PROCEEDINGS

of

1964 TURF CONFERENCE

Sponsored by the

Midwest Regional Turf Foundation

and

PURDUE UNIVERSITY

LAFAYETTE, INDIANA

March 2 to 4, 1964

PROCEEDINGS OF THE

1964

MIDWEST REGIONAL TURF CONFERENCE

The 32 talks included in these Proceedings are condensations of talks by speakers before sections and divisions of the 1964 M. R. T. F. Conference. We appreciated the willingness of the speakers to participate and prepare material for your reading. See Table of Contents next page. Proceedings of each annual Conference since 1948 have been prepared. A limited number of 1960, 1962 and 1963 Proceedings are available at price below.

A copy of these Proceedings were mailed to:

1. The 580 attending the 1964 Midwest Turf Conference.
2. One person of each member organization within the Midwest Regional Turf Foundation not represented at the Conference.
3. List of those in educational activities.

Additional copies are available at $ 1.00 each from:

W. H. Daniel, Executive Secretary
Midwest Regional Turf Foundation
Department of Agronomy, Purdue University
Lafayette, Indiana

Attendance divided by interest as judged by registration card	
Golf Courses	353
Turf Materials & Supplies	115
Sod Nurseries & Landscape	44
Parks(most have golf courses)	6
Industrial Grounds	11
School Grounds	11
Cemeteries	4
Non-Profit & Educational	36
Total	580

Distribution by States	
Illinois	176
Ohio	127
Indiana	142
Michigan	29
Wisconsin	22
Missouri	21
Kentucky	24
Outside Midwest	19
Purdue	20
Total	580

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

For Lawns first see

Pages 11, 16, 19, 22, 27, 31, 34, 37, 40, 41, 45, 49, 53, 63a

For Sod Production first see:

16, 17, 19, 31, 33, 34, 35, 37, 39, 40, 45, 49, 51, 53, 63a

For Golf Courses - All including:

13, 19, 22, 33, 34, 35, 37, 39, 42, 53, 55, 55a, 56, 60.

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PRESIDENT'S REPORT

Stephen L. Frazier, President, M.R.T.F.
Supt., Woodland Country Club, Carmel, Indiana

I always look forward to this Midwest Regional Turf Conference, the fellowship - seeing old friends - exchanging ideas, but for the most part receiving the benefits of the educational portions of the program. We all need to share the enthusiasm of our speakers and take home with us some of this enthusiasm - the ideas - the stimulation of imagination - and apply what we have learned.

There is always new interest in Midwest Regional Turf Foundation, and this is evidenced by the 23 new members joining our Association this year. There are so many people here for the first time, and we welcome you newcomers, and also the many loyal supporters that we see every year. The total membership for 1963 was 362, and all phases of Turf Management are represented in our membership. We continue to progress and we can evaluate this by our well-attended Fall Field Days, and by nearly 600 people attending this Conference.

Midwest Regional Turf Foundation has released two grasses this past year. Evansville bentgrass foundation stolons have been released to six growers to produce certified stolons. This is the direct result of five years testing.

Midwest zoysia has been released through the Agricultural Alumni Association to produce certified stolons for growers, golf courses and country clubs. Midwest is the result of a ten-year research program - the first new variety for this area since the release of Meyer in 1950.

The turf program has been supported by membership dues, tax funds and facilities by Purdue University, and grants from industry. We canot forget the materials that were donated by so many organizations. We extend our deepest thanks to Dr. Daniel, Bob Seager, technician, and Kaye House, secretary, for their efforts in keeping Midwest Regional Turf Foundation in its high state of excellence.

An honor has been bestowed upon our Executive Secretary this past year. He was elected a Fellow in the American Society of Agronomy at Denver in 1963.

It has been an honor and a wonderful privilege to serve M.R.T.F. as President, and I want to thank the Board of Directors on behalf of the Foundation for their able assistance through the year, and for their capable handling of the educational sessions during this Conference.

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Abstract for
EXECUTIVE SECRETARY'S REPORT

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

Each Conference and Field Day is a portion of a report for you. Our program is going well - some changes, but gradual enough. Last year we had less graduate students, but expect normal next year.

Our undergraduates are doing well - send us all the good ones you can find.

Your Board of Directors and Officers have been most kind. I especially appreciate your kindness in providing a gift - through donations - for my boat trip expenses. It was most surprising.

Your President mentioned a second highlight of the year for me. I was chosen as one of 22 elected as a Fellow in the American Society of Agronomy for 1963. This recognition for a worker in turf was acknowledgement of your interest. I thank you for making such possible.

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REFLECTIONS ON AMERICA'S IMAGE ABROAD

Harvey F. Baty - Coørdinator, International Programs
Purdue University, Lafayette, Indiana

Americans are an international people. If we look back two or three generations, most of our parents and grandparents will have come from some other country. Few of them were native Americans. Many of us have traveled or worked outside the United States. If, when we go abroad, people are friendly and welcome us, it is not because of anything we have done personally. Someone who looks like us or speaks our language had been there before and make a good relationship. We "cash in" on it. If, when we go abroad, people are hostile, it is not because of anything we have done, since we will have just arrived. But, someone who looks like us has hurt them and we inherit the resentment.

Wherever we go, people have an "image" of America and Americans. What is this image, how is it formed, and how can it be improved? These are the questions I wish to discuss with you.

1. What is the American Image Abroad?
   It is a composite of many things. It is a cumulative residue of the impacts of all the impressions people have received from or about America and Americans. It is colored by the experience, the national aspirations, hopes, and disappointments of the people in countries abroad. It is distorted out of proportion by the pressures of passing events. It is a changing thing, from country to country and from time to time.

2. How is the American Image Created?
   a) By Americans going abroad. This year, right now, over a million Americans are living or working abroad. Over a million others will go abroad this year as tourists. Everyone of them receives and gives some impressions. Everything they say or do helps to create the image of America in the minds of people in other countries.

   b) By American movies. Unfortunately, many movies which are not fit for showing in U. S. theaters or on television screens - and many which are shown here - find their way abroad. People who see these "western" movies, where the 2-gun man with the fast draw is the hero, think that is a picture of American life. They also get the impression that the love stories shown on the screen are typical of American family life.

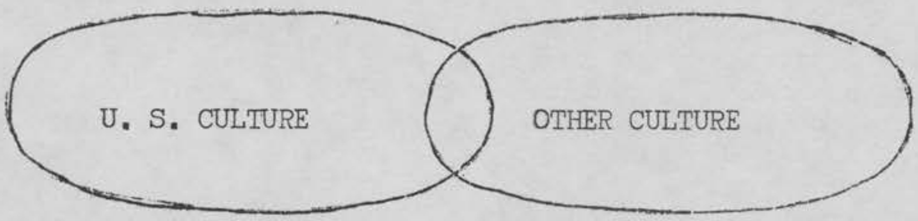
c) By American history. Most people growing up in foreign lands - especially those which have been struggling to be free from colonial rule, have studied American history. Our national struggle has been a source of inspiration for them. They may know more about the Boston Tea Party and Lincoln than we do. They have read about our Revolution and somehow expect us to be with them in theirs.

d) By American newspapers, television, et cetera. We do not have to go abroad to make an impression. Our newspapers, picture magazines, such as Look and Life, go abroad to represent us. Just as the unusual and the sensational is played up in our press, so it is abroad - that news and pictures of race tension such as Little Rock, Montgomery, Washington, are sent abroad and given editorial treatment - in most cases to our discredit. The worst things that happen here will become the headlines abroad.

e) By foreign students and visitors coming to the United States. This year, over 60,000 students from other countries are studying in the United States. Most of them come from Africa and Asia. Many of them experience hardships, anxiety, discrimination. Their observations and experiences shape their attitudes toward the United States.

How can America's image abroad be improved? All of us help to make the American image abroad. All of us reap the benefit or suffer the hurt which comes from it. How can we improve it? I believe we can create a better American image abroad and at the same time have a part in shaping the world of the future toward something that we want to live in. In fact, I think this is going on now. Beyond all contacts, incidental or accidental, with cultures of the world, there is presently coming into being something which is new to this generation and which, in my judgment, has great promise. This new development has been called a "third culture." Nations can live in isolation and ignorance of others - without any contact.

But, by education and travel, cultures tend to overlap.



The area of overlap may grow to become a "third culture."

This year, 300,000 students are studying abroad in countries other than their own. When they go home, they will never be the same again. Many American universities have developed "Area Studies" programs. Their aim is to understand another culture. Many people are going abroad - e.g. in U. N. FAO - as international civil servants. In accepting such employment, they pledge themselves not to promote the interests or advantage of their own country above that of other countries. They do not forget their own country in becoming a part of a new culture, but they become, in a sense, a part of this "third culture" where their concerns and efforts are for mankind.

The relationships built in the colonial period were between dominant cultures and subordinate cultures. In this present era of development, the relationships are more of appreciation, understanding, and working with peoples on a basis of mutual respect and equality. In the colonial period, the authority and rank of the administrator (French, British, Spanish) was strong. And even though we Americans were not building colonial empires, we fell into the colonial trap of paternalism. In the "third culture," we work to help indigenous people develop their own institutions to meet their needs. We are no longer the managers. We increase their capacity for authority, responsibility, and management. This demands the growth of a whole new set of attitudes and relationships. Today, there are perhaps 100,000 people in the world who are living a large proportion of their lives in this "third culture" and millions who experience something of it. Their number is increasing at a rapid rate. To some of us, this may appear as a threat to our position in the world. But, I believe it is a good thing and that it will increase. This will not help us to preserve the world "as it was." It will not make everyone love us. But, it will help us to bring a new era which, we hope, will increase the areas of mutual respect, agreement, and cooperation in the world and decrease the areas of distrust, misunderstanding, and strife.

I realize that this has little to do with this audience's interest in Turf. But, it does affect our lives and the lives of generations to come. In your industries and in your work you get better products through research. I believe it is possible to apply the same research methodology to the larger human problems of the world and to create better human relationships. Looking back fifty years, who living then would have dared to dream or believe that the technological advances which have come,would be possible? Looking ahead fifty years, is it possible that there is something as far ahead of what we now have as the Boeing 707 is ahead of the horse and buggy? I believe that technological advance will continue, and that this will force us and inspire us to apply the same creative reason to the human and social problems of the world.

