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PROCEEDINGS

First Annual

New Mexico Turfgrass Conference

Oct. 6-7, 1955

Sponsored by

New Mexico A&M College

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WELCOME

Albert S. Curry
Associate Director
New Mexico Agricultural Experiment Station

I would like for you visitors and participants in this Turfgrass Conference to know that the college staff is pleased that you were willing to hold your first conference on our campus. We hope you will adopt it as a practice to hold your future conferences with us. Our institution is not large, but it is growing rapidly. The Physical Plant is increasing in size and quality. Each year there is an increased number of students and they are served by an ever-growing number of qualified staff members.

We are a land-grant college and our functions are numerous. Our classroom instructional program, our regulatory responsibilities, our Physical Science laboratory, our various services and educational and research programs are designed to assist in improving the economy of New Mexico and the nation.

We hope you will find time while you are here to visit the campus and the Experiment Station farms. If there are points of special interest to some of you, please do not hesitate to ask for assistance regarding them.

I think it is a fine thing that you have developed your interest in the turfgrass situation. Turfgrasses properly selected and managed can make a real contribution to the improvement of our homes and communities. They are a thing of beauty and because of this they add greatly to our comfort and peace of mind. They increase our contentment and leave us with pleasant feelings. They increase our sociability and harmonious relationships. These things assist us to understand each other's problems. They increase our tolerance with respect to difficult situations. In some ways these contributions can be of minor importance but in other ways they can be of real value in coping with difficult situations. I think much good can come from the work you people are concerned with. I hope these good things can be made to reach every home, every park, every golf-course, every cemetery, every roadside and all other places where people will be favorably impressed by the beauty and full value of green grass properly selected, used and cared for.

After reading the agenda and the registration record, I was quite pleased to notice the wide representation we have from various localities and activities. This is quite encouraging. It indicates you people will have the opportunity of serving and influencing a large segment of the public. I hope your interest is not solely financial because turfgrass as indicated before have esthetic as well as financial values. Admittedly, some people receive economic benefits from the turfgrass industry

through the media of transportation, irrigation systems, equipment, seed production, supplies and labor. Despite the financial benefits derived by some of the turfgrass enthusiasts, I am sure many more of us obtain a benefit of a lasting nature measured in terms of happiness, comfort and sociability.

The turfgrass activity, like all others pertaining to agriculture, is confronted with many problems. Much time and research effort will be required before the answers are found. This is a new industry for New Mexico. We have very little first-hand information regarding the various problems that will arise. However, the general knowledge we have regarding plant life, soils and water will be of material assistance in establishing and maintaining a turfgrass industry.

In New Mexico we have a great variety of environmental conditions such as altitude, rainfall, humidity, temperature, length of growing season, soil and irrigation water. These various conditions will have definite problems regarding the adaptability of grasses, insect pests, plant diseases, soil management, irrigation and fertilizing practices, weed control and various other cultural and management procedures.

Some of these problems will be discussed at this meeting, and many answers will be given. However, I am sure many questions will remain unanswered and that in the future many new questions will arise.

As a part of the business of this meeting I understand you will form a Permanent Turfgrass Association. Much work remains to be done regarding education and research. I hope these two things will be recognized in setting up your organization. I think your support of them should be an important part of your objectives.

Again, may I assure you that President Corbett and the rest of us are glad you are here. We hope you will enjoy your visit and that your meeting is a successful one. Don't forget to ask us if you have any questions about the college. Later in the program when the coffee break comes, I would like to assure you that President Corbett is very pleased to have you as our guests.

We hope you will meet with us regularly and often.

"THE IMPORTANCE OF RESEARCH AND EDUCATION IN TURFGRASS WORK"

Dr. Fred V. Grau, Agronomist
West Point Products Corporation
West Point, Pennsylvania

(Paper prepared for presentation before the First Turfgrass Conference in New Mexico. Presented by Dr. J. V. Enzie, Head, Horticulture Department, New Mexico A & M College.)

Research and education in turfgrass work and to turfgrass users is important because the turfgrass industry is important. It is important to a great many people whether they be the growers, the processors, or the vendors of turfgrass seeds or vegetative material of those improved grasses for which there is no seed. It is important because a tremendous industry has developed around the mowing of turfgrass areas, and recently more specialized machinery to cultivate and condition the soil and to properly manage the surface of turfgrass areas has grown up. The superintendents of golf courses, of parks, cemeteries, athletic fields, military installations and many other areas comprise an important segment of the turfgrass industry because more and more they are being recognized as men with a high professional standing, commanding excellent salaries and other considerations. Under them there is a virtual army of foremen, laborers, and workmen who handle the machines and perform the various functions maintaining literally millions of acres of turf. I should like to call your attention to Volume 5, No. 1, January, 1955 issue of Southern California, Turfgrass Culture, Los Angeles 24, California, wherein Marston H. Kimball, Extension Ornamental Horticulturist, prepared an article "Turfgrass by the Thousands of Acres" based upon a recent survey of Los Angeles County. In the county there are conservatively some 63,000 acres of turf. To establish this grass would cost about 262,000,000 dollars. And nearly 100,000,000 dollars are spent each year in maintenance. As Mr. Kimball puts it "this puts turfgrass in the big business bracket".

This is only one of the reasons why research and education in turfgrass work is important. Another reason is that several million golfers each year enjoy the championship quality putting greens that are being produced on most of the courses in the country by modern machines and men and money. Millions of spectators thrill each Saturday afternoon to the Collegiate contests on the gridiron. This has become a very important factor in turfgrass work, heretofore sadly neglected. I could go on and on describing more reasons why research and education are important but it hardly is necessary at this point.

I should like to discuss the role of research for just a moment. Probably no living man has a complete concept of the extent of the research that went into the development of the discovery of

nuclear energy. It is not an apt comparison, but is is safe to say that no user of turf today realizes the extent of research that has gone into the development of a single grass or of a single procedure or technique or the development of a control for disease. It is not necessary that the users of turf recognize all of this effort. What is important is that the turf is continuously satisfactory for the type of use for which it is developed.

The research that goes into the development of a new grass, let us say for example, Penncross creeping bent for putting greens, is only a beginning. That research then must be carried to the seed fields where the growers will produce the seed that science has developed. Here a great deal of practical research is necessary and much of it unfortunately has been by the trial and error method through which great losses are encountered. When the seed has finally been processed and reaches the hands of the user then another series of research problems are encountered and that is the proper management of the turf that these seeds produce. This phase of research has been somewhat neglected because it is difficult to find in many cases a specific, concise arrangement of the factors that enter into the successful use of any particular grass. In many cases this is left to the discretion of the user and he makes many mistakes before he finally learns the proper management of a specific grass.

This I believe then is a challenge to the research people of the nation, that is to develop for each new grass as concise as possible a listing of the management procedures necessary for the most successful growing of the particular grass.

Research on diseases continues to grow primarily from the standpoint of trying to discover better chemicals with which to combat the various diseases. I should like to submit that perhaps some of that energy in research should be devoted to the discovery of the management practices which will help to create in the grass a resistance to the various diseases. In my Column in Golfdom I have referred to the historic research done nearly 25 years ago, when I was priviledged to work with Dr. Monteith and Dr. Dahl, in discovering that early morning watering of bentgrass putting greens resulted in a significant reduction in disease. This was a piece of research that must be told and retold because it certainly is not being practiced in many places in the country. We need this type of research as regards the application of fertilizers, and again the amount of water. We need to evaluate the use of water in relation to the porosity of the soil and in learning how to keep the surface of a green dry so as to minimize the occurrence and development of disease organisms. Research is needed on the wear-resistance of turf. With the advent of the motorized caddy cart we hear loud wails from many quarters that the turf is being ruined, worn out. We need research in this direction to learn how to grow grass in spite of traffic from the

motorized caddy carts in addition to all the other traffic on the golf course. We need to know which grasses and which management practices help to create a turf on an athletic field that will withstand the terrific punishment of the Saturday afternoon games as well as the practice sessions during the week.

It is important that research be coordinated. It is possible to do a great deal of useless work that already has been done somewhere else unless safeguards are taken to learn what has been done in a particular field previously. The coordination of turfgrass research must be on the broadest possible basis in order to encompass all phases and uses of turf.

I should like to discuss briefly now the importance of education to turfgrass users. It has been my pleasure to have been active in this field for nearly a quarter of a century. As Extension Agronomist in Pennsylvania I learned something of the need for education among the home owners, the high school principals and coaches, the cemetery owners and operators, the highways and many other segments of the turfgrass industry. As Director of the U.S. Golf Association Green Section I became thoroughly acquainted with the need for education in this field. Now as a representative of a manufacturer of specialized turfgrass maintenance equipment I am still in the field of education from the broadest possible standpoint. Not long ago I had the opportunity to present a paper before the National Science Teachers Association in Cincinnati. The Science teachers in the high schools are trying to teach high school students something about plant life. Some of them are beginning to teach something about turfgrass management with very little background material. To me this is one of the great challenges in the educational field. Through this avenue of approach we will reach the coaches, the principals. We will find those boys and girls who have a natural trend toward this field of endeavor and it will assure us of topnotch turfgrass superintendents, research men and educators in the future.

I submit that we need to give more attention in this field of education to the high school level and perhaps even to carry it down into the grade school level. This too is possible.

It is appalling the extent of mis-information being distributed over the country regarding turfgrass work. Let us say that much of it is non-malicious and that there is no intent of anything but good, yet it remains that a great deal of information being distributed is erroneous. There are many avenues of approach to education to turfgrass users. Many people turn to the County Agent for information on things agricultural, and now with expanded information in turfgrass work, the County Agent is becoming more aware of his responsibilities and capabilities in this regard. Through bulletins, radio and the press, information from the Agricultural Experiment Stations is relayed through the specialists and county agents so that sound, accurate information

is available, within the reach of everyone. In addition to this, the various associations of golf course superintendents, of nurserymen, of gardeners, cemetery and park superintendents and many others, have available to them top notch speakers who are capable of carrying education in turf to those who are organized and can make a call upon his services. This includes Agronomists from many walks of life, including fertilizer companies, seed firms, golf associations, equipment manufacturers, salesmen of equipment, nursery men and many others. Each representative regardless of his affiliation must ultimately pledge himself to carrying accurate information for the education of turfgrass users for the ultimate benefit of the industry.

It is interesting to note that in the last few years there has been a considerable effort attempting to create a national council or institute or body which would be the central source of information in turfgrass work. To date this has not been accomplished. This is in the future but it is one of the steps that is necessary in education in turfgrass work.

To summarize, research alone is sterile. Efforts at education without research are equally ineffective. Combined research and education teamwork is absolutely essential to future success. In our efforts at education let us not lose sight of the fact that the basis of success in the future is the training of qualified men and women to occupy positions of importance, not only in research and in education, but to take their places as turfgrass superintendents which is one of the important and one of the nationally recognized professional positions in the agricultural field today.

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TURFGRASS PROBLEMS IN PUBLIC AREAS

Fred Day, Director, Campus Maintenance
New Mexico A & M College

I have recently attended the annual Conference of the American Institute of Park Executives held in Louisville, Kentucky. The membership of that organization represents leaders in park development and maintenance as well as recreation leaders in those parks from all over the U. S. and Canada. Everyone of those men, whether a park man or a recreation man, had a profound and primary interest in the development and maintenance of turf. And everyone shared the problems associated with keeping turf intact in public areas.

Essentially, we have only one problem and that is the maintenance of a growing turf in heavy use areas.

There are many who will point to specific problems that they know have prevented them from keeping a good turf going; but more than likely they are putting their finger on a cause of failure and it is a number of these causes that somehow seem to snowball together and defeat our efforts for growing grass right where we need it most.

The first cause, of course, is that the area gets too much use, too many people, too many interuptions in the maintenance schedule. This may lead to infrequent, irregular, or even scanty watering. It may further lead to the relaxation of good care methods. We may be called on to begin use too early in the growing season or too soon after an irrigation. Such use invariably leads to compaction, scant stand of grass, introduction of weeds and finally bare ground.

By this time we are convinced that the area should be paved with concrete and all our problems would be solved; but we are always stopped by the fact that this is the one area that should, by all means, be in grass.

It is at this time, too, that we pose the questions that nearly all of us are seeking the answers to. Is this failure due, really, to just too much use? Is it due to using the wrong kind of grass? Could it be that the area is too small for its intended use? Is it improperly arranged? Has it had the proper care?

