fertilizer included so as to get the grass up quickly, then continue growing the grass through the "Continuing Establishment" period until it is ready for play and Early Maintenance begins.

Let's boil it down to a specific example. We are fall planting a fairway to a bluegrass mixture. Ideally I would incorporate, along with the needed limestone, basic fertilizer such as 500/acre 0-20-20 or superphosphate, plus 6 to 8 pounds of slow-release nitrogen per M as granular ureaform (38-0-0). When planted in the early fall this treatment will produce dense usable turf in the shortest time without further attention except water and mowing.

The alternate method is to incorporate, along with limestone and basic fertilizer, only enough cheap soluble N to get the grass up for a first mowing. We know that we can use safely only 1 to 2 pounds N to 1,000 sq.ft. Soon after the grass is up the soluble N will have been used and leached so that a supplemental application should be made soon after the contractor has been released.

Several state highway departments now specify that Ureaform nitrogen be added to the hydraulic seeder tank in addition to the conventional starter fertilizer (10-10-10, 10-20-10, or similar). The stated purpose is to avoid having to make a second application of fertilizer soon after the grass is up. The economy effected here applies equally to turf on golf courses and other large areas.

When the specifications call for just enough seedbed N to get the grass up and to release the builder, there should be firm directions for Continuing Establishment, especially with regard to fertilizer applications. This will insure continuity and should be welcomed by the superintendent and the owner, especially if the architect maintains a supervisory role until the course is opened for play.

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SANDS FOR ROOTZONES

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Purdue University

The purpose of this research was to determine the particle configuration boundaries within which lie structurally stable media suitable for athletic turf, those best able to continually meet the plant's soil air-water requirements when gravitational drainage tension is less than one meter.

Twenty sand materials were used in this investigation. Soil was excluded due to its structural instability. Commercially available aggregates were excluded as their long-term properties were not fully understood.

Top avenues of investigation were followed. First, three dimensions of each sand's constituent particles were determined. These were degree of gradation,

particle size and particle shape. Secondly, certain porous properties of each sand when highly compacted were determined. These properties included: bulk density, total pore space, pore size and frequency distribution saturated hydraulic conductivity rate, and evaporation rates under varying water table and external environmental conditions.

Constituent particle parameters were then compared to measured porous properties of the same sand when highly compacted. To enable a common basis for making the desired comparisons between sands, two weighted size dimensional parameters were developed. One dealt with particle size and was expressed in terms of weighted particle diameter (WPD). The second dealt with pore size and was expressed in terms of weighted volumetric pore diameter (WVD). Other indices dealing mainly with relative pore size were developed from these parameters. Excellent correlation was found in many instances of comparison.

It may be concluded that many of the porous properties of compacted sand studied herein can be predicted with reasonable accuracy when the three particle parameters are known.

Changes in any of the three constituent particle parameters measured did yield changes in the compacted sand's porous properties. It was found that changes in the degree of gradation caused changes of the greatest magnitude in the porous properties, followed by changes in particle size and then in particle shape.

Gradation indices greater than 4.0 would overshadow the effects of size and shape.

Total sand 100% disregard coarsest 5%
95%
5%
disregard finest 5%

Because of variable processing of sands permit (disregard) coarsest 5% and likewise overlook (variable) finest 5%

So, 95% wt. size is at microns
and 5% wt. size is only microns

so divide 5% size into 95% size to get gradation index. If all were same size then a G.I. of

1.0 values for 17 sands
ranged from 1.15 to 3.54

Values for 3 local Lafayette sands were 7 - 26, which shows wide gradation.. The high correlation found between particle dimensions and measured porous properties of compacted sands simplifies determining the suitability for rootzones for turf.

It may likewise be concluded from this invetigation that a suitable rooting medium can be achieved from an all sand material if it is highly compacted and placed above an impervious layer permitting controlled drainage tensions within one meter of the surface. The particle dimensional characteristics needed to insure the desired rooting conditions should be within the following limits:

1. Gradation indices $>$ 2 but $<$ 6.
2. WPD_{50} $>$ 0.074 mm but $<$ 0.450 mm
3. Particle roundness values $<$ 0.6

The porous properties of compacted sand material whose unconsolidated particle dimensions fall within these limites will provide a rooting medium exhibiting the following properties:

1. A structurally stable rooting medium whose total pore space, pore size and pore distribution will remain essentially unchanged with time.

2. Pore frequency and distribution allowing saturated hydraulic conductivity rates $\geq$ 5 cm per hour.

3. Not less than 15% available water in the surface 15 cm immediately after gravitational drainage has ceased.

4. Water-free pore space immediately after drainage that will allow at least 10% water-free pores at a 5 cm depth, and 5% water-free pores at a 10 cm depth.