To create not only a better American image abroad, but a new era in human relationships across cultural barriers, I would like to suggest that we set up somewhere in the world a Research Center for Creative Interaction. That we bring to it the most creative people of the world and charge them to work with intensity in the area of human problems and international relations. They would work for a break through into an era of peace, prosperity, international understanding, and cooperation.

Could we not charge them to think ahead and to discover what is posible for mankind? For example:

1) What are the next steps in the evolutionary process? If in the past, we have had human and social evolution with little conscious human planning, what could happen if man becomes a conscious cooperator in the process?

2) What is the human potential in terms of genetics and how do we realize this

potential? How can we increase the quality of life and control the quantity?

3) What is the earth's potential in terms of nutrition and how can we realize this potential? How can we create a world in which no one need lack sustenance?

4) What is the economic potential of the world and how do we release or organize human energies so that human beings in all societies will not suffer from want or waste? Then no one would live in a shack unless he wanted to.

5) What is the potential in the international dimension, in our relations among nations and what needs to happen to realize this potential? How can we make it possible for human beings to plan their lives in confident dedication to the well-being of humanity and not spend their resources of mind, energy, and material in acts of fear, hate, or destruction?

6) What is the incubation period for hatching a great idea? How can we cause great ideas to be born and to grow in the world?

Finally, we need to realize that a better world for all mankind can come. No one can give us such a world! It has to be built, and the people who are living in it will have to build it. It must be constructed in our own thoughts, attitudes, patterns of behavior and relationships. Indeed, we must be the world we want! It has to be built into the very fabric of our lives!

I believe that such a world is possible and that we know enough to create it. It may be realized in our lifetime - or it may have to wait for future generations. But it will come. When the new day has fully come and men have learned to use the material resources of the earth and their own productive powers for the well-being and not the destruction of mankind, the epochs of history will be revised. The period of the "Dark Ages" may be extended to include our own time. Then the emancipated and enlightened humans of the new earth will look back to the people of today with tenderness and regret that we were so close to a great idea that would have transformed our lives, but couldn't quite grasp it.

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PARLIAMENTARY PROCEDURE

Bruce Kendall, Assoc. Prof, Speech Dept.,
Purdue University, Lafayette, Ind.

Most organizations, at one time or another, become discouraged with the amount of time they consume in conducting routine business. Meetings frequently become bogged down by the indecision of a presiding officer who does not understand parliamentary rules of procedure. The confusion is increased if a few members know more about such rules than the president. Frustrated members in this situation are likely to blame the rules themselves. "If we weren't tied down by rules," they say, "we'd get along all right."

Actually, if one can guarantee anything about rules of procedure, it is that where officers and members know them, business can be conducted with dispatch. Parliamentary rules are designed for two basic purposes: to insure efficiency in the conduct of meetings; and to safeguard the democratic rights of the membership. The more the members of an organization know about the rules under which they should be operating, the closer the group will come to realizing these objectives.

My purpose in this paper is to present to you some basic rules of parliamentary procedure to help you improve the conduct of your meetings.

First, any organization must decide how formally it wishes to operate. A good rule of thumb is that the larger the membership, the more rigidly the organization should adhere to the rules. With ten to twenty members, an organization could operate more as a committee, striving for unanimity rather than majority rule. With more than twenty members, such informality becomes impossible, and to insure efficient and democratic operation, rules of procedure should be carefully followed.

Once an organization has determined its degree of formality, the second rule should be enforced. Unless you intend to operate strictly as a committee, the presiding officer should allow no discussion or debate unless a main motion has been moved and seconded. Unless this rule is followed endless amounts of time can be wasted during a meeting. Without a main motion, discussion can continue without limit, and when it is over, no action can be taken because there is no motion to vote upon.

The third rule is that any motion of importance, particularly any main motions and amendments should be submitted to the president in writing immediately after they have been made from the floor. Any substantive motion must be specific in wording and should be entered in the minutes. Time will be wasted if the member making the motion is asked to dictate it for the secretary to write down. Above all, no member should ever be allowed to make a short speech which concludes with, "Mr.Chairman, I so move."

After debate has been concluded, the time for voting arrives, and the fourth and fifth rules apply. Rule 4. To improve the conduct of meetings is that all motions requiring a simple majority should be voted on by voice. Counting votes consumes much time, and anytime a vote is counted, the count must be entered in the minutes. This time can be saved by having the vote by "aye's and no's." (Never have the negative vote by "the same sign.")

The fifth rule, which also applies to voting, is that all votes are computed on the basis of the number of people voting unless the constitution of by-laws specify otherwise (such as for amendments to the constitution of by-laws). In most organizations, no member is required to vote or even to register an abstention. Thus, regardless of the number of members in an organization, if a quorum is present, a vote of two votes for a motion, and one against, would constitute either a majority, or a two-thirds vote.

If an organization were to follow these five rules, its operation would be greatly improved. Of course, more knowledge would improve it even more. It is a good idea to have some member who knows parliamentary procedure appointed as parliamentarian to advise the president on procedural matters. In addition, member need to learn as much as possible about the various motions, their purposes, and when they can be used. The following chart, which has the motions arranged from bottom to top in the order of their precedence, is a good place to start learning and has proved to be a help for both president and members in improving the quality of business meetings.

TABLE OF TWENTY-FIVE MOST FREQUENTLY USED PARLIAMENTARY MOTIONS*

	MOTIONS	PURPOSE	NEED A SECOND	AMEND-ABLE	DEBAT-ABLE	VOTE REQUIRED	MAY INTERRUPT A SPEAKER
IV.	Privileged Motions (arranged from bottom to top in order of precedence)						
25.	Adjourn to specific time	to arrange time of next meeting	yes	yes	no	majority	no
24.	Adjourn	to dismiss meeting	yes	no	no	majority	no
23.	Take a recess	do for specific length of time	yes	yes	no	majority	no
22.	Raise a question of privilege	to make a request during debate	no	no	no	decision of chair	yes
21.	Make a matter of special order	force consideration of specified time	yes	yes	yes	2/3	no
20.	Call for the orders of the day	force consideration of postponed motion	no	no	no	decision of chair	yes
III.	Incidental Motions (no order of precedence)						
19.	To appeal a decision of the chair	to correct or reverse chairman	yes	no	yes	majority	yes
18.	To call for a division of the house	to correct or reverse chairman	no	no	no	majority if chair desires	yes
17.	To raise a point of order.	to correct a parliamentary error	no	no	no	decision of chair	yes
16.	To object to consideration	to suppress action	no	no	no	2/3	yes
15.	To divide motion	to modify motion	yes	yes	no	majority	no
14.	To modify or withdraw a motion	to modify a motion	no	no	no	majority or unanimous consent	no
13.	To suspend the rules	to take action contrary to standing rules	yes	no	no	2/3	no
II.	Subsidiary Motions (arranged from bottom to top in order of precedence)						
12.	To rescind	to repeal	yes	yes	yes	majority with notice; 2/3 without notice	no
11.	To reconsider	to consider again	yes	no	yes	majority	yes
10.	To take from table	to consider again	yes	no	no	majority	no
9.	To lay on the table	to defer action	yes	no	no	majority	no
8.	To call for the previous question	to force into immediate vote	yes	no	no	2/3	no
7.	To limit or extend limits of debate	to modify freedom of debate	yes	yes	no	2/3	no
6.	To postpone to a certain time	to defer action	yes	yes	yes	majority	no
5.	Refer to committee	modify a motion	yes	yes	yes	majority	no
4.	Amend an amendment	do	yes	no	yes	majority	no
3.	Amend or substitute	do	yes	yes	yes	majority	no
2.	Postpone indefinitly	suppress action	yes	no	yes	majority	no
I.	Principal Motion						
1.	A main motion	introduce business	yes	yes	yes	majority	no

*Based on Robert's Rules of Order. Arranged by Leroy T. Laase

THE PICTURES YOU MAKE

Howard R. Knaus, Ag. Visual Aids,
Purdue University

Whether a person is a scientist, educator, technician, or laborer, he can use photography to further his cause. It is gratifying to the teacher, for instance, to know that with pictures his information has been conveyed to and received by all of his students in a clear, concise form with no possible chance for misunderstanding.

The development of the single lens Reflex camera and the remote control slide projector have made it possible for everyone to make and use his own communication tools. What do we mean by single lens Reflex camera? It is simply that the viewfinder is incorporated with the lens so that we are actually looking and focusing through the lens when lining up our picture. What we see in the viewfinder is exactly what will be in the picture. If the image we see in the viewfinder is sharp, then the picture will be sharp. This type of camera has been on the market for a number of years, but has been expensive. To buy any other type of 35mm camera today is to not take advantage of one of the best features developed by the camera industry. Why? Because, of what it can do for us. For instance, there are many illustrations in magazines that we can readily convert to usable slides by simply taking pictures of them. Inexpensive close-up lenses and the direct viewing and focusing make this possible.

Close-up pictures of all types, flowers, grasses, weeds and seeds become a simple procedure with the single lens Reflex camera and inexpensive close-up lenses. There are two main types of shutters available--the focal plane and between the lens. Both have distinct advantages. If most of your pictures are outdoors in natural light and you want a variety of lenses, the focal plane is good. If you take many flash shots, the between the lens type has some advantages.

For black and white or larger than 35mm photography, the double lens reflex has become quite popular. They are fine for most work, but are not as good for scientific photography as the single lens reflex, again because viewing and focusing are not accomplished through the taking lens. Single lens reflex cameras using the larger film (2½" wide) are still expensive and there are only a few manufacturers making them. I foresee a rapid change from the double lens to the single lens type as soon as the manufacturers can get the costs down.

What about filters? The main use of filters today is to change the brightness of one part of the picture in relation to another. Darken the sky for instance so the clouds will show on the print as they do to our eye.

The general rule is - to make a subject show <u>lighter</u> on the print - use a filter of the <u>same color</u> as the subject. To <u>darken</u> the subject, use a filter from the <u>other side</u> of the color wheel. Thus, to darken a sky we use a yellow filter, or to darken green grass use a red or orange filter. In general, in black and white photography on pan film, the yellow, green and red filters are the ones most commonly used.