Fred Roewekamp, Director of Parks and Recreation for Los Angles County reports that they have gone into the oldest parks in the county, some of which were bare of turf, surveyed the needs of the community around them, designed the park for that community, rearranged and re-developed the planting and lawns. They have enticed over twice the population to use the park than formerly, and they are maintaining a good turf. Now can we hide behind the excuse that an area gets too much use?

But that is in California, you'll say. Yes, and it was in California that those same parks were once baren ground. Fred Roewekamp says that by proper planning of arrangement and good care, a turf can be kept.

Then are we using the wrong kind of grass? Most of us would readily agree that there ought to be something besides Bermuda altho in many situations we are thankful for it. The most crying need for a 'right kind of grass' is on our public school grounds. Certainly a grass that goes dormant when the school comes alive could hardly be classed as a choice turfgrass. I think this is one place where a wrong kind of grass contributes to failure.

Along with finding the right grass, we need some measure of how much lawn area per person is needed. We have two practice fields

and a stadium here on the campus. By the time we rotate football practice, band, intramurals, physical education, and military science, we wish we had more space on which to spread them out. Thus more space would allow us to keep up good maintenance practices.

Adequate space must also be carefully studied to work out arrangements that will insure balanced use. The shining example of unbalanced use is any football field anywhere. Everything takes place on the 50 yard line and that wonderful turf in the end zones even goes unnoticed by the spectators. Paths across turf areas come in for a lot of criticism and are considered problems. I have had more advice on how to cure such paths than on any other point. It's always the same - pave it with concrete. That is rather unimaginative, as I see it. Here our schedules change from time to time or a new building is built and you are left with walks going nowhere. Circulation studies can pretty well determine where the traffic is to be. We don't mind students walking on the grass. We rather like it. People like to walk on grass. We have cured walks across the horseshoe with just good care. Many paths can be prevented by providing wide landing at exits to buildings that let traffic off at many points. Many can be cured by screening the destination the pedestrian is headed toward or by barricades or plantings that shift his starting point over to a walk. There are many ways to prevent paths occuring in lawns - the last of which is to pave them.

I have referred to the term "good care" a number of times and yet I can't tell you exactly what it is. We have stumbled on to some things that seem to work here, but if it is right, I'd like to know why. Some of our best grass is on a low side of a supposedly level terrace and it gets 8 to 10 inches of water per week. Last year, due to some night time sprinkling, we put on 5 inches of water per week on the horseshoe and had the best turf ever. Is that the answer? Or would fertilizer reduce water requirements? Is nitrogen really the only fertilizer that turf needs? What is the proper cutting height and frequency of cutting? I'm even wondering if the type mower used makes much difference in turf response.

The only thing I know about turf growing is what I have seen tried here and what others are doing. The questions I have posed here reflect the need for research and trial in many parts of the state.

I want to congratulate you on your interest in this economically and esthetically sound program of promoting better turf everywhere.

It is with hope and enthusiasm that I look forward to an association here dedicated to building better turf.

TURFGRASSES AND THEIR ADAPTATION TO NEW MEXICO

Clarence E. Watson, Assistant in Agronomy
New Mexico A & M College

The area of New Mexico and adjoining states could easily be classed as a region of extremes. This area has a wide variation in elevation, temperatures, rainfall, soils and we might include water quality. Due to these conditions, the selection and management of turfgrasses is an extremely variable problem. A grass that is right for one section may be entirely wrong for other areas. Even the soil types within a given area play an important part in grass selection and management.

Much of our turfgrass selection and breeding work has been done in the East and Southeast; therefore, we have considerable controversy over the merits of grasses as they apply to New Mexico conditions. Actually, we have been using a hit-or-miss proposition in recommending grasses for any given area in this region. The publicity that is given some new turfgrass may cause the public to accept and plant this grass outside the area in which it was developed. Occasionally, one of these grasses may find a place in some particular area out of its general habitat.

Naturally, every person interested in turf is always looking for the wonder grass. One that will meet all the necessary requirements for all areas, uses and individuals. It should be constantly stressed that such grass is not in existance. The grass that will meet the requirements of one individual will not be satisfactory for someone else. Even people who grow home lawns will differ in their demands of a grass to fill their needs.

There are examples of rather inferior grasses that have done a remarkable job with proper management. At the same time, there are many improved strains of turfgrasses on the market today; but needless to say, without good management they are worthless. Too many individuals feel that because a grass is an improved strain that this automatically does away with part of the management problem. Every turfgrass worker should realize that man is just as important in growing a good turf as the grass he selects for his specific purpose.

In choosing a turfgrass, one fundamental question should be answered: Will this grass do the job required of it? Whether it is for a green or fairway on a golf course, football field, home lawn, public parks or school campus, it must do a particular job and do it well. Secondary questions to be answered are: (1) Is the grass adapted to the area? (2) What are its management requirements? (3) Is this grass better than those now being grown in that area? (4) For what purpose is this grass best suited? The individual should make certain these questions are

answered to his satisfaction before planting one sprig of grass. The old adage that "It is better to be safe than to be sorry", certainly holds true when selecting a turfgrass for any area or a particular use.

It is hoped that the information given here will be of some benefit in selecting a turfgrass for your locality and for certain uses.

Bermuda grasses

Bermuda grass has a rather limited area of adaptation in New Mexico. Its use is mostly limited to the southern one-third of the state. Some strains can be successfully grown as far north as Albuquerque in the Rio Grande Valley and to Tucumcari on the east side. In the higher mountain regions of southern New Mexico, Bermuda will not survive and produce a good turf.

In recent years, there have been several improved strains of turf Bermuda grass released to the public. It is only natural that many of these are not adapted to our conditions. Some of the better known varieties are Tiffine, Tiflawn, T-47, T-35A, Gene Tift and U-3. Other selections that show considerable promise are Tifton 328 (Experimental), T-94, T-82 and a South African selection. The selection T-47 has shown considerable promise in the Mesilla Valley for home lawns, public areas, football fields and possibly for tees and fairways on golf courses. There are several objections to the use of this selection, however. Applications of chlorodane causes it to go off color for several days. It is rather coarse textured and does not possess the vigor of other Bermudas; however, it is very drought tolerant.

A Tifton selection, Tifton 328, is an extremely fine leaved plant, with nice color and good vigor. This selection has shown well during the summer and may give the golf courses in southern New Mexico a grass for putting greens. T-94 and T-82 have both looked good in an observational nursery. U-3 is a medium textured grass with good color, and winter hardiness, that may be utilized for fairways, tees and home lawns. African is being used for home lawns in all the regions of New Mexico where Bermuda grass is adapted. With the exceptions of U-3, T-47 and African, all the above Bermuda grasses may winter-kill. They have not been tested under winter conditions; and as a result, recommendations can not be made as to their winter hardiness.

Where ever Bermuda grass is utilized, it should be remembered that the growing period is from two to three weeks after the last frost in the spring until the first frost in the fall. If a green turf is desired for a longer period, then overseeding the Bermuda sod must be practiced or else go to some other grass.

Kentucky Bluegrasses

In the higher elevations and the northern two-thirds of New Mexico, common Kentucky bluegrass thrives fairly well. Its main drawback is the inability to withstand high temperatures and close clipping. It will do well on home lawns, since close clipping is not an important factor in this case.

The improved Merion bluegrass has several advantages over common Kentucky bluegrass. It has expressed considerable tolerance to leafspot, where this disease is prevelant; however, leafspot is not considered a serious problem in the west. Other diseases can be just as disastrous to Merion as to common bluegrass.

Merion can survive under much closer clipping than common bluegrass. This is especially important on golf courses where close clipping is demanded. Merion has a prostrate habit of growth and has been reported to be successfully maintained at one-half inch clipping.

Merion bluegrass requires heavy fertilization, especially with periodic nitrogen applications. It does not thrive well on acid soils, a condition that rarely exists in New Mexico. It is more drought tolerant than common bluegrass and watering too frequent is detrimental to good growth.

The Bentgrasses

The bentgrasses are adapted primarily to the northern one-half of the state and in the higher mountain areas; however, it can be grown throughout the state if properly managed. Most turfgrass workers will agree that more problems are involved in growing bentgrass successfully than for most other grasses. In some of the cooler areas of the state, bentgrass is almost a must for golf courses, even though management is a problem.

The merits of the various strains of bentgrasses will not be discussed here since there is no experimental data available on bentgrass for the New Mexico area. At present, there is an observational nursery at an Albuquerque golf course which contains some of the better strains of bentgrasses.

Two general types, colonial and creeping, are in common use today. Colonials are used to some extent in greens, but possibly have their greatest use on fairways and overseeding on a Bermuda grass base. Creeping bents have their greatest place on greens and in some sections possibly tees and fairways as well.

Fescues

Alta fescue is generally adapted throughout the state. It is a tall growing perennial bunch grass. When seeded heavily and

clipped short and regularly, it forms a dense coarse turf that is resistant to hard wear. It will grow in moderate shade and is very drought tolerant. Its main use is lawns, football fields, and fairways or tees on golf courses. Its use as a general turfgrass is still questionable where other species are adapted.

Meadow fescue may be used instead of Alta in the northern one-third of the state. There is a necessity for selection and breeding work on Meadow fescue for this area. The possibility of utilizing sheeps fescue for turf should not be overlooked. To our knowledge, the red fescues have not been used in New Mexico; however, they may have possibilities for lawns and fairways and tees in the cooler region.

Ryegrasses

There are two ryegrasses used for turf purpose, one being perennial and the other annual ryegrass. The ryegrasses are fine-leaved bunch grasses and are generally adapted throughout the state. This grass is used primarily for lawns and overseeding of Bermuda grass bases. Unless properly managed, ryegrass can cause serious damage when overseeded on a base grass such as Bermuda.

The ryegrasses require well drained soils of good moisture holding capacity. They need liberal fertilization where soil fertility is medium to low. Ryegrass will not grow well on soils that are compact or strongly acid and are severly injured by hot dry weather. In the southern one-half of the state, they will disappear almost entirely from turfed areas except in the shade.

Zoysia

Zoysia species include Japanese lawn grass, Manila grass and Mascarenegrass. Selections and crosses have been made from Zoysia species to improve its turf quality. Two of the better known strains are Myer Zoysia (Z-52) and Emerald Zoysia, a cross between Japanese lawngrass and Mascarenegrass. Whether Zoysia is adapted to New Mexico conditions is still questionable. Several plantings survived one winter in the extreme southern part of the state, but it is not adapted to the colder areas of New Mexico.

Zoysia is much slower in spreading than Bermuda grass and is more costly to establish quickly. It is less drought tolerant than Bermuda and produces too dense a turf to allow overseeding of winter-growing grasses. There are, however, several advantages such as being shade tolerant, highly weed resistant, highly resistant to wear, more frost tolerant than Bermuda grass, and disease and insect resistant. It should be mentioned again that it may winter kill here in New Mexico.

Miscellaneous Turfgrasses

Several grasses fall into this category because some quality makes them suited to a particular condition. The wheatgrasses, especially crested, show considerable promise on areas where little water is available. They are extremely drought tolerant and could possibly be utilized along highways, tees, fairways, and lawns where watering is impractical.

The grama grasses are also drought tolerant and show promise for home lawns, highway cuts, and golf courses, except on greens. This group is fine leaved and selection work might be worthwhile.

Buffalo grass is utilized on the eastern side of the state for lawns, golf courses and areas where water is not available. It is very drought and heat tolerant. The turf is fine leaved and dense and will withstand frequent close clipping.

Other grasses not mentioned here may show promise for turf. The field of selection and breeding better turfgrasses for the southern Rocky Mountain Region is wide open. The value of such program in this area could be immeasurable to turfgrass users. There are numerous fescues, bluegrasses and others that are native to this area which could possibly produce a better adapted turfgrass than those now being grown.

General comments

Everyone has seen turfgrass mixtures being used by the public. Too many times these mixtures are not labeled as to their content and unless an individual has the ability to identify seed, there is no way of knowing what is being planted. The persons in the process of buying turfgrass seed should beware of such mixtures. Know what you are planting. Ask yourself those fundamental questions; will this grass do the job? is it adapted to the area? what are its management requirements? is this grass better than other grasses that are available? for what purpose is that grass best suited?