5. Capillary flow rates allowing replacement of most soil water removed by evapotranspiration during extended periods between irrigation of rainfall.

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SUMMARY OF TEN WAYS TO CONSTRUCT HIGH USE TURF AREAS EXPOSED TO COMPACTION

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Purdue University.

SOIL PREDOMINATES - due to fines present

1. ANY SUBSOIL - mud in - shape to grade - and leave as soon as paid!

2. TOPSOIL ONTO TOPSOIL
   - avoid any subsoil - no wet work
   - carefully conserve what's good - can save funds
   - can do for sandier soil - low budget installation

3. SUBSOIL UNDER TOPSOIL
   - plus deep tile DRAINAGE - pea gravel backfill
   - more desirable where major fill is required

4. Above plus SAND (60%?) and PEAT (20%?) mixed into top 2-3-6-10 inches in hopes of better water movement.

5. VERTICAL POROUS STRIPS
   - to remove excess surface water promptly
   - narrow trenches - above tile - into pea gravel, in low spots, between tiles, across tiles, 2 - 3" wide, 1 - 3' deep
   - slits - surface and downward - 1/2" wide x 10" deep, 3' apart
   - grooves - 8" apart, 3" deep, $\frac{1}{4}$" wide
   - all are filled to overflow with sand or calcined aggregates

   Use as CORRECTIVE where better drainage is needed

6. INTIMATE TOP MIX - mixed off-site - U.S.G.A. spec.
   Follow laboratory spec. based on sample submitted
   10" - 14" settle top mix over
   2" washed sand over
   4" pea gravel over tile drainage

   Gives low tension at gravel "dump action of excess water"

POROUS TEXTURES PREDOMINATE (no soil)

7. THIN ROOTZONE - mix on or off site
   Top 3 - 6" - maximum surface storage of (mix of peat, calcined agg. & sand)
   Over clean sand 3 - 4" for lateral INTERNAL drainage
   Above slitted plastic drain lines (frequent) in narrow trenches in subgrade

8. IMPERMEABLE LAYER - plastic sheet - giving ZERO TENSION
   For drains use slitted plastic pipe laid on plastic sheet with adjustable overflow outlets.
   Depth of sheet and drains based on texture - porosity characteristics of stable materials used (SAND, CALCINED AGGREGATES).

9. RESERVOIR POOLS - use double plastic sheet - laid FLAT, LEVEL with upturned edges to form shallow pools (1 - 3" deep) at base of porous rootzone.
   Drainage and depth determined as above.

10. Above, plus SUBSURFACE FLOAT irrigation, adjustable level, for constantly wetness/on.
    Use porous rootzone as wick to keep surface uniformly moist.
    Could add SOIL SENSING - adjust sensing for dryness

WATERING GREENS EFFECTIVELY - A REVIEW

J. R. Watson,Jr., Director of Agronomy
Toro Manufacturing Corp., Minneapolis,Minnesota

To water greens effectively requires an understanding of several basic concepts which, individually and collectively, affect water and its proper use. There can be no set or predetermined formula or prescription for effective green watering. Rather the superintendent must balance the variablesthat affect watering practices and arrive at the solution that best suits each green.

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

Role of Water

Water is essential to plant growth and activity, and is involved either directly or indirectly in all phases of the care and management of turfgrass. Water is necessary for germination, cellular development, tissue growth, food manufacture (phytosynthesis), temperature control and resistance to pressure.

It acts both as a solvent and as a carrier of plant food materials, for nutrients dissolved in the soil are taken in through the roots and then carried to all parts of the grass plant in water. The food manufactured in the leaves is also distributed throughout the plant body in water.

Water transpired by the leaves and evaporated from the surface serves as a temperature regulator for the plant. Syringing is based on these phenomena. The amount of water within the cells of the grass leaves plays a role in counteracting the effects of traffic. When the plant cells are filled with water (above 80%) they are said to be turgid, a condition that helps leaves resist pressure from traffic (foot and vehicular) and avoid the damage, sometimes death, that may occur. Wilt is a condition that exists when cells do not contain enough water and are said to be flaccid. A 10 - 20% loss of water from the plant body frequently will cause permanent wilting and death.

Soil

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

These characteristics directly affect satisfactory green watering practices. The intake of water is through the roots - the root hairs are the organs through which water is taken in. Hence, the depth of rooting and the extent to which a given root system occupies the soil determines the available water capacity of that rootzone. When the need for water by the plant is great (high temperature,

high wind movement, low humidity), this reservoir must be continually replenished.