In color photography it is entirely different. We use filters to match the type of light to the film we are using. Sunlight is more blue than artificial light, so colored films are made to use with each type of light. When we want to take "outdoor" pictures on film made for artificial light, we must put on a salmon colored conversion filter so the correct color light will be recorded on the film. A blue filter would convert daylight film to artificial light, but is not recommended since the blue filter is quite dense and the exposure must be increased to properly expose the film.

To solve the entire problem, use <u>outdoor type</u> film outdoors and a <u>blue flash bulb or strobe light for interior pictures</u>.

Speed of the film determines the exposure for any given light situation. Use of an exposure meter to determine the exposure is the surest way to consistent results for proper exposure and good prints or slides. Two general types are in common use. The reflective which measures the light reflected from an object, and the incident type which measures the light source. The incident type is generally preferred, especially for copying and critical work. Manufacturer's instructions should be carefully followed to make use of the features built into the instrument.

All good pictures have three essential qualifications: good technical quality, interest or impact, and good composition.

What is composition? Composition is a pleasing arrangement of objects, mass, lines, contrasts, and colors to form an harmonious whole. General rules for composing pictures are as follows:

For what use are you taking the picture:
Pictorial, publicity, educational
Record, popular appeal

Arrangement and placement of main center of interest:
Compact arrangement to cover picture area
Center of interest slightly off center

Placement, center of interest with regard to background:
Avoid conflict of main point of interest with vertical or horizontal lines.
Place livestock away from fences, vertical and conflicting diagonal lines.

Backgrounds (make them plain):
Look beyond the foreground
Avoid confusing, cluttered background
"Put" background out of focus if conflicting
Avoid strong vertical and horizontal lines
Place horizon on upper or lower third of picture
Keep horizon line level

Framing:
Use people, trees, buildings, etc.

Focusing attention toward center of interest:
Try to use pointer, or
Use of facing people

Facing people:
Have people facing into picture;
Not facing camera

Strong lines:
Bending of body
Direction of arms
Roads, fences, trees

Lighting center of interest:
Black and white, 45 degrees, front, back
Color, flat lighting
Shade or cloudy days

Film manufacturers are constantly working to provide us with faster, fine grain films to open up new opportunities and possibilities. Kodak has two new color films in Kodachrome X and Ektacolor X; Ansco has three new color films, and the new Agfa film is gaining converts every day.

Photography is fun and it can work for you. Put some of this new film and equipment to work and I am sure you will be amply repaid by satisfaction of producing pictures instead of snapshots.

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AN EXTENSION AGENT LOOKS AHEAD

Wilbur L. Bluhm, Graduate Student,
Purdue University, Lafayette, Indiana

As with many professions, today's County Extension Agent is faced with the task of keeping informed in an age of rapid change. To help him do so, most State Extension Services are granting sabbatical leaves of from 6 to 12 months for study in fields related to the Agent's job.

After corresponding with nearly half of all Agricultural Colleges in the U.S., I chose Purdue because of its special study program for County Extension Agents. The "interdisciplinary" program here permits study of agricultural subjects, and others which help the Extension Agent more effectively present information. Thus, I have taken courses in plant physiology, plant pathology, soils, land economics, agricultural policy, statistics, and communications.

For the past seven years I have been Urban Extension Agent at Salem, Oregon. I've been responsible for the turf and ornamentals program, working with both homeowners and commercial and professional interests. Ten years ago it was mostly servicing the "flood" of office and telephone calls. These took nearly all of one's time, allowing little opportunity to plan, prepare and conduct necessary meetings, demonstrations and programs.

Since then emphasis has shited to "leader training" type programs and to "mass media," and away from individual service. In leader training programs we work closely with organizations and groups of people who serve as "leaders" in passing information along to homeowners. Typical of these are garden centers, lawn and landscape contractors, and service companies, parks and school grounds managers, golf course superintendents, nurserymen, landscape architects, garden clubs, and various professional, civic and social groups.

We use mass media--newspapers, radio, television, newsletters, timely mailings, publications, exhibits, etc. -- to pass on information to those who want and need it. With leader training and mass media programs, we are directly and indirectly helping many times more people than we could by personal service--phone and office calls and home visits--alone.

Upon my return to Oregon, emphasis on leader training and mass media type programs will continue in an effort to "reach" more people. The training here at Purdue will be quite helpful in getting this job done.

Many turf activities are planned. Demonstration plots can provide useful information on turfgrass varieties; weed, disease, insect, and rodent control; proper mowing; thatch removal; aerification; and fertility. Meetings and short-courses will be held for the "leaders," previously mentioned, on many turf topics. Field days provide much useful information. Turf people will be encouraged to participate in turf conferences and field days, such as you are here at Purdue.

Comparable programs will be developed for persons interested in ornamentals. In Oregon many problems arise from using less desirable plants, and from a lack of knowledge on how and where to use plants. Programs on ornamentals must emphasize desirable plant use.

We would be doing the turf industry a favor, in many cases, if more plantings of trees, shrubs, and groundcovers were encouraged in the home landscape as replacement for some of the grass. The lawn would become a more important part of the landscape then. As such, this smaller lawn area would likely get more attention. It would cease to be just something to cover an expanse of "dirt," often grudgingly cared for.

A few problems of the "Urban" Extension Agent have been cited, others inferred. Still others bear some attention. Most Extension workers have a commercial farm orientation. They think, talk, and act in terms of acres, tons, and gallons instead of square feet, pounds and teaspoons--a must in working with homeowners, and with others who work with homeowners. It is not always appreciated that today's homeowner, and the public generally, is concerned with convenience--that price, although important, is relatively less so than formerly. The interests and background of urban people need to be well understood.

This field is relatively new to most Extension personnel. Adequate information on turf and ornamentals for those who want and need it is not always available. Other times this information is available, but not in a readily usable form. It must first be interpreted. Information on fertility is an example. The Extension Agent has a wealth of material on this subject, but not always in a form directly applicable.

An Extension Agent in this field must adapt himself to interests and needs quite different from those of the farmer. We have learned, developed and used methods of getting information to rural people with acknowledged success. In working with urban people, we're just beginning. He must develop some business acumen and an appreciation for it, if he's to work with garden dealers, nurserymen, and other business people. He must learn to play golf if he is to work with golf course superintendents. He needs to garden and care for a lawn if he is to be of most help to the homeowner. He must learn the uniqueness of the professions and interests of the people with whom he works.

In the future we will be of increasing help to you and your interests. Specialized Extension Agents will be working more in the field of community development. This will involve, among other things, the orderly growth and development of our urban and rural communities. It will be concerned with urban sprawl, renewal, land use, beautification, and a host of other problems and situations. You will be vitally involved in this program when it comes your way.

Even now your Extension Agent has more to offer than you're probably aware of. He is quite knowledgeable on many matters relating to soil fertility, irrigation, disease and insect control, weed control, and other areas of interest to you. Much of this information can be readily adapted to your turf problems. He is in a position, too, to call on specialized help when you need it. As Extension Agents become better acquainted with your turf interests, it should be mutuall helpful. Do what you can toward this end in your county.

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THE MASTER PLAN FOR GOLF COURSE IMPROVEMENT

Edward Lawrence Packard, Golf Course Architect
La Grange, Illinois

In every trade and profession, there are always individuals who are perfectly satisfied with the status quo. Many either do not have the knowledge and ability to see any opportunities for improvement, or they do not wish to create any disturbance in the calm, quiet routine in which they are working by suggesting conditions can be improved. In every profession also, there are a small handful of individuals who not only can see opportunities for improving existing conditions, but these individuals also have the desire, the discernment, the temerity, or the audacity, call it what you will, to make an attempt to prove them.

The fact that the golf course superintendent's meetings, both regional and national, are so well attended year after year, attests to the fact that an extremely high percentage of all golf course superintendents are genuinely interested in the steady improvement of their courses from year to year. It is a fact, also, that as each superintendent grows in his experience, visits the golf courses of others, observes the ease, or the difficulty with which certain routine maintenance is accomplished, compares maintenance costs, and in general grows in his ability to evaluate the quality of his own maintenance practices, he will begin to see that certain improvements on his own golf course can be made.

This brings us then to the question, what does constitute items which can be, and which frequently are the object of an improvement program on an existing golf course? High on the list of items which can result in an improved golf course are items which receive considerable maintenance. These include the size, shape and elevation of tees; the size, shape, contour and drainage of greens; the size, shape and contour of sandtraps; the location and the condition of the edges of any ponds, creeks, or streams on the golf course; the existing condition of the water system; and finally the placement and condition of plant material on the golf course. Let us consider each of these items briefly.

In regard to tees, these should be as large as it is possible to make them. It is probably not advisable to recommend the cutting of fine old trees in order to extend tee surfaces. Sometimes moving a tee 50 or 100 feet in one direction or another will enable a new tee of adequate size to be built. Where possible, tees should be at least 7,000 sq.ft. in area. The correct relocation and enlargement of existing tees is one of the easiest and cheapest things which can be done to improve an existing golf course.

In regard to greens, all too frequently even brand new greens are constructed with bumps and back slopes which are entirely unmowable except by hand maintenance methods. A good average size for greens is 6,500 sq.ft. In my opinion it is possible to have greens built which are too large. Of course, there are thousands of greens which have been built too small. It is not an easy thing to revise, or remodel a green to enlarge it because it means in many cases reconstructing a good part if not all of the old green. Nevertheless, it is possible to so add to an old green as to keep the existing surface intact, and to add to this existing surface sufficiently to obtain a green of the proper size. It goes without saying that the surface of all greens should be made to drain and in more than one direction. All undulations of the green and contours of the shoulders should be mild enough so that there is little danger of scalping with mowers. This means that the back slopes and side slopes must be carried out sufficiently far to permit machine mowing, whether it be by means of fairway units, or the more precise mowing of the three unit riding type mower.

In the matter of sandtraps for easy maintenance, the trend has been toward milder convolutions of the edges of the traps, and more gentle rise from the bottom of the trap to the top edge. The edge of the sandtraps should be mild enough so that a power mowing unit can follow them without leaving areas which must be mowed by hand. It is also perfectly obvious that in order to be able to maintain sandtraps with power mowing units, that the back slopes and the side slopes of the traps must be gently contoured so that scalping does not occur.