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POINTERS ON BUYING TURFGRASS SEED

Elizabeth McSwain, State Seed Analyst
New Mexico A & M College

The purpose of the New Mexico seed law--of any seed law-- is not to tell people what they want but to help them know whether they are getting what they want. In the case of grass seed, however, people need a little help first of all in knowing how to express

what they want. They all want good grass, but how is that expressed in terms that can be asked for over the counter or written into specifications for seed? The problem is made more difficult by the fact that quality percentages of grass seeds differ considerably from species to species. Because of these considerations, the New Mexico State Seed Laboratory compiled some information on lawn seeds which we thought might be useful to seed dealers and also to buyers of seed.

Under the New Mexico seed law, as under the Federal Seed Act, grass seed must be labeled as agricultural seed: that is, each component in excess of 5% of the whole must be listed with the percentage, by weight, of that component; the germination with date of test of each component; the percentage by weight of crop seeds not listed; the percentage by weight of inert matter; and the percentage by weight of all weed seed. In addition, the number of noxious weed seeds as designated by the law must be stated in rate per ounce. Lawn or turf seed, incidentally, need never contain noxious weed seeds--that is, those weed seeds which have been blacklisted as agricultural menaces. They seldom occur in or can easily be cleaned from most grass seeds. Other weeds which may not be agricultural menaces can look menacing in a turf. To prevent adding to the number, seeds as nearly free from all weed seeds as possible should be purchased. The maximum acceptable percentage for chaffy grass seed such as blue grass is 0.50%. Freer flowing seed can be more easily cleaned and the presence of any common weeds at all is an indication of careless handling somewhere.

In our information leaflet, therefore, we have shown typical labels so that the dealer and the buyer can check to see if all the information is given. Then we have prepared a chart for reference in case further study is needed to evaluate the tag. The primary purpose of each of the common grasses is listed, chiefly with the hope that this will help people in evaluating mixtures. The mixture problem may be of only academic interest to professional turfmen, but it is a pocketbook matter to people who buy pretty boxes. They need a reminder that the cheaper the mixture the more temporary grasses there are in it; and that this information is right on the box, in somewhat smaller figures than the price mark, if they will only read it.

Then in the chart we have given the minimum purity and germination percentages for good quality seed of each kind. This we hoped might be of help even to professionals--particularly those who may be new to the business. The figures are based on recommendations of the Association of Official Seed Analysts and other published data on the less common species, and have been checked against, and in some cases modified by, the averages found in testing seeds in the New Mexico laboratory over a period of years. We know that the specifications are attainable. We also know that some very low quality turf seed has been introduced into the state to fill

bids for public works--a situation which would have been avoided if the bids had been on quality as well as price.

Copies of "Pointers on Offering Lawn Seed for Sale" may be obtained from the New Mexico State Seed Laboratory, Box 458, State College, New Mexico.

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FUNDAMENTALS OF BENTGRASS MAINTENANCE

C. G. Wilson, Agronomist
Milwaukee Sewerage Commission

Some will wonder from the title of this talk, "What about bentgrass makes it worthy of separate discussion?" or, "Why should bentgrass differ radically from other cool-season grasses in its maintenance requirements?"

To answer the first question, bentgrass might well be considered the prima donna of turf. When it is managed properly, nothing else quite compares with it from the standpoint of beauty. Its utility value also is well-known. In a golfer's mind, no finer playing turf exists. We know of one satisfactory athletic field in Mexico City that is solid Washington bentgrass, although we would be the last to recommend it for this purpose. Even in tropical climes it is receiving increasing attention as a companion crop for Bermuda during the cool season. And last, but far from least, the layman's idea of a lawn Utopia is a broad expanse of No. 18 green from The Country Club in front of his home.

These facts are self-evident. Why else would mankind fool with a turfgrass that seems to fall prey to every ill known to the plant kingdom? Actually, the bentgrasses are more sturdy than some of us are willing to believe. We have heard it said: "They certainly are not drought tolerant. Next to Poa annua, bents are the first to turn brown when water is lacking. They certainly are not disease-resistant. Name a turf disease and you will find it has been recorded as attacking bent. They certainly are not insect-resistant. If bugs could choose, bent would receive preference 10 to 1. They certainly are not heat and wear-resistant. In hot, humid areas we are even afraid to use a greens mower on them during midday."

Ah!, but are we being fair to this "Prince or Pauper," or have our eyes deceived us? Bents may fall somewhat short on drought-tolerance, but their resistance or ability to recover after a dry spell is great. After a lapse of time let's take a second look at what we thought was brown, dead turf, and we may be pleasantly surprised at the recovery. The same holds true for

disease. Marshall Farnham, Superintendent, Philadelphia Country Club, has no objection to light disease attacks on his bent fairways. He is probably right in giving nature credit for an assist in keeping down thatch in this manner. Insects will attack any grass. The most notorious bug problem is scale on Bermuda - not bent. Not heat-resistant? Bent probably has a greater tolerance for heat than any cool-season grass. Yuma Country Club's summer temperatures of 115 degrees Fahrenheit hasn't prevented Tige Stanley from maintaining some of the best year around bent greens in the world. As to ability to withstand punishment in both hot and cool weather, who will challenge Bill Johnson's official record average of 306 players a day for 365 days at the 18-hole Rancho Golf Course in Los Angeles?

Bent is seldom condemned from the standpoint of cold tolerance. Most winter injury relates to disease, drying out, or poor drainage. All cool-season grasses are subject to these maladies and one should never condemn bent for suffering under poor drainage because close observance will indicate that bent was the only grass capable of existing under such conditions to begin with! Bent really comes into its own in cold climates if there is a desire to lengthen the playing season by getting an earlier start in the spring. Annual blue grass may be sanctioned for resort courses with their late opening date. However, city clubs with their permanent resident members are entitled to something better than "Poa." Here again, an improved bent is the answer.

If, then, you agree that bentgrasses will be with us for many years to come, the answer to the second question concerning maintenance requirements, whether they differ radically or not, is worthy of our attention. We are all aware that a poor bent strain in the hands of a good turf manager can perform beyond our highest expectations. Conversely, the best of improved bent strains is worthless if management is bad. Therefore, it behooves one to understand the idiosyncrasies of this "prima donna" of the turf world. Quite naturally, this paper cannot delve into the basic fundamental requirements of all turfgrasses. Bent is no different from the others in being capable of responding to a deep, uniform soil profile of proper texture and structure to permit rapid removal of excess moisture yet hold a sufficient quantity to promote good growth.

Bentgrass is unique, and, some will say, finicky, in its maintenance requirements. Where lawn and garden experts are correct in advocating a high height of cut for most lawn mixtures, such practices are disastrous on bent. For lawn and fairway purposes, it should never be mowed higher than 3/4 inch, and preferably the height should be below 1/2 inch. We know of bentgrass greens that are mowed daily at 3/16 inch during the growing season, and such practices have not varied over many years.

As a matter of fact, one's mowing practices directly influence success or failure with this grass. Because of its vigor, bentgrass must be mowed frequently or partially decomposed stems, stolons and clippings will build up above the soil surface. We call this build-up "thatch" or "mat" and strongly object to it because it harbors disease orgnisms; both holds and sheds moisture; and is detrimental to play of the game. On putting greens this problem is even more severe because of the intensified cultural practices. A worthwhile step towards arresting thatch development is elimination of the scalping roller by substituting side caster wheels. The roller is very effective in pressing down the grass before contact is made with the bed knife and reel, and no doubt is equally effective for selling purposes in demonstrating a new machine. Where labor cannot be trained to mow properly without a scalping roller, combs, or brushes must be used throughout much of the good growing season.

Vertical mowing machines, Delmonte rakes, combs for fairway units, and a garden rake with sharply filed teeth also have their place in keeping thatch under control. Rather than object to bent because of its thatch-producing tendency, we should be thankful that a grass with so much vigor exists, while at the same time keeping the problem under control. Remember, grass should be growing in the soil and not on top of the ground. Some will argue that a little thatch is necessary to hold the approach shot. We think this can be accomplished through proper nutrition on actively growing grass. We will agree that a sole or cushion of turf is needed, but maintain it should not be dead organic matter.

An actively growing child requires plenty of food, and unlike we older folks, utilizes it for growth rather than to add more fat. Possibly for the same reason an actively growing grass like bent has high fertility requirements. Unlike humans, grass has the ability to manufacture its own food. And, like any manufacturing plant, it must have a supply of raw materials on hand in order to accomplish this end. The building blocks for bentgrass have received a great deal of attention from turf research workers and practical superintendents in the field. As a result of all this work, we know that bent thrives best on neutral to slightly acid or slightly alkaline soil in the range of pH 6.5 to pH 7.5. Seven is the neutral point. When the scale drops below pH 6.0, it is time to add lime to correct acidity. Soil-testing service is available from most Experiment Stations, a few fertilizer companies and several laboratories.

Soil tests serve another valuable function in giving us an inventory of some of the fertilizer elements required by grass. Samples must be taken in accordance with directions, and must be properly interpreted by a person who has some knowledge of growing grass. When used in this light, soil-testing recommendations will overcome deficiencies of phosphorus, potash, calcium and magnesium. After this has been done, bentgrass feeding is primarily a matter

of supplying nitrogen at the right time and at the right amount.

Plant pathologists tell us that dollarspot is minimized when the grass is utilizing 1½ to 2 pounds of actual nitrogen per 1,000 square feet per month during good growing weather. This rate is equivalent to 25 to 35 pounds of a natural organic source of nitrogen. Timing also enters the picture. Where summer brown patch is troublesome, rates should be lowered and fertilizer applied more frequently. The difference can be made up by applying more during the spring, early summer and fall. Where snow mold is troublesome, some say the bent should become slightly hungry for nitrogen before entering the winter season. Here again compensation is made by applying more during spring, summer, and possibly early fall. It is a simple matter for anyone to determine the length of growing season by checking with their local agricultural authorities. These general principles also hold true for other bentgrass turf areas. In recent years, research workers have indicated that even where clippings are allowed to remain, growth increments continue above one pound of actual nitrogen per 1,000 square feet per month of good growing weather even on inherent fertile soils.

Water management is very critical on bentgrass. Since bent is a shallow-rooted turf species, it must be watered at a lighter rate and more frequently than Kentucky blue grass or possibly the red fescues. A good rule-of-thumb is to add water when the grass wilts. Wilting is distinguished by an off-color gunmetal blue, lack of dew in the morning, or foot-printing. The important point to remember is that bent can wilt when the soil is overly wet as well as overly dry. Under either condition, the solution to good turf is prompt syringing during the day when temperatures are high if the above condition is noticed. Neglect of this can result in brown turf, especially on greens.

We should also add that bentgrasses are often damaged by indiscriminate use of 2,4-D and related compounds, and insecticide emulsions where a petroleum derivative is used as a vehicle to keep the ingredient in suspension. Concerning insecticides, wettable powders are far safer to use. In weed control work, arsenicals still are unsurpassed when coupled with an adequate feeding program. It is recognized by all foremost turfgrass authorities that weeds are secondary rather than primary causes of poor turf. Without exception, they advocate that good management will either keep weeds at a minimum or enable a good herbicide to accomplish the desired control.

In conclusion, we must say a word about the bentgrass family. The title of this talk indicates that we are dealing with one grass. This is far from the case. Bents are as variable as your children and mine. We have coarse strains and fine strains; selections that are susceptible to snow mold, but resistant to brown patch; types that are grainy and types that are tight; and rugged

individuals that endure drought but cannot stand wet feet - or vice versa. With such a broad genetic base, a vegetative strain to meet any need is either available or waiting for someone to select it.

Therefore, when you think of turf, be sure to include the bents in your thoughts. Good management makes them tops in their field. Why settle for less?

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WATERING PRACTICES

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A practical watering program embodies three basic concepts. These concepts may be set forth as the questions:

1. How should water be applied?
2. How much water should be applied?
3. How often should water be applied?

The answers to these questions are quite simple: Water is applied in a manner slowly enough for it to be absorbed by the soil; apply as much as is needed; and, it is applied when it is needed by the turfgrass. While the basic concepts of a sound watering program may appear simple enough when answered in the above manner, in actual practice there are many and varied problems associated with the successful application of each. Some of the factors involved when watering practices are based on these concepts will be discussed.

Factors influencing the manner in which water is applied.