If the need for moisture (evapotranspiration) is 0.3 inch daily - as the case may be during July and August - the soil must easily supply that amount between irrigations. Soils that are good for putting greens otherwise may only hold 0.50 to 0.75 inches per cubic foot. This would be an adequate amount of water for one to two days if it is available to the plant. For this to be the case, the roots must extend through this volume of soil, the soil must supply the needed amount of water, or have the characteristics necessary to move the needed amount of water at a rate rapidly enough to permit uptake by the active roots.

The root systems on most putting greens frequently extend only to a depth of three or four inches, so the volume of potentially available water is drastically reduced. Thus, the advice to water deeply and infrequently is not valid for many putting greens. For that matter, for many turfgrass areas.

Poor aeration, whether from poor drainage, compaction or an inherent soil condition, further complicates effective green watering.

Equipment for Applying Water

Equipment presently available permits the controlled application of precise amounts of water. Further, the flexibility of the automatic control mechanisms is such that pinpoint (each head) application of the amounts of water needed by the grass can be delivered in conformance with the ability of a given green to take in (infiltration capacity) and store it (water-holding capacity). Master controllers located in the superintendent's office, or in any central area, may be programmed to signal satellite controllers to re-cycle or to apply water at intermittent periods. This assures proper infiltration and prevents run-off with subsequent overly wet spots on greens. The satellite controllers, located in easy view of the green, may be operated independently for syringing.

Today's controllers, valves and sprinklers, when used in accordance with a good design, when installed properly and when serviced and maintained, will aid substantially in the effective watering of putting greens.

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NEW GRASSES FOR NEW AREAS

Arden W. Jacklin, Jacklin Seed Co., Inc.,
Dishman, Washington

The title directs me to start with a "now" look and then to project into the future for worn areas, etc. Golf course architects are primary in the selection of kinds of grasses, or kinds of mixtures of grasses for use on new job sites. Therefore, I'd like to get just a little technical with you about precepts revolving around selection or choice of grasses both new and old for new plantings.

For many years there has been a growing practice by planners for turf to mix a wide range of anything and everything into one overall turf mixture to cover the widest possible conditions on a job site. I most earnestly disagree with this theory for general practice under most conditions.

The philosophy back of this theory is relatively simple and is based principally upon two premises -

1. That most job sites are not uniform - not uniform as to soil rainfall, shade, exposure, drainage, fertility requirements and prospective usage.

2. That various diseases attack different species and/or varieties to different degrees.

Therefore, simple postulation would indicate that it would seem desirable and feasible to mix a wide range of kinds or species and varieties, and through natural competition to let the "devil take the hindermost" and end up with a good self-adapted turf. Let the more "adapted" ones out-compete the less "adapted" and become dominant. Let disease remove the "susceptible" ones and let the "resistant" ones take over. In theory this seems to make sense. But, in practice it just doesn't work out like it's supposed to. Many things happen in the hoped-for progression to a mature turf.

Research in performance, however, has rather sharply pointed out that with proper management "simple" mixtures, or straight plantings of a single variety will out-perform the complex mixtures. It does take time - years - to test and prove. Please understand -- I am talking of good or better-than-average turfs secured with better-than-average management, and not above average,or service, or utility, or ground cover turfs.

There isn't much published information about old turfs and their quality in relation to what was oiriginally planted. In my opinion, this is understandable because complex mixtures generally produce mediocre turfs. For example, in one part of our trials, over ten years old, a plot seeded with 50% Park and 50% Merion, the Merion predominates, but the Park is strong enough to persist and because of its different growth habit and color merely detracts from the total appearance. This was true when established and is still true today. For a truly good turf, I don't know of any "common" type or variety of Kentucky blue which mixes well with Merion.

There is growing evidence that mixtures of superior or elite varieties may produce good turf. At this time 0217 brand of Fylking Kentucky blue shows promise in mixtures with Merion. So also does Pennstar, and Prato may be all right.

There has been plenty of research done in the past to definitely establish that the "broad gene base" common or native harvested Kentucky bluegrasses produced in the Central and North Central States never did, is not capable of, and never will produce more than a mediocre, or average, or utilitarian, or service, or whatever term one chooses to use, quality of turf. I don't think we need argue about this - it's documented. Also, in a mixture of common types of varieties of Kentucky bluegrasses the resulting turf will not be any better than its most aggressive component. Under average management for the use intended they are quite satisfactory.

But, for <u>superior</u> turfs maintained with <u>high</u> levels of management, there are better materials available. Conversely, however, it should be quickly added that under most conditions an elite or improved, or specialty, or whatever term you choose to use, kind of bluegrass when not adequately managed may not produce and persist as a turf as good as one from common origin.