In connection with the location of ponds and creeks, not too much change can be done economically. However, the edges of these natural features are often so steep that a ball going over the edge cannot be played and sometimes is difficult to retrieve. In addition, areas of this kind are frequently very difficult to mow properly and to keep maintained in an orderly fashion. If it is possible to gently slope these areas down toward the edge of the normal water level, a much more easily maintained area will result. This will improve the appearance and also reduce the maintenance cost.

In regard to the water system of the golf course, this should be as fine a system as the owner can afford. The importance of this item cannot be over-emphasized. Where existing water systems are inadequate, and this means either from the standpoint of the water source, or from the standpoint of the size or condition of the piping, or from the standpoint of the capacity or pressure of the pumping unit, recommendations are definitely in order on the long range improvement plan for rectifying these deficiencies.

There is frequently inadequate planting, either from the standpoint of safety, or just from the standpoint of beauty. It is advisable to furnish a detailed planting plan for the replacement of elm trees and for the supplementing of existing plantings by additional new trees, small trees and conifers. The foregoing items, therefore, are some of the considerations of the master improvement plan viewed from the perspective of better maintenance.

From the standpoing of better architectural quality, the following items should be given careful consideration. First of all, the general playability of the golf course is a rather broad term. Safety on the golf course means not only as full and complete visibility as possible from the tee through the fairway to the green, but also the relationship of one fairway to another, and of one tee to an adjoining green, or to another tee. Although there are hundreds of blind golf holes in the country in play today, none of these can be characterized as safe. Of course, golfers are under a legal responsibility for their acts if they strike another player with a ball. The cost of moving dirt today is quite economical. New construction, in particular, should never have a blind hole deliberately laid out. Existing blind holes should by all means be scheduled for elimination in the master plan.

A fine 18 hole golf course should be laid out on not less than 160 acres of ground, that is usable ground, exclusive of deep ravines, water or other obstacles which cannot be developed into fairways. Reduced acreage for a golf course greatly reduces the safety of the course. This also results in uninteresting back and forth parallel holes, and the consequent loss of interesting, or challenging features to the golfer. Therefore, where additional land is available, the master plan may recommend acquiring areas to spread out the course.

Closely related to the acreage of any given golf course is the length of the course. Most players will agree that a middle yardage of 6,500 yards will furnish a challenging round of golf. A course of this kind can be shortened or lengthened by 500 yards. This permits the use of red, white and blue tee markers; thus, spreading the wear on tees, and providing for the short hitters as well as the scratch players.

Fairway sandtraps should be placed far enough from the tee so that tee shots by the average golfer will not reach the sandtrap, while at the same time, the shot by the expert player will have to be carefully placed in order to avoid, or to carry the trap. In addition to the very precise location, the number of traps to be used also affects playability. Sandtrap should be situated around greens so as to pose a greater or lesser problem in regard to the length of approach shot to that particular green. Many times a golf course architect is asked to retrap an existing course so as to make it more interesting, but at the same time not to make it more tough. This is one area in the golf course master plan for improvement where the most substantial showing can be made, and for a reasonable cost.

We have considered how a golf course can be improved from the standpoint of maintenance, architectural quality and safety. Let us now consider briefly a system by which a golf course master improvement plan can be achieved, and the specific items required.

The first step in obtaining the information necessary for preparing a master improvement plan is to obtain a vertical aerial photograph of the existing golf course. This photograph should be enlarged to a scale of 1" equals 100'. It is best if the photograph can be a new one. It will then show all of the latest work which has been done on the course and any and all existing conditions.

A copy of this vertical, aerial photograph is utilized to produce a base map of the existing condition of the golf course. In other words, a black line print is prepared, showing the exact location of the clubhouse, entrance drive and parking space, features such as swimming pool and bathhouse, and the golf course including tees, fairways, sandtraps, and greens and all existing plant material. This base map is then brought to the golf course, and the entire golf course is carefully inspected by walking from each tee, through each fairway to each green. Careful notes are made in regard to topography, drainage, size and condition of tees, sandtraps, and greens. Notes are especially important in regard to the visility of all sandtraps and greens.

In addition to the physical inspection of the golf course, the golf course architect will confer with the owners and with the golf course committee, and with the golf course superintendent in regard to desired changes and revisions. Not until all of this basic existing condition information has been obtained can a proper evaluation be made of the existing course and proposed improvements. We now have factual information upon which to base our decisions and our proposals. Therefore, from the information thus compiled, we will now prepare a preliminary master improvement plan, incorporating as many of the improvement features as it is possible to make commensurate with the preservation of valued existing features. This preliminary master improvement plan is now brought to the club for evaluation by the committee and superintendent.

From this conference in regard to the preliminary master plan and the suggested changes or revisions to it, will emerge the final drawing of the master improvement plan. This plan will now show on one sheet in light lines the existing location of tees, fairways, greens and sandtraps, and in heavy lines the proposed changes and improvements. A colored rendering of the master improvement plan will be furnished which can be used for presenting the improvement program to the membership. We have now arrived at a point where the total improvements can be tabulated and a cost estimate made for each item. These can then be assigned priority numbers so that certain items can be selected to be done first and others at subsequent periodic time intervals.

The specific blueprints for any new greens can now be drawn for any particular hole with the full knowledge that this green will be the proper size, shape, and located in the proper position in relation to the master improvement plan. Design of additional sandtraps, addition of a new or enlargement of an existing pond, changes in size or location of tees, additional tree plantings, can all be specifically provided. Modification in the existing water system, or if needed, a new system can be designed in accordance with the proposed master plan.

Getting a program of this kind accepted in your club is not a simple, or easy procedure. Careful ground work must be laid and carefully drawn master improvement plans prepared, then your greens chairman and committee will be thoroughly prepared to furnish effective answers to all members who are concerned with the proposed improvements. Once approved there is absolutely no substitute for complete preparation such as I have outlined. A master plan can protect your schedule and provide effective continuity.

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RESEARCH REPORT

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

This audience realizes that our turf program has four components: research, teaching, extension and administration. This man's travel, speaking, observing, writing, grading tests, lecturing, taking data, maintaining records, writing reports and keeping budget and records straight. It means being busy, but it's my favorite job. I love it and appreciate the chance to work with you.

Current work on bluegrass varieties is being pushed very hard. We are going in two directions. We are wanting the close-mowed, the petite for front lawns and fairways. At the other extreme we need the vigorous, the aggresive for roadsides, athletic fields, and hard-wear areas. We have a good start and lots of work to do yet.

We have the machinery operating for certified Evansville bentgrass stolons. It takes cooperation of the six producers and five state certification groups to keep the process in order. But, for your protection a system is in use. Do yourself a favor and use the system to assure purity of vegetative strains of Evansville bentgrass.

We, with Ag Alumni doing the merchandising, sold Midwest zoysia to 52 purchasers in 15 states in 1963. Adequate supplies are available in 1964. It will be available from April 1 at $ 4.00 per square foot.

Only initial work is being done with a perennial ryegrass, originally observed by Lou Trapp of Dayton Country Club. It is most persistent and looks very encouraging.

Currently we are not doing much on *Poa annua* control. We have repeatedly told our arsenic toxicity story - that bluegrass and bentgrass tolerate arsenic, while *Poa annua* and crabgrass do not. I am encouraged by the possibility of light (1/2 lb. active, or 1 pint formulation/acre) use of Maleic hydrazide for reducing seedhead formation and excess vigor of *Poa annua*. Much more research is needed.

For years we have had continuing crabgrass control series of about 1000 plots/year. Weekly applications of standard rates proved that 6 weeks are normally available to apply the ten basic formulations now available from eleven chemicals.

Recent progress on knotweed control is excellent. Banvel-D at 1/2 to 1 lb. active/acre has given excellent selective control with good grass survival. It should be a boom to athletic and fairway areas.

Using repeated liquid Zytron sprays to slectively control nimblewill (muhlenbergia) continues to be the best available.

We need more work on creeping bentgrass killing in bluegrass lawn turf. Paraquat seems to be the best chemical to combine with vertical mowing.

Don Schuder has done extensive work in Entomology on sodwebworm control. He finds Dieldrin to be a preferred control.

Finally we have a spreader for experimental work that does a fine job. Empties completely, feeds uniformly, and by diluting a known volume we get 3 - 4 passes over the plot.

Nitrogen testing continues with five companies having experimentals - mostly soluble N blended into slow deteriorating pellets.

Continued work on calcined clays as a part of rootzones is needed. Our earlier data has served as a basis for widespread calcined clay trials and use. More new work is needed.

Always we work closely with machinery manufacturers to observe and test to some extent new machinery. Thatch control is getting a good discussion at this Conference.

Finally our interest in soil warming under turf is quite genuine. It's the next step for some stadiums and special areas.

Research - Yes, briefly I mentioned 16 research areas where we have activity and results. It's our way of working with and for you.

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REVIEW AND PREVIEW

Purdue Stadium

W. H. Daniel, Turf Specialist
Purdue University

In the early part of 1961 Red Mackey, a personal friend of many of you and Athletic Director at Purdue, asked me to develop an improved stadium turf. Well, two years before (in 1959) I had said "no" to the same request. This time new ideas were available. These included: vertical slitting, calcined clays, Newport bluegrass for fall vigor and vertical mowing. After spring practice in 1961 we planned to vertical slit, aerify intensely and overseed, but instead of 3 items we had 14 to do. Our subsoiling was too rough on the surface so we:

1. subsoiled and vertical slit on 36" or 18" centers,
2. top-spread about .5" of calcined clay on surface,
3. roto-tilled twice over,
4. raked and dragged and rolled,
5. and hauled off loosened grass,
6. and seeded on June 1, 1961,
7. and rotary hoed, over the seed
8. and surface spread calcined clay,
9. and kept moist,
10. and got weeds and turf,
11. sprayed to kill sedge and crabgrass 3 times,
12. and overseeded thin spots
13. and kept mowed high,
14. and then vertically mowed closer,
15. and mowed to 1.5" in September,
16. and got wear of games, which sealed them
17. then mud - for vertical slits were roto-tilled, so put in more vertical slits on 3' centers after season,
18. and spread crushed corncobs - 10 tons on field to aggregate soil and reduce crusting,
19. and got a good turf (2.5"/hr. infiltration at saturation) for 1962 and 1963,
20. then excavated to lower field for 1964.