Water should never be applied at a rate faster than it can be absorbed by the soil. The ability of a soil to absorb moisture at a given rate depends upon a number of factors, most of which are directly or indirectly associated with certain physical soil properties. Properties that govern water infiltration (movement of water into the soil) are texture, structure and the degree of compaction. Texture (size of soil particles) and structure (arrangement of soil particles) influence not only the infiltration of water, but also govern water holding ability and drainage of soils. Sands permit more ready infiltration of moisture than do clays. Likewise, soils that exhibit good aggregation (a measure of structure) permit more ready infiltration of water than soils that display poor structural properties.

Compaction refers to a condition in which aggregation is reduced or absent; hence, the soil is dense. The degree of compaction at

or near the surface is of especial importance, insofar as infiltration of water is concerned. It has been shown experimentally that a very thin layer of compacted soil will materially reduce the rate of infiltration. It has also been established that most of the compaction on turfgrass areas occurs within the upper one-half to one inch layer. It follows, therefore, that if a soil is compacted the rate of infiltration will be reduced; hence, water will have to be applied slowly in order to avoid surface runoff and insure penetration at a rate necessary to permit wetting of the root zone.

Another very important factor that influences the ability of a soil to absorb moisture is the rate at which the water is applied. Sprinklers that do not adequately disperse moisture, as well as sprinklers that deliver a large volume of water within a concentrated area tend to cause surface runoff. Whenever the water being applied is at a rate faster than it may be absorbed by a given soil, the water is being wasted. A sound watering program then would call for sprinklers that apply moisture at a rate which permits absorption by the soil.

Once surface runoff is evident, the sprinklers should be turned off. If the soil has not been wet to the desired depth -- this may be determined by probing and examining the depth of penetration -- then the sprinklers may be turned on again at the end of thirty minutes to an hour, depending on the permeability of the soil.

Factors governing the amount of water to apply.

The amount of water to apply at any one time will depend upon the water holding capacity of the soil, the amount of moisture present when irrigation is started and the drainage. As has been mentioned earlier, water holding capacity of a soil is related to the texture and structure of the soil. Organic matter should also be mentioned as a component of soils that greatly influences water holding capacity. In most soils, however, organic matter is usually an integral part of the aggregate -- the basic structural unit.

The water holding capacity of a soil will, to a large extent, determine how much water will be needed at any one time. Loams and clay loams are generally considered to have desirable water holding capacity, whereas sands display very little water holding capacity. A sufficient amount of moisture should be applied to insure that the entire root zone will be wetted. Too, sufficient water should be applied to bring about contact with sub-soil moisture. Contact between the upper and lower levels of moisture is desirable in order to avoid a dry layer through which roots cannot penetrate. Generally speaking, one need not be too concerned about this factor, unless the soil moisture has been exhausted to a depth of several feet. Irrigation studies at Davis, California have shown that grasses exhaust moisture to a

depth of three or four feet on well drained soils. In a case such as this, it is essential that sufficient moisture be applied to wet to this depth. A soil probe may be used to determine the depth to which the moisture has penetrated. Once the soil has been wet throughout the root zone, or after contact with sub-moisture has occurred, any additional water applied will merely fill the large pores and, hence, would be considered "excess". The removal of this excess moisture is of vital importance in the care and management of turfgrass areas.

Removal of excess water from soils is referred to as drainage. In many cases, drainage may be of far greater importance than some of the other factors mentioned. On most turfgrass areas one is usually able to apply water when soil moisture is near exhaustion, but in too many cases during periods of heavy rainfall rapid removal of the excess does not take place. Unless soils are adequately drained, many problems arise because of the slow removal of excess water.

A watering program based on sound watering practices must be one that insures "getting the water into the soil", "holding some of it in the soil for use by the plants", and "getting rid of the excess through drainage". When or how often to apply water is related to some of the factors already discussed. In addition, there are other points that need to be mentioned in relation to the frequency of irrigation.

Factors determining the frequency of irrigation.

It is generally recognized that supplemental irrigation will be necessary if turfgrass areas are expected to remain green throughout the growing season. How often these areas will have to be irrigated will be governed by the type of grass, the soil and the climate. Soil properties that exert an influence on frequency of irrigation are, as already mentioned, texture, structure, compaction, water holding capacity, etc. Climatic factors -- especially rainfall, humidity, temperature and wind movement -- likewise influence the frequency of irrigation.

It is often said that many turfgrass problems may be attributed to improper watering. Perhaps one of the most important factors contributing to improper watering is frequent irrigation -- watering too often. Earlier we set forth the premise that turfgrass should be watered as often as the plants need moisture. In general, it is an excellent idea to let the condition of the grass determine when to apply moisture. On most general turfgrass areas the time to apply moisture is just as the plants begin to wilt. As a matter of fact, with one possible exception, this could become a rule of thumb for watering turfgrass. The exception is on newly seeded areas which must be kept moist during the period the seed are germinating. Syringing of golf greens during the hot summer months does not deviate from the general rule of thumb,

because even though the soil may be adequately supplied with moisture, the grass may begin to turn blue and footprint. This is an indication that wilting is beginning to occur and that syringing is necessary. Hence, the general rule that grasses should be watered when they begin to wilt applies in this case.

Correlation between the condition of the turfgrass at the various levels of soil moisture provides an excellent means of determining when to water. Periodic observation of the soil moisture characteristics following a soaking rain or a deep thorough irrigation until the soil is dry and the turfgrass begins to wilt will provide familiarity with soil moisture levels and growth characteristics. One soon becomes able to examine the soil and to determine from a practical standpoint the amount of soil moisture present. In actual practice, it is seldom possible to water all the turfgrass areas under ones control at just the time they begin to wilt; hence, some means of determining when the available moisture in the root zone is near exhaustion is practically essential if one is to set up a sound watering program. There will be areas that will have to be watered perhaps a day or two before the grass wilts. There will be others that will have to be watered after the grass has wilted.

Frequent, shallow watering tends to keep the upper layers of soil near a point of saturation most of the time. This encourages shallow rooting and promotes weak turf which is susceptible to disease and insect attacks, as well as damage from traffic. The fact that the plant roots are surrounded by water is not necessarily in itself a serious situation -- the science of hydroponics has proven that any plant can be grown in nothing but water. There is a differnce, however, between water culture and saturated turfgrass areas. This difference is primarily associated with the oxygen content around the grass roots. In water culture a constant supply of oxygen is supplied by a bubbling of air into the water solution. On turfgrass areas such a practice cannot be followed and it is necessary that a constant oxygen supply in the soil be maintained by controlling the amount of water within the soil. The practice of watering deeply only when plants show signs of wilting is for most turfgrass areas a practical approach to a sound watering program and it is a big step forward in the development of healthy, vigorous turfgrass. Far too many of our turf areas are watered too frequently and for too short a period of time.

In summary, water practices should be such that they provide for the proper distribution of water, permit good water infiltration and assure sufficient water retention to support plant growth without irrigation for a reasonable period of time. Above all, good watering practices should provide for the removal of excess water. Finally, a sound watering program should utilize only as much water as is needed by the turfgrass plants to produce healthy, vigorous, wear-resistant turf.

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DISEASES OF TURFGRASSES

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You will note the phytophathological connotation of the title assigned to me. You no doubt are expecting the usual listing of diseases, their causes, and control, and I am sure you would no doubt receive this usual treatment of turf diseases had the speaker been primarily a grass pathologist. To a pathologist, the easiest approach to such an assignment is to describe the pathogen, its symptoms and control, since in most instances the symptoms produced by the various pathogens are similar regardless of the crop or host plant. I should like to change my approach to turf diseases by making a slight change in the title as follows: "How to Keep Turf Grass Healthy." Now we bring into play a number of principals which I feel play as important a part as do the pathogens or fungi themselves.

The most important principal is management. And if you will become more familiar with some of the basic principals which bring about unhealthy turf, your approach to turf health will not be one of applying a fungicide to give temporary relief, but one of intelligent management to prevent the occurrence of conditions which favor diseases.

To begin with, lets look at the disease producing organisms or fungi and see what factors favor their growth and development. There are well over 100 different fungi responsible for diseases of turf grasses. This number is extremely high because we grow grasses under very unnatural conditions. We cut the blades, reduce the photosynthetic area, crowd the plants, overwater them, and in general weaken them to such a degree that the weakest parasites will cause damage. Actually, in nature, our turf grasses are very resistant to the most common diseases which attack them when they are planted in turf. Fortunately, natural selection over the years has helped to develop strains of grasses which are adapted to turf planting.

Now I would like to discuss a few environmental factors which favor the development of turf diseases. Briefly, these are: temperature, humidy, wind movement, ground moisture, and vigor of the host. When any two or more factors are favorable for the development of the disease producing organism, we are in trouble. By increasing or decreasing one key factor, the host will usually be favored and the disease will disappear. This sounds hypothetical, but many turf managers can list numerous instances where diseases have been checked by simply eliminating the ecological factor or factors which favor the disease producing organism. Simply, fungi are plants and have certain requirements for normal growth. They live on green plants because they cannot make their

own food. This condition is called parasitism and when the parasite is favored over the host plant, injury results. When the host is vigorous, the disease organisms remain alive in the soil until conditions again favor their development on the turf.

Now lets take a look at our host plant. What can we do to minimize the activity of the disease organisms, yet favor the host plant and produce a healthy turf? Again, let us emphasize healthy turf rather than a discussion solely of plant diseases.

Turf management entails many meticulous operations which vary in as many ways as we have turf managers. However, underlying the entire art, certain principals have evolved which are basic. Those which especially apply to keeping turf grass healthy will now be enumerated and discussed.

1. Overwatering Not only favors fungus development but reduces host vigor by excluding oxygen from the plant roots. Films of water on grass blades are conducive to rapid growth and development of most disease producing fungi.

2. Correct Drainage Excess water again excludes oxygen and does not allow for normal root development, thereby reducing host vigor. Here again, most fungi are favored by high soil moisture.

3. Aerification This can be done mechanically. There are a number of machines on the market that are designed to do very fine jobs of aerification. Such an operation will tend to dry out fungus spores and resting bodies and at the same time favor turf vigor by increasing the amount of oxygen for root development. Unnecessary shrubs may also be removed to allow wind movement, thereby reducing humidity and shade which favor disease fungi.

4. Fertilization Each turf grass has a slightly different fertilizer requirement for vigor. This level should be found and the various fertilizers applied in correct amounts. Timing should also be considered. Keep turf vigorous, but not overstimulated. This overstimulation will produce succulent growth which is extremely favorable for fungus growth. As for timing, an example may be quoted to stress this point. It has been found that two pounds of available nitrogen to 1000 square feet applied at seeding time will control dollar spot of bent grasses in Rhode Island.

5. Height of Cut All grasses should not be cut to the same height, as each strain has its own inherent qualities which adapt it to various cutting heights. Very close clipping usually weakens most turf and subsequently decreases vigor which allows fungi to attack the plants and produce disease. A noteworthy exception would be the bent grasses which make better healthier turf when cut close.

6. Rate of Seeding In most instances, heavy seeding increases susceptability to turf diseases. Rate of seeding varies with the species and part of the country where the turf is being established. Ascertain the recommendations of the State Experiment Station or local nurserymen and follow them very closely.

7. Weed Control Chemicals Amount, kind, and timing of applications are very important. Improper timing or the use of the wrong formulation will tend to weaken turf and allow disease organisms to take over. On the other hand, correct usage of weedicides will insure turf vigor by removing competing weeds and annual grasses.

8. Grasses Resistant to Diseases Herein lies one of the most important aspects of healthy turf. The proper selection of grass species as well as those strains which are resistant to common diseases is very important in establishing and managing turf. This means of keeping turf healthy cannot be overstressed. Breeding for resistance is still in its infancy; many new developments will be forthcoming in the next decade. I should like to call your attention to some excellent examples of accomplishments in this field. We have bent grasses which are resistant to the brown patch disease, some of the varieties are Washington and Arlington. Conversely, Colonial and Metropolitan are very susceptable. These latter varieties should not be used in sites where brown patch may be, or is known to be, a serious problem. Arlington, Congressional, Highland, and the Seaside bents are tolerant to dollar spot, while Washington and Toronto are very susceptable. Our creeping bents, C-115, C-1, and C-19 are also tolerant to most serious turf diseases. Merion blue grass is an excellent example of a grass that has been developed in the last few years for its resistance to Helminthosporium leaf spot. This disease was considered a serious threat to blue grass turf over the United States before Merion was developed. We also have bermuda grasses such as Tifton 57 and U-3 which are resistant to leaf spots. Meyers Zoysia (Z-52) should also be mentioned. This grass is very resistant to most common turf diseases and seems to be widely adapted and possesses a great deal of drought resistance. The grass breeders have come a long way and I am sure we can anticipate many new disease resistant turf grasses in the near future.