Notice that I have carefully related variety or type to level of management. As of today, there is strong correlation between the two -- the higher bred or more elite requiring the higher levels of management for good expression of their attributes. Here the plant breeders hope to make improvements -- to have better blue-

grasses, performing well, even with lack of, or some shortcomings in management.

There is growing belief among U.S. workers in turf research that the next big advance in turf improvement will come about from pre-determined blending of three or more similar-appearing types, strains or varieties into a synthetic variety. This was done in creating such items as Penncross creeping bentgrass, Pennlawn red fescue, Ranger alfalfa, and Saratoga Smooth bromegrass, among others. Notice that I said "types, strains or varieties." This may not be good technical language, but it conveys a point, this point being that the three or more in the possible synthetic must be so close in compatibility for the synthetic to be successful; that they may be virtually indistinguishable except for one factor - RESISTANCE TO DIFFERENT DISEASES.

Turf researchers are at work now on improved varieties with the possibility of blending for a synthetic included in the objectives. Let me emphasize that this possible synthesizing is a long term proposition and there is no proof, let alone agreement, that the product may be superior or even equal to a good single strain variety.

Numerous institutions, both private and public, have some excellent looking experimentals coming along. Dr. Daniel here at Purdue, has some dwarf and low, slow-growing ones that are beautiful. Dr. Funk at Rutgers has a most ambitious program under way in both crossing and selection. Dr. Duich at Penn State has some accessions which make one sit up and take notice. Michigan State, Ohio State, and many more are breeding and searching. I would venture to say that today, right now, over 500 types, varieties, strains or mixtures of Kentucky bluegrasses are in various stages of testing in public institutions.

Three of the last five new varieties of Kentucky bluegrasses on the market are of private origin -- 0217 Fylking, Windsor and Prato -- and not including Warren's three A series. I suspect that this ratio of private to public varieties may continue -- so private breeding is "on" at an accelerated pace. There are already 20 plus varieties of Kentucky bluegrasses on the U.S. market -- 30 some named and distinctive. But, they're not all truly outstanding for turf and there's not only room for, but great need for the really good ones.

New controls for stripe smut are most heartening. Many grasses are susceptible in more or less degree, but absolute kill-out of turf is rare. Generally, an attack shows, then the grass partially, or seemingly completely, grows out of it, but the smut then shows again the next season. Turfs as a general rule don't show infestation until they are three years old or older. Unfortunately, some of our finest Kentucky bluegrasses do not have high resistance to stripe smut. To date the greatest proved natural resistance is shown by 0217 Fylking, Pennstar, Newport and Park.

Up to 1967 there has not been chemical control available. Now, however, both Dr. Hardison at Oregon State and Dr. Halisky at Rutgers have demonstrated practically complete control from use of new systemics. The Merion Bluegrass Association by grant assisted in financing the research. Systemics, one from duPont, one from Uniroyal, can be sprayed, dry applied, or mixed with fertilizer for application. One application may last a whole growing season. Incidentally, the systemics have disease control effects on several other diseases of turf including powdery mildew, dollarspot, and reputedly some Fusarium spp. complexes.

In quick summary, what have I said so far?

1. You people are significant in planning new grasses for new areas.
2. I favor straight or simple mixtures for new plantings and do not favor complex or wide-range mixtures.

3. Mixtures or mediocre or average varieties produce mediocre or average kinds of turf for average management.
4. There are few superior or elite bluegrasses that can be used beneficially together in mixtures under high level management.
5. A new variety, to be secured from synthesizing superior types into one variety, may be possible - but it's quite a time away.
6. There are several new bluegrasses just on or coming onto the market.
7. Stripe smut need not be, in the future, of as much concern as in the past.

Finally - please don't louse up an elite bluegrass by submerging it into a hodge-podge mixture.

(Editor's note: Blends of the best bluegrass varieties available are widely used in the Midwest. However, as suggested above - the final best turf should be the best performing varieties, so just start with them.)

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NEWER GRASSES

Howard E. Kaerwer, Jr., Research-Service Dept.
Northrup, King & Co., Minneapolis, Minnesota.

Several new and improved grasses have recently been released, or will be coming on the market in the near future. The advent of these superior strains will provide sod growers with the ability to merchandise grasses and turf formulations in a more aggressive and profitable manner. Other species of grasses, as well as the bluegrasses, are becoming available which will fit into progressive sod growing and merchandising schemes. Consider how you can utilize the new bluegrasses, fine fescues, fine texture perennial ryegrasses and new bentgrasses.

Properly formulated blends offer opportunities for the sod industry, as well as for the ultimate customer. Experience shows that blends of varieties within species, as well as blends between species, can provide higher quality turf than when separate varieties are used to establish turf. Formulas also provide the sod industry with the opportunity to develop and merchandise proprietary sod products.