<u>Series of Rootzone Building Steps to be done</u>

1. after excavating 8' down
2. slope silty clay subgrade 1%
3. cut tilelines 18" - 24" deep
4. place 4" tile 30' intervals
5. fill trench with pea gravel
6. place 2" sand over pea gravel
7. rip and loosen compacted subsoil
8. back in trucks - spread 6" sandy topsoil
9. subsoil and till to partially mix and remove compaction
10. spread 6" more sandy topsoil
11. and fertilize with 12-4-8, 800# acre
12. and peat (brown coarse) 500 cu.yds. (1")
13. and calcined clay 80 tons on 60,000 sq.ft. (1")
14. and till and disk in
15. and smooth to 1" slope 10" crown center to sidelines
16. and irrigate heavily to water settle
17. and when dry re-slope as needed
18. and sod
19. later fertilize with Ureaform 300 lbs. on 60,000 sq.ft.
20. and use arsenic toxicity to prevent crabgrass and to kill <u>Poa annua</u> that germinated in <u>nursery</u>.

We started sod with plugs in May 1963 as

alternate rows of Midwest zoysia pluts, and
vigorous bluegrass plugs

then, later fall overseeded with Merion, Delta, Newport blend. But, we had volunteer <u>Poa annua</u>, so started building arsenic toxicity in September 1963.

We would like to install automatic watering as built - not decided yet. We expect to put in vertical slits to remove excess water in late fall of 1964. We expect to put in soil warming cable in spring of 1965. There's lots to do - it is my hope to do the newest and most modern possible.

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BASICS IN PLANT PHYSIOLOGY

M. R. Teel, Director of Research, American Farm Research Association
West Lafayette, Indiana

The request for a short lecture on "Basics in Plant Physiology" for this distinguished Conference reflects the changing times. We are moving rapidly from the prescientific to the scientific age. Turf managers are moving their attention from the art to the science of grass management. They recognize the need for a more basic understanding of cell metabolism. In order to discuss "Basics in Plant Physiology" we must strip away the vines and branches which hide the framework of the system in question. We must penetrate to the depth of the cell and examine its components.

The most obvious of the cell's interior is the cytoplasm. A slimy substance adhering to the cell wall. In plants there are usually many fluid-filled droplets with distinct membranes called vacuoles. These droplets may be raw material, excretion products, water, or pigments. The vacuoles are thus important to the cell. The nucleus plays an important role in cell activity. It contains the chromosomes -- thread-like bodies of protein and nucleic acids intimately associated into complex substances called nucleo-proteins. There are two principle nucleic acids nicknamed DNA and RNA (deoxyribonucleic acid and ribo-nucleic acid) which have attracted scientists in this century. DNA seems to be the director of the operations, and RNA the messenger boy. These acids thus play important roles in cell duplication and inheritance since chromosomes carry the genes.

The nucleus is considered to be the control center of the cell, while the cytoplasm is the executive center. However, there is so much interdependence that we should not take this division too seriously; one cannot exist without the other.

What is so essential about the cytoplasm? This jell-like substance is highly organized -- containing many smaller bodies, variously shaped which perform many essential functions. We cannot discuss all of them, but we should become acquainted with the mitochondria. There are as many as 1,000 per cell. They are in constant motion. Recently Dr. Fernandez Moran, University of Chicago, dedigned a diamond knife so thin and sharp that he could cut human hair into 10,000 longitudinal slices (Science, May 27, 1963). With this device, he was able to cut a mitochondron in such a manner to expose the inner cavities. Their membrane is a double layer, the inner being greatly folded. The folds extend deeply into the interior. On these folds we find millions of tiny particles resembling small mushrooms on short stalks. These are presume to be packets of enzymes which carry out respiration reactions, releasing energy to the cell.

Another particle called the ribosome should be mentioned. It is so small that it appears as a mere dot under the elctron microscope. These bodies are believed to be the principal factories for protein synthesis. Both the mitochondria and ribosomes can be isolated by high speed centrifugation. By adding proper nutrients and raw materials to the suspensions, it is possible to study their roles. There are many other particles which might be mentioned, but due to space and time limitations we shall omit them, and consider briefly how some of the pieces of our puzzle fit together.

Life processes start with energy. The sun is the ultimate source. Carbon dioxide is trapped in photosynthesis and stored as sugars and starch. Thus, we have light energy converted to chemical energy. The plant has the unique ability to release this energy slowly ... in a form which cells can use. In this regard there are only minor differences between man and the grass he mows. Both take carbohydrate as a basic material and through a series of reactions involving complex phosphorylation reactions, convert the sugar to a sophisticated substance nicknamed "PEP" (phosphoenolpyruvic acid). This three-carbon sugar derivative is destined to be combusted to carbon dioxide and water in respiration. We are thus dealing with the mitochondria. To the mitochondria, present in practically every cell, flow the necessary raw materials, and from them emerges usable energy --- slowly - carefully regulated so that heat does not become a dangerous by-product.

The slow release of energy results from bonds between carbon atoms being broken one at a time. Without going into thermodynamics, let us trace the path of carbon from PEP to the mitochondria.

We note from our simplified scheme that PEP occupies a pivotal position. If the proper nutrients are supplied it is converted to pyruvic acid (pyruvate). With adequate thiamine (Vitamin B_1) and magnesium, pyruvate is reduced to a two-carbon fragment called acetate. This fragment is attached to another enzyme and delivered to the family of enzymes which act cooperatively producing the Krebs cycle. In this cycle the acetate is combusted to CO_2, the chief by-product of respiration. Water and heat are also by-products.

In order for the mitochondria to accomplish their work they must be healthy. Recent work in Australia with barley seedling root tips shows that they are sensitive to nutrient balance. For example, manufactured materials accumulate within their membranes under a potassium deficiency. Other research shows that their surfaces become encrusted with protein fragments. It appears that we have a new method of studying the influence of fertilizer ratios on plant growth.

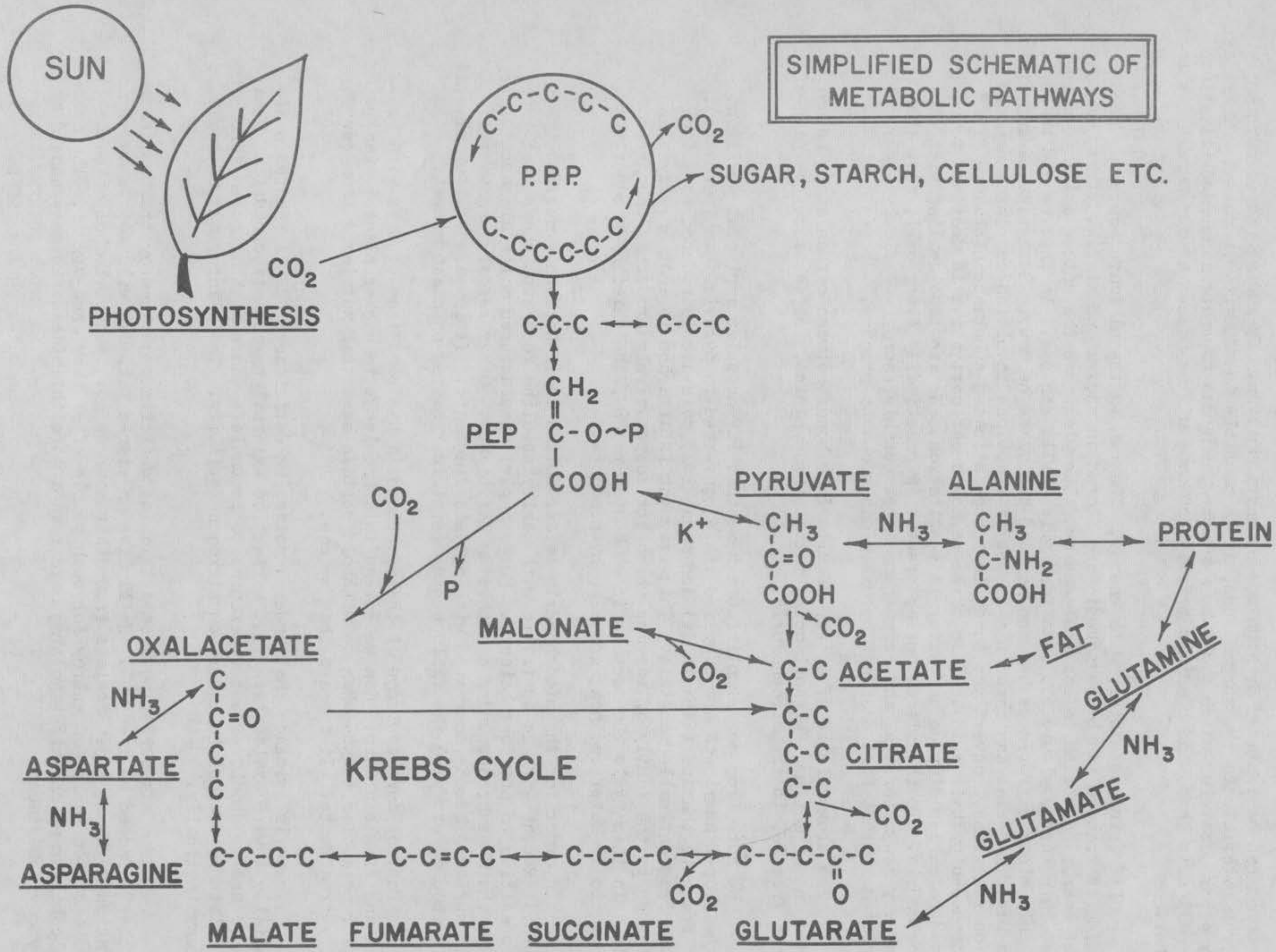
Most of our knowledge of the mitochondria has come from studies with bacteria and simple plants. Can we extend this knowledge to higher plants? Can we predict metabolic events when we withhold certain essential nutrients from our fertility treatments? It appears that we can.

There is evidence that under a potassium deficiency, PEP is shunted preferentially toward oxalacetate .... a reaction external to the mitochondria. When this occurs we should expect asparagine to accumulate under high nitrogen fertility, and malate to accumulate under low nitrogen fertility. The plant fixes CO_2 non-photosynthetically.