Now, I would like to focus our attention for a few moments on a number of the common turf diseases which usually develop under improper maintance practices:

Brown Patch, a fungus disease, is favored by excessive humidity and high temperatures. The fungus grows on the leaves causing them to die. As a result large unsightly brown areas 8 to 12 inches in diameter develop in the green turf. Should proper management fail to check the disease; such as, overwatering, improper drainage, and wind movement, chemicals can be utilized. Any of the mercury compounds such as CALOCLOR, PURATIZED, or

TERSAN are equally effective! Amounts required for control vary according to the form of mercury utilized in the fungicide. These fungicides are usually mixed in 5 to 10 gallons of water which is applied to 1000 square feet of turf.

Dollar Spot, a fungus disease, is favored by low temperatures and high humidity which occur in late spring or early summer, therefore, we would expect this disease to be less prevalent in mid and late summer when brown patch usually occurs. The spots produced by the fungus are much smaller, actually about the size of a silver dollar, than those produced by brown patch. Old stand-bys for control are the mercury compounds used for brown patch. A most recent development has been the cadmium compounds which have a very good residual effect, such as Puraturf 177, Crag 531, and Cadminate. These compounds need only be applied every 3 to 4 weeks if repeated applications are necessary.

Helminthosporium Leaf Spot, a fungus disease, causes a leaf spotting that discolors grass leaves and eventually kills out the crowns if it is not checked. The leaf spot is common wherever blue grass is grown. It can be checked by preventive methods in addition to the use of a disease resistant strain of blue grass (Merion) mentioned previously. Fertilization, to stimulate leaf growth, and the raising of the cutter blades will, in most instances, check the disease. Planting of Merion blue grass in newly established turfs is also recommended as a preventative measure in controlling the disease.

Snow Mold, a fungus disease, may occur in mountainous areas of the Southwest where snowfall is heavy and remains on the turf for long periods. Diseased areas may be 1 to 12 inches across and appear just as the snow melts. From a management standpoint, low areas and north exposures are especially vulnerable to snow mold. Special care, fertilization, etc., may be given such sites to avoid the disease. Grasses that are resistant to cold injury should also be considered for planting on sites where snow will collect or remain frozen late in the spring. Fungicides used for brown patch control have proven very effective in controlling this disease. The fungicides should be applied before the first snow and again at the first thaw.

Fairy Ring The fungi which cause fairy ring are cosmopolitan. They very seldom cause extensive damage to the turf; however, the fruiting bodies which they produce are a very unsightly nuisance. Eradication of the underground mycelium is almost impossible, but certain of the cadmium fungicides are reported to inhibit production of fruiting bodies or mushrooms. The fungicides, Puraturf 177 and Crag 531 should be applied to the ring where the grass appears excessively green. The fruiting bodies or mushrooms will be produced in this area.

There are other diseases which might be discussed at this time. However, the underlying principals of management and control would

still apply. I am convinced that turf grasses can be kept healthy by the intelligent application of management principals which have been discussed, keeping in mind the factors which regulate the relationship between healthy turf and disease producing organisms.

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PECULIARITIES OF NEW MEXICO SOILS

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The most influencial factor on soil development is climate. The amount of rainfall is particularly important. The soils of New Mexico and other Southwestern states differ considerably from those that have developed under other climatic conditions, but local climatic differences, as between mountains and adjacent lowlands, cause some quite wide differences between soils within this region. The soils that develop in hot, arid climate are usually alkaline and low in organic matter, are frequently shallow, and contain appreciable, and occasionally harmful, quantities of soluble salts.

Alkaline soils With the exception of a few areas in the mountains, most New Mexico soils are alkaline. The alkalinity is due to the low rainfall, which is insufficient to leach out the basic elements. Unless it becomes too extreme, soil alkalinity is more of an advantage than a disadvantage. The abundance of basic elements and other essential nutrients in alkaline soils gives them a higher level of natural fertility than most acid soils, and most plants grown just as well under slightly alkaline conditions as they do under acid conditions.

About the only serious plant nutritional problem associated with alkaline soils is iron deficiency or "lime-induced" chlorosis. Iron is one of the most abundant constituents in most soils, but under alkaline conditions the availability of the iron to plants is greatly reduced. Plants differ greatly in their susceptibility to this deficiency, some being seriously affected on the same soil where others grow normally.

The correction of an iron deficiency is frequently quite difficult. Ferrous sulfate (copperas) may be applied to the soil, but it usually corrects the deficiency for only a short time, if at all, because the soil rapidly converts the iron to unavailable forms. The application of acidifying materials, such as sulfur or organic matter, with the ferrous sulfate usually improves its effect. The spraying of solutions of iron compounds onto the plant foliage often gives better results than soil application, but this treatment must be repeated quite frequently to correct the deficiency

in new foliage as it develops. A new group of chemicals called chelates offer considerable promise for treating iron chlorosis. Some of them are specially formulated for alkaline soils, and they appear to be able to hold the iron in the soil in an available form much longer than the regular iron salts. Many of the more promising of these chelates are not yet available commercially.

The practice of acidifying alkaline soils is probably not justified except for the correction of either an extremely alkaline condition (alkali soil) or iron deficiency. For the latter is usually only practical on a small area under intensive culture, such as on golf greens or small lawns. Unless soils are quite sandy, they are usually very heavily buffered against a change in reaction, making acidification quite difficult. Also, most of the irrigation water in New Mexico contains quite high concentrations of the basic elements and causes a rapid restoration of the normal alkaline condition. Sulfur and acid organic matter are the most widely used materials for acidifying soil.

Soil orgnic matter The amount of organic matter that a soil contains depends on the rate at which a new supply is added to the soil and the rate at which it is lost from the soil by oxidation. The natural vegetation in arid regions is sparse, so little organic matter is added to the soil, and in a hot climate the organic matter that is in the soil oxidizes very rapidly. Therefore, the soils in the Southwest are quite low in organic matter. This tends to create certain problems, because the biological, chemical, and physical properties of a soil are greatly influenced by its organic matter content.

The nitrogen in the soil is mostly in organic form, and the amount present is proportional to the amount of organic matter. Therefore, nitrogen deficiency is quite general throughout the Southwest. Grasses are all heavy feeders on nitrogen, and bermuda grass, one of the more common turf grasses in this area, has an especially high nitrogen requirements. Nitrogen and phosphorus are the only elements, other than iron, that are likely to be deficient in New Mexico soils. Phosphorus can usually be built up to an adequate level quite readily by applying fertilizer, and the level may remain adequate for some time without further additions if the clippings are left on the soil. Nitrogen is much more easily lost from the soil than phosphorus, so the supply must frequently be replenished. Throughout the Southwest, the maintenance of an adequate supply of nitrogen is the main fertilization requirement for turf.

Organic matter is essential for good soil granulation, so physical problems are common in the finer textured soils of New Mexico. This is particularly true of those soils that are high in silt. With the usual low organic matter content of the soils in this area, a soil containing over 40 percent silt is usually very tight and impermeable. The difficulty of leaching such soils often leads to salinity and alkali problems.

One of the best ways to increase the soil organic matter is to grow grasses or legumes, so the growing of turf will do about as much for the soil in this respect as anything that can be done, particularly if the clippings are left on the ground. The application of organic materials to an established turf will probably give little additional benefit, other than that derived from the plant nutrients they contain. Golf greens are probably a notable exception to this, because the very liberal use of organic matter is usually essential to prevent compaction of such areas.

Shallow soils Golf courses and other public areas are often located on soil that would be classed as marginal from an agricultural standpoint. Some such marginal land in the Southwest may consist of just a few inches of topsoil overlaying caliche or rock. Under such conditions the root zones of plants are very restricted, and drouth and fertility problems are intensified because of the limited volume of soil in which water and plant nutrients can be stored.

Sandy soils present many of the same problems as shallow soils. They do not restrict the root zone to a small volume of soil, but they have such a low capacity to hold water and certain plant nutrients that the available supply is rapidly used up.

Saline and alkali soils Saline and alkali soils are natural companions of irrigated agriculture in arid regions. Various salts are formed in the breakdown of minerals to form soil. In humid regions these salts are leached out of the soil and carried down the streams and into the oceans. In arid regions the rainfall is not sufficient to accomplish much leaching, so the salts remain in the soil in appreciable amounts. Irrigation water adds more salt to the soil, and if the irrigation water is very salty or if the soil is very poorly drained, so that little of the salt leaches through the soil, the concentration may soon build up to a level where it is injurious to plants. Such a soil is called a saline soil.

Saline soils are injurious to plants primarily because the high osmotic pressure of the soil solution prevents the absorption of water by the plant roots. The plants may wilt and die for lack of water on such soil, even though it is very wet. Plants differ greatly in their tolerance of salinity. Bermuda grass has the greatest tolerance of any of the popular turf grasses. About the only effective treatment for a saline soil is to leach the salt out by using very heavy irrigations. Good drainage is essential for the success of this treatment.

Alkali soils are another common problem in arid irrigated areas. An alkali soil is one that has high concentrations of sodium adsorbed on the clay minerals. Such a condition is caused by abnormally high proportions of sodium salts in the soil. The granulation of such soil breaks down, making it very tight and

$CaSO_4$

impermeable. The resultant poor water penetration, poor aeration, and possible sodium toxicity seriously interfer with plant growth. Alkali soil may be treated with gypsum, to replace the sodium with calcium, and then leached to remove the sodium from the soil. Sulfur or other acid-forming materials may be used in place of gypsum if the soil contains free lime.

In some cases, both salinity and alkali conditions may exist in the same soil. The use of gypsum followed by thorough leaching may reclaim such soils. If the soil is very impermeable, has a high water table, or for any other reason cannot be thoroughly leached, the elimination of salinity or alkali may be impossible.

Irrigation water quality In a consideration of irrigated soils the quality of the irrigation water is of supreme importance. Salinity and alkali depend to a great extent on the type of irrigation water that is used. A water that contains high concentrations of salt may cause the development of a saline soil, and a water in which a large percentage of the salts are sodium salts may cause an alkali soil. All irrigation water contains salts, but the amount and kinds of salts vary greatly.

Well waters from a particular area are often similar in quality, but frequently very wide differences occur within quite small areas. The only way to be certain of water quality is to have it analyzed. Even then, the water from a single well may change considerable from one time to another.

Water of quite poor quality may sometimes be used successfully if proper precautions are taken. If the salt content of the water is high, the salt may be prevented from accumulating in the root zone by using large amounts of water, so that some leaching occurs periodically and keeps the salt moving out of the soil. The more salt the water contains the more leaching will be required; and, obviously, very salty water should not be used on soil that is not very permeable and well-drained. A high percentage of sodium salts in water may be counteracted by adding gypsum to the water or the soil, provided the total salt content is not too high.

Irrigation and fertility Proper irrigation greatly simplifies the maintenance of soil fertility. If the irrigations are too light, so that only a thin layer of the soil surface is kept wet, the plant roots will be largely confined to this layer, and the volume of soil from which the plant must obtain its nutrients will be greatly reduced from what it would be if the soil were wet to a greater depth.

In addition to wasting water, over irrigation may leach many valuable plant nutrients from the soil. Nitrates are extremely soluble and will be lost from the soil if any leaching occurs. Also, iron deficiency is usually more severe where the soil has been heavily irrigated. Such a small fraction of the iron in alkaline soils is

available, that apparently not much leaching is required to reduce it to a deficient level. Therefore, the amount of leaching should be restricted to that which is necessary to prevent harmful concentrations of soluble salts from accumulating in the root zone.

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CHANGING YOUR SOIL

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Desirable turfgrass growth in a given location is a function of the climatic conditions, soil properties and management practices prevailing.

Climate exerts its influence through temperature, rainfall, wind movement and sunlight. Climate is of particular importance in determining the choice of the species or strain of turfgrass for a given purpose. In other words, the choice of an individual species or strain of a warm or cool season turfgrass for a particular use is predicated on its adaptation to climatic conditions.