Northrup, King is presently marketing several distinctive and improved turfgrasses. We have introduced Prato Kentucky bluegrass and recommend its use in formulas with other improved bluegrasses. Prato's Plus qualities to the sod grower include its ability to develop a tough sod, its manicured appearance, its bright green color and its moderate fertility requirements. From the ultimate customer standpoint, Prato provides a dense, fine-textured, bright green, distinctive turf and withstands short mowing. . . .

This spring we're introducing a new vigorous spreading Creeping Red fescue variety by the name of Ruby. Like other fine fescues, Ruby has the ability to provide turf under shady conditions. In addition it does well in full sunlight. Because of its exceptionally vigorous seedling development and spreading ability, Ruby is a fine fescue variety we believe will find favor amongst the sod industry. Ruby is compatible with bluegrasses, withstands bluegrass management and high fertility levels, and persists well in both sun and shade.

The narrow-leaved Perennial ryegrasses are only now becoming available for general use. Northrup, King is producing two varieties, NK100 and Pelo perennial ryegrasses. They provide rapid emergence and yet are not overly competitive with bluegrass. They are compatible with bluegrasses and provide color, texture and density for rapid sod development. NK100 and Pelo produce a high quality and dense turf with improved shade tolerance, disease resistance and tolerance to traffic. Take advantage of the improved varieties which are becoming available.

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IMPROVEMENT OF KENTUCKY BLUEGRASS THROUGH BREEDING AND SELECTION

Terry Riordan, Graduate Student in Turf,
Purdue University

Kentucky bluegrass is the dominant grass existing along roadsides in Indiana, although it is a relatively slow turf to establish. It propagates itself by underground rhizomes to form a tight-knit turf. It is well rooted and resistant to tearing, has a dense green foliage, and is widely adapted to extremes in heat and cold. Bluegrass has three main usage limitations: it is not tolerant of low heights of growth, it is least aggressive at midsummer when areas are used, and depending upon variety, it is either highly susceptible to leafspot and melting-out, or to rust infestation.

A project,supported by the Highway Department, to develop a fast-spreading, erosion-resistant, easily grown, and economically maintained turf, was undertaken.

Past Background

In 1950, Merion bluegrass was released, and since then new selections have been made. At Purdue a very diverse, sexual parent of Kentucky bluegrass has yielded over 100 different variable seedlings. Among these are several very fine and dark green lawn types, and at the other extreme are several very coarse, wide-spreading, vigorous seedlings which should be preferred for roadside use.

Past Purdue Research

In a 1963 thesis, Melkerson used comparative measurements and observations to show uniformity in some seedlings and wide variation in others. He stated that the preferred vegetative material for future tests was 16-B, and then gave a list of vigorous, aggressive seedlings usable for roadside turf.

In 1964, Lobenstein in a Ph.D. thesis, stated that a vigor rating was highly correlated, thus gave a good indication of vigor of the plant throughout the year.

Berry in 1965, found that certain important bluegrass characters were quite variable, and that the variation was highly inheritable; thus allowing the possibility of high percentages of genetic advance by selection of the superior 5% of the population.

Procedure

A total of 3900 seedlings, derived from 164 promising lines collected between 1950 and 1963 by Purdue, were obtained from random-crossing, certain specific diallel crosses, and other high quality apomictic material.

Quantitative Characters Measured

The following bluegrass characteristics were measured and scored: leaf extension in inches; spread vigor; plant rust resistance; plant color; winter survival; seedhead height, maturity and quantity; and overall rating as a final check.

Sorting

The population of plants was broken down into three plant heights, from 1 to 4 inches in height, 5 to 7 inches, and those 8 inches and above. These three groups were then sorted independently for the various characters on an I.B.M. card sorter 83. The less important characteristics were sorted first, proceeding to the most important characters in order to give more weight to this data.

Upon completion of sorting the superior plants were selected from each group to give a total of 5% of the population as preferred selections for advanced selection work and seed increase.

Results

Table 1 shows the averages of the data for the three plant height groups compared to the population average. This gives a good summary of the data and the effectiveness of the selection process. The data in columns 1 - 4 describe the plant, and columns 5 - 8 indicate data useful in disease prevention and seed production.

Table 1. Summary of selected plants

	Height	Spread	Seedhead Height	Overall Rating	Color	Rust	Seedhead quantity	Seedhead maturity
Avg. for population	5	3.3	16	9	4	5	4	6
Low	2.5	5	6.4	5	4.4	2.3	6.4	8
Medium	5.3	2.3	14	4.5	3	2	4	6
High	8	2	21	4	3	3	3	5.6

Spread shown in column two indicates that spread vigor is correlated to plant height with taller plants having more spread, thus it is easier to select a medium or high growing plant with vigor than it is for a low growing plant.