Would a man suffering from a thiamine deficiency get energy from sugars and starches? Indeed he does not. He'll live on stored fat, but will soon show signs of fatigue. He must get acetate from other sources .... ethyl alcohol often becomes a common source of energy for such people after they once try it. The number of alcoholics which suffer nothing more than a mere thiamine deficiency should be everybody's business.

Albert S. Gyorgi, famous biological scientist and Nobel prize winner, wrote

SIMPLIFIED SCHEMATIC OF METABOLIC PATHWAYS



the prefatory chapter in the current issue of the Annual Reviews on Biochemistry. He suggests that the difference between the pre-scientific age and the scientific age is well illustrated by the story of the two stones involving Aristotle and Galileo. Aristotle, who lived about 2000 years before Galileo, felt that a large stone would fall through space faster than a small one. It never occurred to him that he could test this reasoning by experimentation. To suggest such a thing would have been an insult. Galileo climbed the "leaning tower" and made history. Later on he discovered how to extend his eyesight by inventing the astronomical telescope. Dr. Gyorgi makes a great issue out of the fact that on the one hand we have a pre-scientific thinker, and on the other we have one of the first modern scientists. One had an humble attitude which forced him to challenge himself by experimentation.

Today we need both types of men as never before. We must have some devoted to thinking and some devoted to testing and developing. Each must be an humble man with a realization of our imperfections.

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TURF STRESS - COOL AND COLD CONDITIONS

James B. Beard, Assistant Professor in Crop Science,
Michigan State University, E.Lansing, Michigan.

With the advent of fall weather, gradual cooling of the earth's atmosphere and soil occurs. This cooler environment results in a slowing down of plant metabolic reactions and growth. During this period from late fall to spring, when soil temperatures are below 40° F., there are a number different causes of turf stress which can result in winterkill.

Winterkill is a term encompassing a large number of types and causes of injury. It is used loosely to include any type of injury that occurs during the fall, winter and spring period. These general types include the following:

A. Desiccation. This is a condition in which water loss from leaves exceeds water uptake from the roots. This is most common during periods when the soil water is frozen but the above ground portions of the plant are thawed and actively transpiring. Brown dried leaves and crowns are more prominent during open, mild winters, and especially on elevated, exposed sites.

B. Heaving. It is not a severe problem in turf compared to field crops. However, it can produce significant injury to newly planted areas where the grass passes through the winter in the seedling stage. In this situation the grass crowns are elevated above the soil and exposed to drying conditions.

C. Disease. The most common winter diseases of turfgrasses are pink and grey snow mold. They can cuase severe injury to turf, but are easily prevented by following a wise fungicide program.

D. Direct Low Temperature Injury. In this situation either extracellular, or intracellular freezing processes occur which result in fatal injury to the plant cells. This type of injury is common in annual ryegrass and perennial ryegrass in the Midwest.

E. Injury Associated With Ice Sheets. Winterkill associated with ice coverings is common in areas where sleet storms predominate and in poorly drained locations. It has been of major concern in the north central and north eastern United States.

A number of possible causes can be divided into two major groupings.

Type I. The grass is dead at the time of spring thaw.
Type II. Grass appears healthy, but subsequently dies.

The possible causes of Type I injury include:

1. Oxygen Suffocation Under the Ice Sheet: The respiring plant requires oxygen for maintenance of plant tissue even at extremely low temperatures. The ice sheet could impair oxygen diffusion to the extent that, in time, it might become limiting.

2. Carbon Dioxide Under the Ice Sheet: Even at below-freezing temperatures a minimum respiration rate exists. Thus, it is pcssible, in time, for killing concentrations of carbon dioxide, or for some similar toxic breakdown product to accumulate. Injury of this type has been reported in Wisconsin on alfalfa.

3. Outward Leaching of Vital Cellular Constituents While Submerged in Water During Thawing: On sunshiny days light rays will be transmitted through the ice and be absorbed by the opaque grass surface. It is possible that these absorbed light rays could heat the grass sufficiently to melt the ice surrounding them. This would result in a condition in which the leaves are incased in water with a heavy ice sheet still existing around them. This condition would be favorable for severe leaching to occur, and has been observed in small grains.

4. Outward Diffusion of Water from Leaves Incased in Ice: When leaves are incased in ice the relative concentrations of solutes is higher outside the leaf than internally, due to water existing in the solid phase. This could result in outward diffusion of water from the leaf in an attempt to attain equilibrium. If sufficient water is removed from the leaf, desiccation could occur. However, when the vapor pressures of water and ice are compared it appears that at equilibrium, sufficient water would not be removed to cause plant desiccation.

5. Direct Low Temperature Injury by Freezing Processes to the Cell Protoplasm: This is a mechanical injury to the brittle protoplasm caused by the formation of large ice crystals. This type of injury will be less in plants that are permitted to properly harden through dehydration or reduction in water content. Over-watering, excess fertilization, or any process which stimulates tender growth in the late fall, should favor susceptibility to damage.

Possible causes of Type II injury include:

6. Direct Low Temperature Injury by Freezing Processes to Plants which are in a non-hardened State Due to Premature Spring Initiation of Growth: The grass may survive the winter in excellent condition. Subsequently, the weather may turn extremely warm for three or four days, resulting in a premature loss of hardiness and increased hydration within the plant. If this is followed immediately by a severe drop to below-freezing temperatures, direct low temperature injury may occur.

7. Injury to Vital Crown and Root Tissues of the Plant from Mechanical Injury by Ice Crystals: The original injury would be destruction of the cellular protoplasm in the lower crown tissue due to ice crystal formation. Cross-section of the grass crown shows a browning of the lower crown and roots. The grass plant will appear on the surface to be normal. Plants with severely injured crowns may not be capable of producing a new root system fast enough to meet the water uptake requirements of transpiration. Under these conditions the plant will die of desiccation as drier, warm days come.

Characterizing The Injury

In the spring of 1962 detailed studies of injured turfs in Michigan showed most injury occurred to Poa annua with a minimum of injury observed on the creeping bentgrasses, or Kentucky bluegrasses. The grass appeared healthy and green at the time of spring thaw, but with the advent of higher growing temperatures severe injury occurred.

Microscopie examinations of individual plants showed severe injury to the lower portions of Poa annua crowns. The original cause of this injury was destruction of the cellular protoplasm particularly in the vascular bundles of the lower crown tissue due to ice crystal formation.

Causal Studies

In the fall of 1962 studies were initiated at Michigan State University to determine the actual cause or causes of winter injury associated with ice sheets. Common Kentucky bluegrass, Toronto creeping bentgrass and Poa annua were permitted to harden naturally in the field. On November 26 four inch plugs were collected and placed in wax-coated cartons. Five treatments were applied.

a. Flooding followed by freezing. The treatment was designed to simulate conditions of a heavy rain and the accompanying flooding which was followed by immediate freezing. The resulting ice cover was 1/2 inch thick.

b. Freezing then layering with ice. This represented conditions of a freezing sleet storm which gradually produced a 1/2 inch thick ice layer over the frozen turf and soil.

c. Freezing and layering with ice over snow. One-third inch of snow was applied to the frozen plug followed by 1/2 inch of ice.

d. Freezing in an ice block. The vegetation was sealed in an ice block by completely submerging the carton containing the grass plug in a gallon container of water and freezing.

e. Submerged in water. The carton containing the grass plug was submerged in one gallon of water and held at 35° F. rather than freezing as in the above treatment.

The first four treatments were held in a 25° F. cold chamber for the duration of the experiments while treatment 5 was held at 35° F. At fifteen day intervals,during the 90 day period, replicated samples from each variety and treatment were removed from the chamber, thawed, placed in a 75° F. growth chamber, and evaluated for injury.

Results of this study showed bentgrass to be highly resistant to the three types of ice cover for the 90 day duration of the experiment. A significant amount of injury was produced by ice sheets on annual bluegrass and Ky. bluegrass from the 75th to 90th days, but exceeded 50% in only one instance. Where injury had occurred in the field in association with ice sheets complete kill has usually resulted, while in this study complete kill was not even approached by the various types of ice coverings during the 90 day period. The increasing injury from the 75th to 90th days to Ky. bluegrass and annual bluegrass indicates that oxygen suffocation, or toxic accumulation may produce more severe injury from periods of ice coverage longer than 90 days. However, under field conditions ice coverings in excess of 60 days are rare.

In addition, no significant injury was produced from submergence in water, indicating that outward leaching of cellular constituents into the water was of no importance at near freezing temperatures.

Table I. Survival of Grasses after having been Subjected to Five Treatments.

Treatment observation	Observed after flood, then freeze (25°F)	Freeze then layer with ice (25° F)	Freeze then layer with ice over snow (25°F)	Freeze in ice block (25°F)	Submerge in water (35°F)
days	%	%	%	%	%
			Bentgrass		
30	100	100	100	100	100
60	100	100	100	100	100
75	100	100	100	30	100
90	100	100	95	10	100

Table II. -

			Bluegrass		
30	100	100	100	60	100
45	100	100	100	0	90
60	100	95	100	0	90
75	100	70	90	0	85
90	75	40	75	0	80

Table III. -

			Poa annua		
15	100	100	100	100	100
30	100	100	100	0	100
60	100	85	100	0	100
75	90	60	98	0	95
90	50	50	95	0	90

These results suggest that certain combinations of freezing and thawing, especially in association with high tissue moisture contents during the thawing of ice covers, may be of more importance in winter injury of turfgrasses than the more direct effects of ice sheets, such as oxygen suffociation, or toxic accumulations.

Factors in Freezing Injury

Under field conditions the grass plant can survive winter conditions as long as the vital meristematic tissue of the crown is not injured. Severe injury can occur to the leaf tissue, but it is of no great consequence. Much kill occurs during periods of freezing and thawing when the grass plant is in a reduced state of hardiness. It is caused by destructive freezing processes within the plant. Six factors control the frost killing temperature in grasses.

1. Degree of plant hardiness. A hardy plant is one which is in a reduced state of hydration, or water content. The processes occurring within the plant during hardening include a reduction in growth, a conversion of insoluble carbohydrates to soluble sugars, an alteration of the proteins, and a subsequent reduction in the water content.

2. Rate of freezing. Killing may occur at a higher temperature if freezing is rapid rather than gradual.

3. Rate of thawing. Greater kill occurs if thawing is rapid.

4. Length of time frozen. Greater kill may occur after long continued freezing.

5. Number of times frozen. Kill may occur after two or more freezings at a temperature which fails to produce injury after one freezing. However, repeated freezing and thawing does not always cause injury.