Soil properties influence the kind and quality of turfgrass in a number of ways. There are certain basic requirements which soil must provide for satisfactory turfgrass growth. These are: support, water, air (oxygen), temperature and nutrients. The ability of a soil to meet these requirements is dependent upon its physical, chemical and biological properties.

Management embodies the choice of grass, watering, fertilizing, aerating and mowing practices, choice and application of various chemicals and all other areas of turfgrass care and management requiring decisions by the supervisor. The most important part of management is actually the first three letters of the word, M - A - N. The good manager may be able to produce satisfactory turfgrass in spite of unfavorable conditions, but the poor manager will have difficulty producing satisfactory turfgrass under the most favorable conditions.

The discussion today is to deal with only one of the many problems confronting the supervisor charged with developing and maintaining satisfactory turfgrass. Man has little control over climatic conditions and actually rather limited choice in the type of turfgrass he may select for a given set of use conditions in a particular locality. It is through modification of the soil that the greatest opportunity for adjustment to climatic and use conditions exists.

The title of our discussion, "Changing your Soil", implies the prevention or correction by modification or adjustment of any soil physical, chemical or biological factor or factors that may be limiting satisfactory turfgrass growth.

The stage for this discussion may well be set by asking a series of questions. Is soil modification necessary? Is it practical and economical? If the answers to these questions are "yes", then, which soil properties lend themselves to adjustment and modification? If modification is undertaken, how must it be approached? Is there danger in soil modification? In order to answer these questions, it may be well to define some of the fundamental relationships between various soil properties and turfgrass growth. Accordingly, let us briefly review some of the basic concepts associated with soil properties and plant growth.

Classification of Soil Properties

Soil properties are classified as physical, chemical and biological. Each of these groups exert certain direct and indirect effects upon the soil mass and the plants growing therein. There is also a marked inter-relationship between the three groups of properties. The physical phenomenon have important effects on the chemical and biological properties and processes which, in turn, influences plant growth. Biological properties play a vital role in promoting favorable environment through their effect on the physical and chemical factors. So likewise are the chemical properties influenced by the physical and biological properties. It is apparent, then, that modification of any physical, chemical or biological soil property will affect directly or indirectly all other soil properties which, in turn, influences turfgrass growth.

Chemical Properties of Soil

Chemical properties of soils include the reaction (pH) and the fertility relationships. Modification by the application of lime, gypsum, sulphur and the addition of nutrients (in the form of fertilizer) is a common practice. In most cases these practices are necessary, practical and economical. In some cases they may be dangerous. The danger lies in applying either insufficient or excessive amounts of any particular material. Modification of chemical properties may also be dangerous if the improper material is selected, or if it is applied incorrectly or at the wrong time. For example, the addition of lime to a soil with a high pH may result in a further tie-up of certain nutrients -- iron; excessive applications of phosphorus to a soil already high in this element could upset the nutrient balance between nitrogen, phosphorus and potash and stimulate the growth of certain weeds at the expense of the turfgrass. Inadequate or excessive applications of nitrogent may not only upset the nutrient balance, but also intensify a number of problems such as disease incidence, insect infestation, winter kill, etc.

The answers to our original questions, when applied to chemical soil properties, are simply "yes, modification is feasible, practical and in fact necessary more often than not. It is dangerous only when performed improperly -- too little or too much of the right or wrong material at the wrong time.

Biological Properties of Soils

Biological soil properties include the micro and macro-plant and animal populations of the soil. The populations of these plants and animals may be beneficial or harmful. They are so markedly influenced by physical and chemical soil properties (and vice-versa) that no effort will be made to discuss modification of this particular group of soil properties. It should perhaps be noted, however, that the harmful populations, such as certain disease organisms, weeds and insects must be checked by the application of the appropriate fungicide, herbicide or insecticide. Fortunately, most of the micro and macro-populations of soil organisms are beneficial.

Physical Properties of Soils

The physical properties of the soil (texture, structure, porosity, etc.) govern the infiltration, retention and movement of moisture in the soil medium, controls the air-water relationships and, along with the chemical and physical properties, determines the type of turfgrass that grows best under a given set of climatic conditions. This group of factors deserves, perhaps, the most serious attention in a consideration of soil modification. Each of the physical soil properties exert a direct affect on plant growth and each is dependent, one on the other, for the ultimate effects they produce on other soil properties and on turfgrass growth. This close degree of inter-relationship makes discussion without repetition practically impossible. A very brief discussion of some of the more important physical properties follows:

Organic Matter Although comprising only a small percentage of the total soil volume, organic matter is perhaps the most important component of soils. It plays a vital and significant role in all physical, chemical and biological soil properties and functions. The original source of organic matter is plant and animal tissue, the latter contribution being far less than the former. The presence of colloidal organic matter in soils is a sign that biochemical activities are supplementing and augmenting those of a purely chemical and physical nature. Organic matter in soil serves as a constant source of plant food, especially nitrogen and sulphur; it serves as food (energy) for micro-organisms; it improves the structural relationships, thereby promoting desirable water holding capacity and aeration.

Soil Texture Soil texture is a term used in reference to the size of the individual soil particles. It refers particularly to the

proportions of sand, silt and clay in a given soil. "Soil class" terms like silt loam, clay loam, fine sandy loam, etc. indicate the predominance of the three soil separates. Texture is a most important characteristic of soils because it describes, in part, the physical qualities of soils with respect to porosity, coarseness or fineness of the soil, soil aeration, speed of water movement in the soil, moisture storage capacity and in a general way, the inherent fertility of the soil. Sandy soils are often loose, porous, droughty and low in fertility, whereas clay soils may be hard when dry or plastic when wet, poorly aerated, but possibly high in fertility. Between these two extremes we find the silt loam, loams and fine sandy loams, the ideal soil classes that are generally most desirable for plant growth.

Soil Structure The term, "soil structure", refers to the arrangement or grouping of the individaul particles into units. A structural unit may be defined as a group or groups of particles bound together in such a manner that they exhibit different physical properties from a corresponding mass of the individual particles. Such a structural unit is called an aggregate. Terms used to describe various types of structure are granular, crumb, platy, etc. In general, the granular and crumb structure is most desirable from the standpoint of plant growth. Platy structure is generally associated with slowly permeable soils derived from shales. Soils in which structure has been destroyed -- partially or completely -- is said to be dense and compacted.

The structural aggregation of soil is greatly influenced by the amount of organic matter present. The end product of decay of organic matter -- humus -- is an integral part of soil aggregates. Sometimes it is referred to as the cementing or binding agent in aggregates. Stability of aggregates is directly dependent upon the amount of organic matter present. The recent development of synthetic soil conditioners offers, possibly, another approach to aggregate stability. It is known that these materials, properly applied, create water stable aggregates; however, the stability of these aggregates under player and equipment traffic is not known and needs further investigation.

The structural aggregation of soil determines, to a large extent, the porosity, permeability and water holding capacity of soils.

Porosity Soil porosity may be defined as the percentage of the soil volume not occupied by solid particles. In a soil containing no moisture, the pore space will be filled with air. In a moist soil, the pores are filled with both water and air, while in a saturated soil the pores are completely filled with water. The relative amounts of water and air present will depend largely upon the size of the pores.

Two types of porosity are recognized -- textural porosity and structural porosity. Textural porosity is that associated with

texture. It is the type found in water deposited sands where the individual particles are so large that no matter what is done (within limits) there still remains a certain amount of large pores. This is not necessarily true with wind blown sands which will pack or compact very tightly because of their angularity. Structural porosity is the porosity associated with the clay fraction of the soil. It is the porosity found within the aggregate.

Pores in the soil may be either capillary (small-structural porosity) or non-capillary (large-textural porosity). The large pores are responsible for drainage, whereas the small pores are responsible for moisture storage. The total amount of pore space in a soil is set by the texture. If a soil contains a certain proportion of sand, slit and clay, this sets the total amount of porosity in the soil. To a large extent, nothing in the way of management has very much effect on the total pore space, but management may have a profound affect on the proportions of small and large pores.

Actually the total porosity of a soil is not as important as the relative distribution of the pore sizes. Total porosity is inversely related to the size of the particles and increases with their irregularity of form. Porosity also varies directly with the amount of organic matter present in the soil under field conditions. The total pore space is seldom less than 30 percent (coarse, clean sand has about this amount of pore space). In silt loams the total pore space is about 50 percent. The ideal soil for plant growth would have about 50 percent total porosity equally divided between small and large pores, or in other words, contain 50 percent solids, 25 percent water space and 25 percent air space. If a soil with this type of pore space could be prepared and if one could be assured that the structural conditions could be maintained, many of our current problems on turfgrass areas would be solved. Mixing, or developing through modification, a soil with desirable physical properties is not in itself too difficult a task. The maintenance of these desirable properties is a big problem.

Modification of Physical Properties

As stated earlier, physical soil properties (texture, structure, porosity, etc.) govern the infiltration, retention and movement of moisture in the soil, controls the air-water relationships and, because of their inter-relationship with the chemical and biological properties, exert a major influence on the productivity of soils. It is apparent, then, that physical soil properties are modified primarily to: (1) Improve water infiltration (getting water into the soil), (2) Improve water retention (water holding capacity -- hold some water in the soil for use by plants), (3) Facilitate percolation (movement of water through the soil column), and (4) Facilitate drainage (getting rid of the excess). When these functions proceed in a desirable manner, the air-water relationships (a fifth reason for modification) are properly balanced.

Modification to Improve Water Infiltration Modification to improve water infiltration becomes necessary when the soil does not take in sufficient water to meet the requirements of the turfgrass growing therein. If surface compaction is preventing water infiltration, the situation may be corrected by cultivation with existing aerating equipment. This is in general the most practical and economical solution. On newly seeded areas that have crusted, the use of a spike disc will often correct the situation. If infiltration is reduced because of an inherent textural or structural problem, modification - as discussed later - may be the answer on small intensively used areas; on large areas improvement through fertilization may be the only practical approach.

Modification to Improve Porosity The improvement of porosity (pore space) will result in improvement of water retention, percolation and air-water relationships. The addition of sharp sand, organic matter and sometimes clay or clay loam, as well as other conditioning materials, is sometimes necessary. The addition of these materials is usually economical and practical on intensive areas such as golf greens. On large scale areas, however, modification by these methods is not practical and, again, one must work with the existing soil and improve it through, primarily, fertilization and sometimes cultivation (aeration). Through these latter methods, better turfgrass cover may be developed and, hence, improvement of physical properties will result because of the beneficial effects of the grass roots themselves. In general, grass roots are the most effective way to improve soil structural conditions. Sometimes grass roots do not produce improved structure, but this is a result of extenuating circumstances such as compaction, excessive use of chemicals, etc.

Modification to Improve Drainage Two types of drainage are recognized -- surface and sub-surface. Drainage problems arise when water accumulates faster than the soil can remove it. Obviously surface drainage is of prime importance when abnormally heavy rainfall occurs. Sub-surface drainage problems are intensified by inadequate surface drainage. Sub-surface drainage becomes a problem when adequate large pores are not present, or if layers of impervious material are present in the soil profile. Modification by grading to improve surface drainage and by altering pore space, the use of tile, french drains, etc. for improving sub-surface drainage is often necessary. The topography, soil and usage will be the determining factors insofar as prevention and correction of drainage problems is concerned.

Dangers of Modification to Improve Physical Soil Properties Textural porosity may be modified by the addition of coarse sand, structural porosity, indirectly by the addition of clay and organic matter. We have pointed out earlier that a small pore holds water more tightly than a large pore. Water moves through soil because (1) pull or force exerted by gravity, (2) attraction of water molecules for each other which creates a tension or pull on the

water -- film adjustment. For these reasons, water moves from a fine soil (small pores) to a coarse soil (large pores) only with difficulty. This may be demonstrated with columns of loam soil with and without a coarse sand layer. Equal amounts of water may be added to each column at exactly the same time. The column containing the sand will be wet to the sand layer, but no farther, while the unlayered column will be wet throughout. The water cannot move into the sand because the small pores of the loam have a much greater attraction for the water than the large pores of the soil. If water were added to the column containing the sand layer until the loam became saturated, the excess will practically drip into the sand and then move very readily; however, the soil above the sand would remain very wet until evaporation or transpiration (loss of water from plants) removed the water. It could never be dried by drainage.