The third column shows that the seedheads average 2.6 times the leaf height in each of the groups, indicating a high correlation for these characters.

As shown in column 4, the average rating for the population was very poor, but improvement through selection is indicated by the ratings 5, 4.5 and 4 respectively, for the three height groups.

The improvement for the characteristics of color and rust resistance is shown in columns 5 and 6 respectively. From the summary it may be seen that

lower plants have a lighter color and more rust resistance than the higher growing plants. Rust resistance seems to be affected more by the length of the leaf, with a longer leaf more susceptible to infection.

Seedhead quantity and maturity are arranged in a similar manner, with lower growing plants having less seed and longer development time on the average than the higher growing plants. When compared to the population average maturity is later for the selected groups, indicating late development is possibly related to better development.

Conclusions and Recommendations

Improved plants on the basis of higher ratings were selected from the population. The selected plants will be the basis for further study and seed increase for possible use on roadsides, home lawns and golf courses.

Planned objectives for further study of the selected plants include: selection of better progeny, chromosome counting and calculation of percentage of apomixis as a means of knowing the mechanism of seed production, and also possible crossing as a means of obtaining improved bluegrass plants.

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SODCO BLUEGRASS

W. H. Daniel, Breeder
Purdue University

A multiline selection has been released by Purdue University as Sodco. Breeder's seed was supplied to Agricultural Alumni Seed Improvement Association, 2336 Northwestern Avenue, West Lafayette, Indiana. 47907.

They have contracted with two farms for breeder's seed production (planted in 1967). Seed produced (first in 1968) will be foundation for growers (under contract) planting for 1969 harvest of certified seed.

Thus, in 1969 the Sodco variety can be available in small quantities. The stripe smut resistance, slow, lower growth, and less thatch formed should be matched by good management programs.

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BACTERIA AND ORGANIC ADDITIONS

James M. Latham, Milwaukee Sewerage Commission
Milwaukee, Wisconsin

"The death and decay of animal substances tend to resolve organized forms into chemical constituents. The fermentation and putrefication of organized substances in the free atmosphere are noxious processes; beneath the surface of the ground they are satulary operations. In this case the food of plants is prepared where it can be used."

Sir Humphrey Davy

The addition of organic materials to the soil is a much used but still misunderstood operation. In some instances its benefits seem contradictory.

1. Organic additions improve the water-hodding capacity of sands.
2. They improve the porosity of clays.
3. Base exchange capacity, or nutrient holding capabilities of most soils are enhanced by organic matter.
4. Soils are "softened" oftimes by increasing their resiliency.

All these benefits are accomplished with the help of micro-organisms and their enzymes that feed on the organic matter. A count of soil bacteria under park grass in England amounted to 1% of the soil weight in the top 6 inches of soil. This amounts to 1300 pounds per acre. Besides bacteria the major decomposition organisms are: fungi, Actinomycetis and protozoa.

In humus, the nitrogen present is in a complex form, largely unavailable to further decomposition. A measurement of availability is the ratio of carbon to nitrogen in the material. Sphagnums, for instance, have a carbon nitrogen ratio of 12:1, with composts at 8:1.

When raw organic matter is added to the soil, the rate of decomposition is in proportion to the available nitrogen in the material or in the soil. Generally speaking, for every 30 parts of cellulose to decompose, 1 part of nitrogen is needed. If the residue has a high nitrogen level, the excess is given off as ammonia. This is either lost into the atmosphere, or is held as ammonium by soil particles, or is nitrified to nitrate ions. If the residue has a low nitrogen content, the deficit must come from the soil or from addition as fertilizer. About 1.7% is the breakeven point.

The speed of cellulose decomposition depends on:

1. Associated substances, especially lignins, hemicelluloses, etc., that are not easily acted upon by bacteria.
2. The native of micro-organisms active in the process, their speed of action, population, etc.
3. The presence of nitrogen and other minerals needed for microbial nutrition.
4. The environment.

Most decomposition organisms require aerobic (presence of air) conditions. Anerobic conditions can support cellulose decomposers, but lignin decomposition is almost nil. An example of the latter is a peat bag where only lignin remains from the original plant.

The best lignin decomposers are the fungi. The fairy ring is a good example, starting from a tree stump, buried boards, or thatch from excessive turf growth. These are largely aerobic, but can send their filaments into anerobic areas.