6. Post-thawing treatment. Kill may increase after thawing if the plant is exposed to unfavorable conditions, particularly drying. Death may not occur until days, or even weeks after thawing.

Management Factors in Freezing Injury

Bentgrasses can survive temperatures 5 to 10° F. lower than Poa annua. In addition, they are more resistant to injury from ice covers. Other factors which increase the chance of injury include:

1. Poor surface drainage. It has been observed that where concentrations of water occur kill is greater. Also, removal of ice sheets from putting greens has reduced kill.

2. Poor internal soil drainage. It has been noted that kill is greatly reduced where the cups were most recently changed and on newly constructed greens. Kill was most frequent on the heavily compacted areas. Here again poor internal soil drainage impairs removal of water from the immediate area of the plant crown; thus, increasing the hydration level and the chance of kill.

3. Excessive thatch. Thatch, where excessive, elevates the vital plant crown above the soil. In this condition theplant crown is subjected to much lower temperatures than if it were in the soil. Also, thatch holds excess moisture near surface.

4. Potassium deficiency. It has been reported on a number of crops that potassium increases the winter hardening characteristics, including the grasses.

5. Close mowing in late fall. Individuals who permitted their fairway turfs to grow some during late fall noted less injury. This practice may aid proper hardening of the grass plant through accumulation of carbohydrates as well as serving as a protective mulch.

6. Late fall nitrogen fertilization. Late fall fertilization at temperatures which permit grass growth will stimulate late vegetative production and in turn reduce the level of hardiness through increases in the plant water content.

7. Premature spring nitrogen fertilization. Applications of nitrogen fertilizer too early in the spring will stimulate vegetative production; thus, increasing the chance of kill should a severe, late freeze occur. It will also adversely affect the plant's survival should it's root system be severely injured by earlier freezing processes.

8. Excessive late fall watering. Have adequate, but not excessive soil moisture.

Additional research is needed to clarify the conditions which do produce injury to bentgrasses and thus assist in completing our understanding of winterkill causes in turfgrasses.

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WETTING AGENTS -- THEIR ACTION & EFFECTS

Robert Moore, Pres., Aquatrols Corp. of America,
Camden, New Jersey

This opportunity to explain the action and effects of soil wetting agents should tell what a wetting agent is, some of the differences between them, and how they affect water in soil. A wetting agent is a surfactant -- a peculiar group of materials that are very active at surfaces (1). In this group are detergents, emulsifiers, and, of course, wetting agents. Their difference is primarily moleeular weight and chemical structure - much like a Chiquaqua and a St. Bernard are quite different even though they are both of the canine family. One very important difference in these materials is that they can be ionic, or non-ionic. The original research showed that non-ionic materials were preferred because of their safety to living plant materials and micro-organisms. As an example, many ionic materials are used as scouring compounds and germicides, and others are very toxic to plants.

The non-ionic wetting agents usually consist of an alkyl, and an aryl group of differing molecular weights, either as an alcohol, an ester, or an ether. These materials act in such a way that part of the molecule is water soluble and part is water insoluble. This strange behavior causes the attractive forces of water, which are exceptionally large, to be tremendously reduced. A few thousandth of one percent will reduce these forces by more than 60%.

To first explain their action in and on ~~soil,~~ let us look at a flat surface with a drop of water standing on it. The attractive forces of water tend to pull it up into a ball. We've all seen this on the leaves of our grass. A wetting agent lowers these forces, and increases (if the insoluble portion is correctly chosen) the spreading attraction of the water over the surface (2).

Now let us look at a small pore in the soil - untreated soil that is! We will see that the attractive forces of water will cause a bridging over these pores and inhibit downward or sideward movement. It then becomes necessary to increase the weight of water (filling the large pores or saturating of the soil) before enough pressure is created to rupture this tension and force the water through the pore.

What happens in treated soil? With very little attractive force, bridging does not occur and the water readily wets the sides of the pore and moves downward and sideward without saturating. Data from Penn State University (3) shows that water passed through the entire profile at field capacity in one hour in a loam soil treated with a blended soil wetting agent. In contrast, the untreated soil was wetted to only one-third its depth and was above field capacity in this limited area. After 80 hours this untreated soil still had excess water now located in its lower profile due to a perched water table effect.

So much for the action of soil wetting agents. Let's have a look at their effects! Recent work from Texas A & M (4) bears out that there are vast differences in commercially available wetting agents. Some materials were only effective for one irrigation; some only worked in one soil; some didn't work at all. What is desired is a material that lasts for many irrigations and works in all soils and soil mixtures. The improved infiltration and movement through treated soils contrasted with water backing up in untreated soils reduces infiltration, and decreases the percentage penetrating with time. Core samples show this effect on treated and untreated halves of a green. A picture taken the day after irrigation showed better and more wetting. Note the depth and uniformity of moisture in this core from the treated area (15 inches versus about $1\frac{1}{2}$ inches).

Infiltration alone is not the answer. Letey of U.C.L.A. (5) pointed out: "---the soil treated with the (soil) wetting agent became wet much more uniformly throughout the entire core compared to the untreated soil in which moisture moved through in channels rather than in a uniform pattern." In this slide we see deep but very channelled wetting on the untreated half of another green, as compared to the deep and uniform wetting of the treated half. Infiltration was good, but uniformity was poor without the soil wetting agent. These drier areas can lead to poorer roots and localized drying, or disease under times of stress.

But once again infiltration and uniformity are not the complete answer. Soils treated with a blended non-ionic wetting agent hold water at a much lower tension. Another paper from Texas A & M (6) showed moisture content versus tension in the soil. The area under the curve represents the energy the plant must exert to obtain water (and, therefore, nutrients) from the soil. We feel that this conservation of energy is related to some of the cell structure improvements in the plant leaves that you'll see a little later. The immediate and definite benefit is an increase in the time between irrigations. Penn State (7) and Cornell (8) data with tension blocks showed a 100% increase possible -- we suggest only a 50% increase. In a year's time these lower tensions can save considerable water and labor (generally estimated at 30%).

So far we have seen an improvement in the infiltration, transport, uniformity, and availability of moisture in soils treated with a soil wetting agent. Let us now go to the recent work done at Yale University by Harry Meusel (9). This work studied the effects that soil wetting agents, watering practices, and fertilizers had on the wilting, appearance, internal cell structure, and stomatal openings of Poa annua. A color slide from this work shows the pots from one of the replicas.

A closeup showing the more compact growth and slightly better color with the wetting agent is shown in the next slide. Minus "W" means no wetting agent - the one refers to infrequent watering (once a week) and the N-1 refers to one pound of added nitrogen per month. A top view even more clearly showed the good tight turf and darker color in the wetting agent treated soils. Incidentally, these tests were conducted using a mixture of sand and vermienlite in an effort to avoid introducing added variables from the soil.

These treatments were all allowed to naturally wilt. General conclusions from this work showed that frequent watering (6 times a week), representative of a rainy period, increases wilting. Fertilization at this time aggrevates the situation. The use of wetting agents gave a very significant increase in resistance to wilting. You may wonder at the length of the grass. The grass was clipped at 1/2 inch twice weekly for 12 weeks, and then allowed to grow for 8 days.

The wilting characteristics of these grasses was also checked in a wilting chamber where effects of light, humidity, temperature, and air movement were studied. The order of wilting was verified with those that were allowed to die naturally, ie.,

1. Frequent watering and fertilizer
2. Frequent watering
3. Frequent watering, fertilizer, and wetting agent
4. Infrequent watering
5. Infrequent watering and fertilizer
6. Frequent watering and wetting agent
7. Light watering, fertilizer and wetting agent
8. Light watering and wetting agent

It is evident again that frequent watering, or a rainy period, increases the susceptibility to wilt, and that fertilizer tends to aggrevate the situation. The soil wetting agent, on the other hand, has the effect of slowing wilt under all conditions.

From each set of pots of grass, blades were picked at random before the wilting test for leaf impressions and cross sectional studies. By studying the cell structure of the grass blades under the microscope, it became evident as to why the plants reacted as they did. We will now look at a series of these cross sectional slides.

The first slide shows infrequent watering, no added fertilizer, and no wetting agent. We see a very compact cell structure, very little intercellular air space (about 1%) and small epidermal cells.

Next slide shows the cross section of frequently watered grass, no fertilizer, no wetting agent. Note the less compact cell structure, the increase in intercellular air space (20 to 30%) and the larger epidermal cells.

The final slide in this group shows the frequently watered grass, plus fertilizer, but no wetting agent. Note the very poor cell structure, large intercellular air space (50 to 70%), and large epidermal cells. Actually, these mesophyll cells were so weak that many were torn by the microtone blade. Try to remember these pictures as we now move to the next group.

The infrequently watered grass, with no added fertilizer but with wetting agent in the soil, gave the same good looking compact cross section, with very little intercellular air space (1%). Though the cellular structures were the same, the soil wetting agent increased the time before wilting by 100%. This is due to the low tension and more available (lower energies) water that was discussed earlier.

The next slide shows the cross section for frequent watering, no added fertilizer, but with the wetting agent. Note the continued good compact cell structure, almost no increase in air space (5 to 10%) and fair epidermal cells.

The final slide of this group shows the frequently watered grass, plus fertilizer, plus the soil wetting agent. Note that we have lost only a little of our cell structure. The mesophyll cells are still quite turgid, little or not tearing is evident. This extra turgidity of the cells was very evident in all samples of grass where the wetting agent was used. Again, intercellular air space has increased, but only to 20 - 30%.

The next four slides show these same points again, but at a higher magnification. Here we see the weak, easily torn cells and large air space for frequent watering , plus fertilizer and no wetting agent. Next, we see the same, but with the wetting agent and we see more turgid cells, less air space, better defined epidermal layer and a very definite improvement in cutin layer. Next is infrequent watering, plus fertilizer, and no wetting agent. With the soil wetting agent we again note a more turgid cell structure and a heavier cutin layer. This opening here in the epidermal layer is a stomate, which brings us to the closing part of our story.