If the soil in these columns were wetted from the bottom instead of the top, the loam column would be wetted, while the layered column would not. The large pores in the sand do not have sufficient attraction for water to hold it at a height to permit the loam layer to be wet.

The above describes why a golf green or any other turfgrass area should not be layered. It doesn't have to be a sand layer to be undesirable. A clay, gravel or organic layer would be as bad or worse. The greater the difference in particle size (pore size), the more aggravated the situation would be.

Layering, therefore, constitutes one of the major dangers of modification. Uniform mixing of any material used to modify soil is essential. Even organic matter must be integrated and thoroughly mixed with the existing soil if it is to perform its function of stabilizing aggregation.

If improvement by the incorporation of coarse sand is attempted, it must be remembered that large quantities will be necessary to effectively alter the texture of the soil. The exact amount to use will depend on the existing soil. As a general statement, unless one is prepared to add large amounts of sand (hence, invite the difficulties associated with this textural class -- necessity for frequent, light applications of fertilizer and frequent watering), it would be best not to add any sand.

Summary

In summary, soil modification is often necessary, practical and economical. Modification of chemical properties is generally desirable on all types of turfgrass areas. This is accomplished by adding nutrients (fertilizer and, where needed, amendments such as lime, gypsum, etc. Modification of physical properties is practical and necessary on intensively used areas such as golf greens, some lawns and some tees. Direct modification of

physical properties is not practical and economical on large scale areas and one must work with the existing soil. These areas may be modified indirectly through the use of cultivating (aerating) equipment and fertilizer.

The dangers of modification may be found in improper techniques -- too little or too much of the right or wrong material at the wrong time or in the wrong way -- the MAN part of management.

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WEED CONTROL IN TURF

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Any areas where turf grass is to be maintained permanently is continually faced with the problem of controlling weeds. This will include such areas as the home lawn, golf courses, parks, cemetarys, playgrounds, highway rights of way, airfields and schoolgrounds.

Of the relatively few plants which are considered weeds, of the total number of plants covering the earth, the few that are problems in turf rate high on the list from the standpoint of our ability to not control them satisfactorily. Even in the best managed turf there will be a few weed offenders continually invading the turf. Continual vigilance through mechanical, chemical and cultural means is necessary to prevent weed plants from contaminating the lawn by seeding. The importance of a single weed plant from the standpoint of infesting adjacent areas is realized when we know the potential number of seeds crabgrass will produce. A single mature crabgrass plant is capable of producing 100,000 seeds. Many of the other common turf weeds also are capable of producing large numbers of seed.

In the past 10 years we have made a great deal of progress in eliminating a large part of the broadleaf group through the development of 2,4-D and related compounds. Although considerable progress has been accomplished, we still have a long way to go on such difficult to control weeds as crabgrass, foxtail grass and others.

The prevention or control of weeds in turf is most effectively accomplished through cultural practices. Cultural practices as you will recognize them include most of the various good management practices in maintaining good turf. They are: (1) Selecting adapted grasses for the area, (2) Fertilization, (3) Watering, (4) Mowing, and (5) Proper seed-bed preparation. Good turf management which includes these enumerated practices plus disease and

insect control should be considered our most effective means of preventing weed problems. The use of chemical weed killers then may be included in the management program as an added tool.

In the management program proper seed-bed preparation for permanent grasses should begin some time before planting. This will provide an opportunity to eliminate many weeds. The importance of this operation, which eliminates weeds prior to seeding, has been realized by many of you in turf work. Nothing seems more impossible than to try and clean up a new grass seeding that is heavily infested with weeds.

For specialized turf areas, such as golf course greens, preplanting treatments to obtain weedfree seedbeds is a necessity. The recent addition of a number of temporary soil fumigants to our various weed killers has resulted in substantial reduction in costly hours of hand weeding.

Methyl bromide is outstanding as a temporary soil sterilant, it is effective against most weeds and weed seed. In addition, these specialized areas may be ready to seed 48 hours after application of the material. The use of this material involves a number of operations. For best results, the area to be treated should be tilled to a depth of over 10 inches. Moisture content should be at a point where the soil is quite friable. The area to be treated is covered with a gas proof tarp such as polyethylene plastic or nylon plastic material. An applicator which attaches to the one pound can carries the methyl bromide through a plastic tube beneath the gas proof cover. Wire hoops or small bags filled with straw should be placed under the tarp to allow circulation of the gas. A splash pan is attached to the end of the injector tube to hold the liquid until it has time to volatilize. The temperature on and beneath the soil surface should be above 60° F to give the best results in good volatilization and penetration of the heavy gas.

For eradication of perennial weeds and weed seed, a rate of 1 pound per 100 sq. ft. is adequate on lighter soils, on heavier soils, however, like those in the Rio Grande Valley, we have found that 2 pounds per 100 sq. ft. is necessary for controlling nutgrass.

Methyl bromide is a colorless, odorless, toxic gas and should be handled accordingly. The Dow Chemical Company markets this material with a warning agent which is chloropicirn. Where a number of areas are to be treated, Methyl bromide is available in 50 or 100# cyclinders.

Several other materials which may be useful in preplanting treatments are: (1) allyl alcohol marketed under the trade name Shell AA Weed Seed Killer by the Shell Chemical Company. This material is water soluble and can be applied using a sprinkler can. The

area to be treated is throughly sprinkled with the allyl alcohol and water, then is followed by watering to seal the surface and to move the material into the immediate surface of the soil. Our results here show this material to be effective in inactivating seeds of foxtail grass, barnyard grass, jungle rice grass, sprangle top grass and pigweed. The use of allyl alcohol, as well as methyl bromide, will be limited generally to the user who has experience in handling toxic material; (2) calcium cyanamide, a granular material containing some nitrogen, is also effective for preplanting treatments on specialized turf areas. It should be applied at a rate of 75# per 1000 sq. ft. and incorporated into the soil at a depth of 2 to 3 inches. Generally, the seedbed will be ready for planting 5 to 6 weeks following treatment.

The use of adapted grasses for your area will certainly reduce the management problems. Some grasses are so poorly adapted to the area where they are grown that even under ideal management, they will not resist weed infestation. Although climatic conditions in New Mexico are such that we do not have a wide choice of grasses, there definitely are some available which are better adapted than others. Cool season grasses are better adapted to the higher elevations and northern New Mexico and are frequently planted in southern New Mexico, generally in home lawns. When these are planted in the fall, they will become established very well; but as the summer temperature of the following season rises, these will go into a semi-dormant condition, the turf will open up a good deal - making conditions ideal for weed invasion. Even under summer temperatures of northern New Mexico, or of the northern part of the United States, these cool season grasses slow up growth considerably during the hot summer months.

The right clipping height may do more to control weeds than any other single factor. Particularly in northern New Mexico or at the higher elevations the cool season grasses, such as bluegrass and fescue, can be weakened a great deal by early close mowing in the spring. At this time, the grasses tend to renew their root systems. It is desirable then to allow roughly 3 inches of growth or more before the first clipping. Bermuda grass will tolerate closer clipping, so this will not be such an important factor in southern New Mexico. Under certain conditions where nutgrass infestations are present, higher clipping heights will tend to reduce densities of this weed. Mowing frequency also will influence vigor of turf grasses and their ability to resist weed invasion. In summary then, proper mowing will prevent seed production for most weeds and secondly will increase the turf grasses ability to compete with weeds.

Time of application and the kind of fertilizer used will influence weed problems in turf. Weeds will move in rapidly when turf becomes thin or open because of lack of available nutrients. Weeds which have peak periods of germination and growth can be stimulated by certain fertilizer practices. For summer annual weedy grasses,

application of readily available nitrogen at their peak periods of germination cause them to initiate rapid vigorous growth. Winter annual weeds may compete seriously with turf grass; therefore, application of fertilizers in the spring may be more effective if delayed until turf grasses begin active growth. The use of fertilizers that are more slowly available and applied at different times of the season should be considered.

Water management influences weed problems in turf. Here in the Southwest, water often is a limiting factor in managing permanent turf due to its shortage. Therefore, the proper use of the limited water supply becomes very important. Frequent light surface applications which keep the surface moist, but does not penetrate, discourages rooting depth of turf grasses and encourages germination of shallow weed seed. Generally weed seed in mature turf, if present, will be on or near the surface, thus timely applications of moisture which allow the surface to dry down an inch or so will kill germinating seeds and reduce vigor of very young weed seedlings to some extent. Over irrigation not only wastes valuable water but will lead to soil compaction in certain areas and further will reduce vigor of turf grass by preventing good soil aeration. Losses of soluble plant nutrients in the soil from over watering may occur. Clover and the knot weeds can tolerate conditions arising from over watering and will invade as the turf becomes thin. Proper watering at the time when weed seed germination and emergence is occuring will be effective in discourging weed invasion.

In turf, the elimination of the weeds through the use of herbicides, without removing the cause will give only temporary control. Repeated treatments will be necessary if a certain management practice is not corrected.

Generally, herbicides available for use in turf are specific for certain groups of weeds and unless properly used, will not affect control of the specific group of weeds. A number of factors will contribute to the success of chemical weed control, and these can be listed as follows: (1) Selecting the right chemical for the problem weed, (2) Applying the chemical at the proper time, (3) Careful application to insure complete coverage of the weeds or weed seed, (4) Proper dosage and correct calibration of application equipment, (5) Repeat applications to insure elimination of escapes and to take care of later germinating weed seed.

The selection of the proper herbicide for the weed problem present and for the specific turf in which the weed occurs will insure better kills. Herbicides such as 2,4-D or 2,4,-5,-T would be the right chemicals for treating such weeds as dandelion, clover, and other broadleaf weeds in most turf grasses, but would not be generally suitable for controlling these weeds on bentgrass greens. With bermuda grass greens, 2,4-D or 2,4,5-T may be used with less hazard involved. Hormone type herbicides such as 2,4-D will not

give satisfactory control of grass type weeds and should not be used for this purpose.

Proper timing of herbicide applications influence effectiveness of the degree of control to a large extent. With a few exceptions, most weeds are very susceptible to herbicide treatments just following germination and emergence, regardless of the species. As weeds become mature, effectiveness of herbicides will decrease, even though the herbicide is selective for the particular weed it is to be used on. Proper timing of herbicide applications then can be considered one of the most important factors to consider in a chemical weed control program.

When application of herbicides are to be made in water, the volume recommended is high. Higher volumes of carrier is necessary to obtain good coverage of small weed seedlings or weed seed which may be protected beneath the turf grass canopy. Some herbicides are formulated to be applied in the dry form. Generally, in this form complete coverage of weeds or weed seed will be more difficult to obtain than for formulations carried in water.

Proper dosage or rate and correct calibration of application equipment are equally important factors to successful weed control and too often are overlooked. Industry involved in manufacturing and marketing of herbicides has gone to a good deal of expense in labeling herbicides as to proper rates to use and suggested methods of application. In most cases these recommendations are based on considerable research and should be followed closely.

Management practices which encourage good growth of turf grasses, discourage growth of weeds.

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TURF INSECT PROBLEMS

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It is surprising to note, after talking with several people working with turf, that there are no major insects which are a constant problem or which occur annually, but instead there are a large number of unpredictable, sporadic pests that appear from time to time. This is a very different situation from that found in the production of other crops such as cotton, alfalfa, vegetables and fruit, in which we combat many of the same pests year after year. For this reason, as turf managers, you must be aware of the various symptoms of injury. You must know and recognize the various pests that you may encounter and you must be prepared to apply, quickly, the proper treatment to prevent severe injury to your turf when the pests do appear.

Therefore, one of the major factors in turfgrass insect control is the diagnosis of the symptoms which are present. If the grass isn't green, there must be something wrong. Analyse the situation. Get down and examine the damaged grass. Look at the blades, stolons and roots. If something is feeding on the grass, it is undoubtedly an insect. Then and only then should insecticides be used.

Our insects on turf may be classified into three groups according to the location of their feeding and the type of damage they do.