The organic content of plants vary, but the following list of constituents should give an adequate example:

Cellulose	20 - 50%
Hemicellulose	10 - 28%
Lignin	10 - 30%
Protein 1% in wood, 15% in legumes	
Cutins, fats, waxes, resins	about 18%

The end process of organic matter decomposition is humus. It is very complex in nature, consisting of certain major groups and several minor groups that

affect chemical and physical soils properties. Contrary to common thought, humus is not static but dynamic and ever-changing. Its formation and accumulation, as well as its chemical nature, depend on the nature of the residues and the soil condition under which decomposition is taking place: temperature, moisture, aeration, pH, and mineral base content. It has been stated that this process makes simples complex and complexes simple.

The process depends on the residue content.

1. Cellulose and hemicellulose are the major energy sources for the micro-organisms. They decay very rapidly.

2. Proteins supply ammonia for the production of micro-organism protein. In the process it is concentrated. For instance, plant protein is from 2% to 15%. Humus protein is from 8% to 35%.

3. Lignins are difficult to decompose. For instance, fresh wood contains about 59% cellulose and 18% lignin. Fully decomposed wood contains about 8.5% cellulose and 80% lignin. The shift in percentages is due to the ease of cellulose decay and the resistance of lignin to decay.

The general classes of humus have individual characteristics that indicate their usefulness:

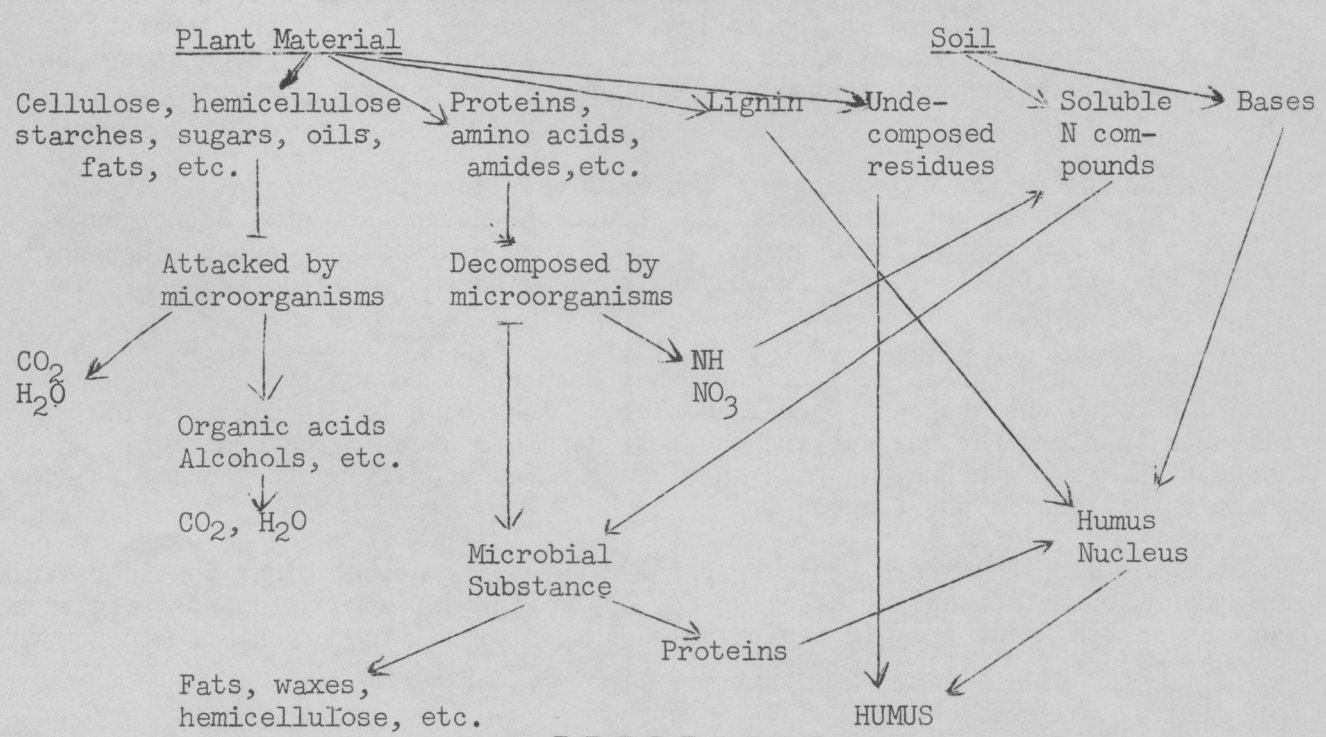
I. Lowmoor peats and forest peat
   - A. High in lignin
   - B. High in protein
   - C. Low in cellulose

II. Highmoor peat
   - A. Low in protein
   - B. High in cellulose & hemicellulose
   - C. High in fats and waxes
   - D. Low in ash (high organic)

III. Sedimentary peats
   - A. High in ash (low organic)
   - B. Low in cellulose
   - C. High in protein
   - D. Low in fats and waxes.

IV. Coal
   - A. Called fossillized humus

FLOW SHEET SHOWING
THE BIOLOGICAL DECOMPOSITION OF ORGANIC MATTER



WHAT IS TURF RENOVATION?

James M. Latham, Milwaukee Sewerage Commission
Milwaukee, Wisconsin

Definition: To renew; make over; repair.

Although popular today, turf renovation is not new - we just have better tools with which to work. To stretch a point, the plow was the first renovation tool. Turf renovation is a hot item. Everyone seems to have some terrible situation that needs fixing. Machinery is being built to do these jobs better and quicker. Turf users are inconveniencedby a seemingly unending cloud of dust generated by well-meaning turf managers unable to provide the turf quality desired. This is a good practice -- as far as it goes.

There are several necessary types of turf renovation. Sometimes design or construction errors make renovation necessary early in the life of a turf area. Changes to highly motorized management has made design renovation necessary on many golf courses. Soil renovation is often necessary to meet the demands of heavy turf usage. Irrigation renovation is at an advanced rate now to provide more efficient, uniform water distribution. Other industrial renovation techniques lead us to the need to renovate the turf itself.

The need for renovation in today's terminology is difficult to determine. One day we're trying to grow grass faster, the next we're having to decimate the surface because we did too good a job. So, we rip the daylights out of the turf and then what? Fertilize like blazes to fill up the voids!

We are a reactionary group. When we see something going wrong, we react violently and go on to something else, forgetting the original problem. It comes back. We react and forget. It keeps coming back. This type operation keeps treating symptoms and not the basic cause.

Let's look at a couple of example; first, thatchy turf. We hear that to grow good fairways we need 6 to 8 pounds of nitrogen per 1,000 sq.ft. per year. So, we blindly go out and start pouring it on. Before long the good golfers complain about poor shots, the mowers begin to scalp,. and the wierdest diseases crop up, not to mention heavy mowing required in the spring. Sure enough, there's that thatch. Well, buy a machine and raise a cloud of dust. It looks awful, and because we don't want weeds, fertilize heavier to heal the wounds. Total accomplishment is very little.

Then, we go to variety changes. You know the picture - bluegrass fairways are cut too high, so we get irrigation and reduce the height of cut. Sooner or later here comes *Poa annua*. It's awful. So, we seed bent and proceed through any number and variety of operations, including scorched earth. What comes back? You guessed it.

In both cases a great deal of money has been spent to achieve little in return. All because the programs were incomplete. Take case I. In side by side fertilizer rate plots the one getting the most nitrogen usually looks better. On golf course fairways, though, we find that lower rates usually perform quite well, since the comparison is not there.

Starting with a lower nitrogen program after heavy dethatching, consider irrigation. Here automation helps, since we can apply lighter, more frequent irrigation to keep the thatch moist and aid biological decomposition. The organisms won't work in bone dry material. Liming and other practices also play a part.

Case II is more complex. Even after a scorched earth program Poa annua remains the principal species because it is more competitive as a seedling. Why not, then, initiate a moderate Poa annua control immediately? Tests dating to the 1930's showed that moderate arsenical rates did not severely damage the desired grasses. Quite often a thatch problem exists too, so some provision for its treatment must apply. Of course, the most sensible route would have been to inter-seed bent at the outset when the height of cut was being lowered.

The question of timing is of great importance. Most renovation programs are performed at times most suitable for Poa annua germination. What better conditions could it want? Reduced competition, plenty of water and fertilizer, good temperature . . .

Pride of ownership contributes to the necessity for frequent renovation, in the South especially, but also in the Midwest. Everybody wants the newest because we're told it is the best. We plant Penncross bent, Tifway bermuda and the like, then curse their vigor. They may cost little more to plant, but management costs skyrocket, and go on and on and on. Seaside and U-3 have their problem, but they are pikers compared to the other two.

A brief notice of greens should be made, since another addition is necessary there. Topdressing is a means of assisting biological breakdown by inoculating the thatch with large numbers of organisms. It also, in effect, raises the height of cut to allow more leaf growing room. It "trues up" the putting surface. There are some golf superintendents who do not topdress. In their case they seldom find it necessary to renovate either, because their overall program makes it unnecessary. Unfortunately, they are few in number.

Please don't interpret this as a De-Sale of renovation tools. They are very necessary in our management processes, but are still inadequate to cope with the situations alone. We have to help by establishing overall programs of frequent mowing, careful irrigation, and knowledgeable fertilization to grow quality, not quantity turf. Then, timely and thoughtful renovation will renew, make over or repair, not fail.

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