I. Subsurface Pests - feed on roots and stolons killing the grass.

A. Scale Insects - sucking mouthparts.

1. Rhodesgrass Scale is a pest of lawns and greens in several areas of the Southwest. This insect is most abundant where a thatch has formed or where there are exposed nodes at the surface of the ground. Evidence of their presence is made known by brown patches in the turf and a close examination of the rhyzomes discloses a scab-like, waxy substance under which the insects are feeding.
2. Bermuda Grass Scale is another insect which sucks the plant juices. The insects appear as very small, dirty-white oysters clinging closely to the rhyzomes. Most severe injury seems to occur in shady areas, but this insect often goes unnoticed if the grass is well watered and well fertilized.
3. Ground Pearls are another scale insect which are often found on the roots of bermuda grass. The feeding of this insect causes irregular, circular dead spots on the turf. The browning of the grass begins to show in midsummer and dead spots appear in the fall. The "pearls" are shining yellowish-white in color and are 1/32 inch to 1/8 of an inch in diameter. The pearls are produced by the waxy secretion of the insect.

B. Beetle larvae - eat off grass roots and when severe, the turf can be rolled up like a carpet.

4. Bill Bug Larvae feeding on the roots of grass cause irregular dead spots in a lawn. The grubs are short and chunky with a humpback appearance and a small hard, dark head.
5. White Grubs are the larvae of May or June beetles. They are 1/2 to 1 inch in length and have a characteristic "C" shaped body. The body is white and shiny and the dark body content show through the smooth body wall. Grubs are usually most abundant in grass under lights since the adults are attracted to the lights at night and, consequently, lay their eggs there.

II. Subsoil Pests - injurious because of mounds or casts thrown up.

1. Ants, which are familiar to everyone, are often very troublesome on turf because of the dirt which they bring to the surface in the construction of their nest.
2. Termites sometimes become a problem soon after summer rains. There is a species of desert termite which is injurious to lawns by its activity of making their crusts, which are from one to four inches in diameter, over the turf surface. Under the earthern crusts, molds are raised for food or the grass itself is modified so it can be assimilated by the termites.
3. Earthworms are not insects, but very often the entomologist is asked about them. Earthworms are beneficial under most circumstances; however, on the golf green, their mounds of casts are undesirable and steps to control them are often needed.

III. Surface Pests - feed on stems and leaves of grass.

1. Sod Webworms or lawn moths are one of the best known turf insects. The larvae or webworms may be found at the base of plants by locating a loose silken web at the surface of the ground which often contains bits of dirt, sand, soil, fertilizer and grass, and then following a short silk-lined tunnel down into the ground. The larvae are short, about 1/4 to 3/4 inch long, rather thick-bodied and usually greenish with black spots of coarse hairs. The larvae are very active and wiggle backward when disturbed. If large numbers of birds are observed feeding on the grass areas, it is often a good sign of the presence of webworms. The moths are rather small, from 1/2 to 1 inch long. They frequently rest in the grass and on shrubs and trees and when disturbed they fly in a zigzag flight for a few feet. When at rest, the moths rap their wings about their abdomen, giving them a stick-like appearance. Webworms cause serious injury to turf giving it the appearance of being ragged and patchy. Webworms are most severe in poorly kept lawns and following severe infestations large areas may be completely killed.
2. Cutworms are large, greasy or dull, tan to brown caterpillars which are 3/4 to 1 1/2 inches in length. If present in large numbers, they can be very injurious to seedlings on new lawns. On established turf they often stay in a hole and emerge to eat the grass surrouding the hole making circular bare patches.
3. Army Worms are very similar to cutworms in appearance and size, but they may be darker and brighter in color. The head is usually black with a prominent inverted "Y" on the front. The feeding of army worms on grass areas also results in circular bare patches.

4. Harvester Ants are a stoutly built ant, from 1/4 to 1/2 inch long and reddish brown in color. The ants live in large colonies which, in porous soil, may extend more than 15 feet into the ground. Small nests usually have but one entrance, whereas larger nests have several entrances. The ants clear large areas from around the entrances to their nests, killing out large areas in turf and lawns sometimes 3 to 5 feet in diameter. They also inflict a very painful sting.

These are but a few of the insect pests which are common to turf and lawns and which very often warrant quick control action on the part of the turf managers.

Both cultural and insecticidal control of insects are needed. It is very often true that a well cared for lawn has very few insect problems. This is probably because the grass can satisfy the insects needs faster than the insects can satisfy their appetites.

In the case of the scale insects, cultural control is probably the best means of combating them. In combating rhodesgrass scale, for instance, the removal of thatch and surface runners with vertical type renovating equipment has proven very successful. In the case of ground pearls, proper fertilizer and water application seem to overcome most of its effects.

Insecticidal control of scales is not too effective; however, parathion, a very dangerous material to handle, and malathion seem to give some degree of control.

The other insects which cause damage to turf are easily controlled by insecticides of chlorinated hydrocarbon group such as chlordane, DDT, dieldrin, toxaphene, lindane, aldrin, and heptachlor. Sometimes pyrethrum or detergents such as Vel or Dreft are used to get cutworms and army worms out of their holes.

Insecticides come in several different forms, and the method of application used may depend on the type of application equipment available. Dusts, wettable powders and emulsions are most commonly used; but for work on lawns and turf, the granular formulations show much promise both from the standpoint of application and more effective and longer lasting control. Most of the commonly used chlorinated hydrocarbons are available in granular form, and they are easily applied with fertilizer spreaders and seeders.

Watering is an important factor to watch in connection with treating of turf pests. In general, it is best to water before foliage applications and water thoroughly after soil applications.

It is always well to remember that insecticides are poisonous to man and should be handled with respect. Follow the directions on

the package as the manufacturer has gone to great pains to tell you exactly how to use each specific product. At the same time, be sure to observe the precautions on the label, they are given there for your protection.

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CONFERENCE SUMMARY

Marvin H. Ferguson, Southwestern Director
United States Golf Association

It is a pleasure to have the opportunity of attempting to summarize this first New Mexico Turf Conference. We have had a very informative two days. I am pleased by the large attendance, and I am sure that all of you have found the conference very much worth your time. We shall merely attempt to touch upon some of the highlights of the conference in this summary.

Mr. Albert S. Curry opened the program by extending a welcome to this group to the New Mexico College of Agriculture and Mechanic Arts. Mr Curry outlined some of the advantages of a Land Grant College and pointed out some of the additional things that this College does which normally are not a part of Land Grant College business. With regard to turf, Mr. Curry feels that it has an aesthetic as well as economic value. He used a term that was new to me and perhaps to you. He said that good turf and pleasant surroundings make a person feel "comfortable." He believes that pleasant surroundings lead to tolerance and other human relations. Mr. Curry said that there are many turf problems which the College has not had an opportunity to study, but he pointed out that the College does have a fund of basic information which can be brought to bear on your practical problems when the College has learned what your problems are. In this respect, education is a two-way process. The College faculty members must first be educated concerning the nature of your problems then they will be able to educate you in helping to solve those problems.

Dr. J. V. Enzie was the next person to appear on the program. Dr. Enzie read a paper prepared by Dr. Fred V. Grau concerning the importance of research and education to turfgrass users. It was pointed out in this paper that it is unimportant for users to recognize the efforts that have gone into the development of a grass, or a management practice. The important thing is that they should know about the grasses and the appropriate management practice for each improved grass. The chief point of this paper was that we need more research; we need more education; and that these two efforts must proceed simultaneously.

Mr. Fred Day spoke about turfgrass problems on public areas. Frequently the problem on public areas is thought to be too much use. Mr. Day doubts whether this is always the right answer. He asks: "May it be the wrong kind of grass?" "May the area be too small?" "Is the area properly planned?" He feels that much can be accomplished through good planning, proper choice of grass and the use of areas adequate in size. Mr. Day discussed many changing ideas with reference to good turf care or turf management, and noted that our ideas are constantly changing as demands for turf quality increase. He pointed out that cutting height and cutting frequency need much further study.

Mr. Clarence Watson discussed turfgrasses and their adaptation to New Mexico. He pointed out that New Mexico is a region of extremes with reference to elevation, temperature, soils, water quality, and rainfall. These variations have a marked influence upon the adaptability of new grasses to the area. Mr. Watson pointed out that presently the turfgrasses were recommended largely upon observations rather than upon experimental data. He described many of the species that are adapted to turf use in New Mexico, and described the conditions which favor those grasses.

Mr. Watson introduced Miss McSwain, the State Seed Analyst, who described some of the work of the seed control agency. Miss McSwain said that one of the agency's primary functions is to describe quality in seeds so that a seed buying customer will be able to adequately describe the quality of seed that he desired.

Mr. Charles G. Wilson discussed fundamentals of turfgrass management with emphasis on bentgrass. Charlie stated that bentgrass is the prima donna among the turfgrasses. He said that bent falls prey to many ills, but that it has amazing recuperative power. He pointed out that bentgrass turf is the acme of turf quality and that when properly managed it will provide a very wear resistant turf. With reference to this point, he cited the Rancho Golf Course in Los Angeles which averages 306 players per day throughout the year. Charlie stressed a need for good soil, correct mowing practices, thatch control, proper nutrition, and water management. All these things must be adequately taken care of if grass is to be grown successfully.

This led well into the talk delivered by Dr. J. R. Watson entitled "Water Management." Dr. Watson told us many things about water management. Some of his statements were:

"One should apply water no faster than the soil can take it."
"One should apply no more water than the soil can hold."
"Drainage is extremely important."
"Key your irrigation operations to the irrigation facilities available."

Dr. Watson left the impression that water management is one of our most important considerations in the growing of turf in an area like New Mexico.

Dr. Philip J. Leyendecker, of the New Mexico A & M College faculty, was the last speaker on Thursday afternoon's program and he discussed the diseases of turfgrasses. Dr. Leyendecker stressed the importance of keeping grasses healthy. He believes that by keeping conditions near the optimum for good turf growth that there will be fewer diseases to contend with. He said that one of the good ways to control disease was to alter the ecological factors which favor disease activity. He mentioned the dangers of overwatering, and the beneficial effects of adequate drainage and aeration. He listed a number of diseases which are troublesome in turf, as well as pointing out some of the management factors which have an effect upon disease control.

In the evening there was an informal dinner meeting which was attended by more than 20 people. This was a very informal affair at which there was good food, good fellowship, and good stories. Of course, I did not appreciate all of the stories which were told because most all of them seemed to be derogatory as far as Texas was concerned. We did have an enjoyable discussion of many problems.

The Friday morning session was begun by Dr. Pack's discussion of peculiarities of New Mexico soils. He stated that climatic factors and parent materials are important in soil formations. He pointed out that most New Mexico soils are alkaline, and that alkaline soils are usually more fertile than acid soils. Iron deficiency was listed as one of the problems of alkaline soils, and in this connection Dr. Pack mentioned the possibility that iron chelates may soon find a usefulness in the control of iron chlorosis. Dr. Pack believes that nitrogen is the greatest fertilizer need as far as turf is concerned because the soils are naturally low in organic matter and, therefore, low in nitrogen. He felt that phosphorus may be lacking in some areas. Dr. Pack discussed saline soils and alkali soils, pointing out the difference in these two conditions. He stated that soils suffering from these difficulties can be reclaimed to some degree by the proper handling of water. He warned against light frequent irrigations and recommended that water be analyzed and that it be used carefully.

Dr. J. R. Watson spoke on the subject of changing your soil. Dr. Watson introduced his discussion by asking four questions: Is soil modification necessary? Is it practical? Is it economical? What is the approach? Dr. Watson said that chemical modification of a soil is relatively less difficult than physical modification. The chemical characteristics of a soil can be altered considerably by the use of soil amendments such as fertilizers, lime, etc. Only on small, available areas can we feasibly make radical changes in the physical properties of soil.

There was a break for refreshments after Dr. Watson's paper, and I should say here that the refreshments furnished by the College have been very much enjoyed by all the people in attendance.

After the break for refreshments, we returned to this room and heard a discussion on weed control in turf by Mr. John A. Long and a discussion of insect control in turf by Mr. John J. Durkin. You have just finished listening to these two papers and I shall, therefore, not attempt to summarize those. It is sufficient to say that both these men stressed the need to water properly, fertilize enough, mow properly, and then pest control of any kind will be much easier.

I feel that we owe a great deal to Clarence Watson, who has done so much work in the preparation of this program and in the planning of the conference. That we owe a great deal to the College for their courtesies, and to the staff members who have contributed greatly to the conference. I feel that you now have a much better appreciation of what your College has to offer you. I should also like to commend all of you who have been so interested and who have listened so patiently to these two days of discussions. I hope that you have found it worthwhile and that your turf conference next year will be a bigger and better one.

Thank you very much.

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