As you know, or may have surmised by this time, water is lost from the mesophyll cells into the intercellular air space (hence the desire to keep this at a minimum) and then evaporates from the blade of grass through a mouth-like opening called the stomata. Leaf impressions of the underside of the grass blade from frequently watered shows large size epidermal cells with respect to the stomata. Impressions of infrequently watered grass show stomata of the same size, but the epidermal cells are more compact -- actually twice as many per stomata. Fertilizer had no effect on this ratio. The wetting agent tended only slightly to further increase the number of epidermal cells per stomata (a move in the direction of decreasing wilt). A chemical control of this stomatal opening was recently found. On an unirrigated fairway in July, after 25 days of no rain, the <u>Poa</u> has gone out, the bluegrass is going dormant, the fescue has stopped growing. On the treated half grass still had to be mowed.

In closing, I would like to summarize by listing the following points:

1. Soil wetting agents lower the tensions of water and permit a more rapid and more uniform infiltration, transport, and drainage.

2. Soil wetting agents lower the soil moisture tension and, thereby, increase the availability of water and nutrients.

3. Lower tensions decrease the frequency of watering; and less frequent waterings improve the <u>wilt</u> resistance of grasses.

4. Soil wetting agents decrease the intercellular air space in grass, and, thereby improve the wilt resistance of the grass.

5. It is significant to note that the poorest grass wilting and cell structure-wise was the second best looking grass. The best grass was grown with infrequent waterings, added nitrogen, and soil wetting agents.

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SEED - A CHANGING STORY

Gager T. Vaughan, Pres., Vaughan's Seed Co.
Downers Grove, Illinois

A few years ago I spoke to this group on the subject of the supply and prices of the various turf seeds. As you know, price of seed is higher in 1964. It goes without saying that if the supply or crop is poor that the prices will be higher, and if in surplus they will be lower than a year ago, but in either case there is not much you can do about it. It may be nice to know why exactly, but you probably won't remember the production figures anyway. And you will be pretty safe if you tell your Grounds Chairman that you are paying higher prices than last year for seed because the crop was poor. And, if prices are lower it's because you are a good buyer and shopped around and saved the club money. What I thought might be of interest to you was the changing of production areas, varieties and specifications of seed that you might purchase.

First of all, let's take the most famous of all grasses, Kentucky bluegrass. It was only some 30 years ago that almost all of the seed came out of a small region around Lexington, Kentucky from pastures that were let go to seed. Seed was stripped, cured in drying yards and threshed and then sent to cleaning mills. Purity of this seed generally ran around 80% with germination of 70% and a weed content of 1/2 to 1%. I believe it was in the late 30's that harvesting started to move into the Iowa, Missouri and Nebraska area, and it wasn't long before that region dominated the production because of generally higher yields. The Midwest regions have yielded up to 40 million pounds of bluegrass seed per year. In recent years much of this area has been declining in production, and the main production in the late 40's and early 50's moved into South Dakota, North Dakota, Minnesota and surrounding areas. Here the seed was generally heavier in weight and generally of higher purities, and by this time a purity of 85% and germination of 75% was considered standard seed.

The big problem in Midwest production has been the tremendous variation in production with figures on production varying anywhere from 2 million to 40 million pounds in different years, and you can, of course, see why we have had quite some gyrations in seed prices from year to year. The yield on seed from pastures in the Midwest generally averaged only around 50 lbs. per acre, so the cost of gathering this seed is relatively high in labor cost.

With the advent of new varieties of bluegrass it was necessary to produce seed on land that had had no bluegrass grown on the land, so, of course, it was necessary to find new areas. This is how the West Coast, particularly Oregon and Washington, got into the bluegrass business. The first large acreage started with Merion bluegrass and yields in the Northwest have averaged around 250 lbs. per acre.

Instead of a by-product of a pasture, seed of bluegrass in the West is generally grown in rows and cultivated as are most crops. In this manner weed content is generally much lower for West Coast grown seeds. Also, becase of special handling, germination is generally higher - anywhere from 80% to 90% with an average of most varieties at around 85%. There are now, of course, many new varieties being grown on the West Coast and production has been estimated this year at around 12 to 15 million pounds with a larger acreage coming up next year.

The heaviest seed producer at the present time is the variety Newport on which a thousand pound per acre yield is not uncommon compared to, as I said previously, a 50 lb. per acre yield in the Midwest. I believe you can see where the production is going to end up unless something unforeseen in the way of diseases or insects shows up in the next few years. Because of the weather conditions and more moisture out West, in these regions production is much more stable on the whole, so we will probably not have as wild gyrations in price as we have had in the past.

Because of the way the seed is grown the standard seed coming off the cleaning mills generally runs to a purity of 95 to 98%. With so much seed coming from these regions the difference in price between 85% purity and 98% purity has narrowed down considerably in recent years, and I predict that before not too ong the standard purity on bluegrass, except Merion which is much harder to clean and by its nature lighter in bushel weight, will be 98% with a germination of 80% or better in comparison to our present standard of 85% purity and 75% germination.

Actually today the best buys in bluegrass are the higher purities. To find which are the best buys you should use the pure live seed basis of figuring, i.e., multiplying the purity times the germination, and then using that old algebraic formula -- For instance, if an 85 purity and 75 germination bluegrass is offered at $ 45.00 per 100 lbs., it has a pure live percentage of roughly 64% (85 x 75 = 64%). Seed of 98% purity, 80% germination has a pure live seed content of 78% (98 x 80 = 78%). Then, if you use that old formula most of you I'm sure remember, i.e., if 64% seed is worth $ 45.00, then 78% seed is worth X - (64:45 = 78:X), then 64X = 3510 and X = $ 54.80. In other words, the higher purity seed is worth about $ 9.80 more per 100 than the lower purity seed. Today you canbuy this higher purity at less than that spread - generally at not more than $ 6.00 per 100 lbs. You will also generally receive a much lower weed content and stronger seedlings in the higher purity seed.

Now going back a step, while the West Coast was building up in production, we also had a new factor on the market - European production. Production in Europe rose drastically because of low production costs and high yields in Holland and Denmark. This year these countries will export to the United States close to 15 million pounds of seed. Generally this seed runs from 85 to 90% purity and 80 to 85% germination. We have one or possibly two main problems with European production and this is the problem of annual bluegrass with both the Dutch and Danish seed, and *Poa trivialis* with the Danish seed. There are also some areas on the West Coast where annual bluegrass is a problem, but in most areas it is not too serious as yet.

Frankly we need more test work before saying how serious a problem a 1/4 of 1/2% of annual bluegrass in a seed is. There are those that argue that Merion, or Kentucky bluegrass will crowd it out in average lawns, and those that argue that the amount of *Poa annua* seeds already in the soil are so profuse that a little more won't hurt. I'll let Dr. Daniel answer this one for you. If you want seed without it you should so specify when ordering. In most states the analysis will have determined if *Poa annua* is present, but the label will not show the presence of *Poa annua* because it is not recognized by law as a noxious weed and doesn't have to be listed.

Even Blue Tag Merion can be loaded with Poa annua as it is not noxious. If you want seed without it you would have to specify Blue Tag without Poa annua, or bent, and insist on analysis. Sod growers and large purchase landscapers may be particularly interested in pure seed stocks for use as overseeding on infested golf courses.

What varieites of bluegrass will finally dominate the market is too early to say at present as it takes many years of testing to be sure, but there are many varieties coming on the market. Probably only 1 in 100 will get very far and most will fall by the wayside. Currently several turf researchers recommend a blend of bluegrasses. Our Company and several others blend Merion, Newport and Delta; plus maybe Park, common, or private varieties. As far as other turf seeds are concerned, the changes have not been so dramatic as with bluegrasses.

The biggest change in production has occurred with Creeping Red Fescue as much of the West Coast production has gradually switched to Pennlawn fescue. So far there seems to be nothing coming along to challenge Pennlawn, although there is certainly room for improvement here.

Penncross bent, has, of course, increased greatly in production this last year, and the price at present is the lowest we have seen, so its use will undoubtedly increase.

As far as the ryegrasses are concerned, there are a few new varieties coming on the market and Dr. Daniel will have to appraise you of their qualities from time to time.

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NOTHING HAPPENS UNTIL SOMEONE SELLS SOMETHING

Wade Stith, Manager, Lynde & Rowsey Nursery
Muskogee,Oklahoma

For several years our good friend, Dr. Bill Dnaiel, and I have visited together at turf meetings over much of the U.S. He has asked me to speak on this program about some of my experiences of trying to sell the ideas, programs and systems for turf improvement by vegetatively planting new grasses.

We find most people want a turnkey job. They feel they need a guarantee. Often they have failed in their own attempts to plant grasses. Many times undesirable grass selections have been planted. And, they want to have quick results.

In selling an improvement program much time is involved. Repeated calls must be made. Individuals of the board must be sold, and sometime well-meaning club members can "sure muddy the water." During the planting there is much phone calling and hand-holding necessary, and as a manager it is very frustrating to have planting jobs sold and then be unable to complete work in a satisfactory manner.

In our experience Bermuda is least difficult to transport. Bemtgras is quite hazardous. Often for our work the bid seems high. Often there are no specifications which are common knowledge to those purchasing and those installing. Nevertheless, all of these problems have led to many satisfcying experiences. It has not been easy to take the ideas available from research, to develop your own equipment, and to incorporate these into a contract production program for the varying conditions found on golf course.

There have been outstanding successes. We find we must seek business over a wide area because of the special nature of our contract planting. Again may I say, nothing happens until someone sells something.

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NITROGEN: YESTERDAY AND TODAY

H. B. Musser, Professor Emeritus, Penna. State Univ.
Executive Director, The Pennsylvania Turfgrass Council

The importance of nitrogen in the economy of turfgrass management demands that every possible effort be made by those who must use it, not only to understand its function and use as a fertilizer, but also to be alert to every development which may affect the fertilizer program that has been adopted.

Recognition of the need for a systematic program for the use of nitrogen on turf is evidenced by published observations and reports of critical tests over half a century. The earlier efforts were confined almost entirely to the use of a limited number of materials, most of which contained nitrogen in a soluble, quickly available form. Because of the quick response of grass to such materials, the practical problems in using them, and the almost total lack of critical studies of their effects, wide variations occurred in early recommendations and programs advocated for their application.

Recognition of the difficulties and limitations involved in the use of these materials stimulated a continuing search for products better adapted to turf production. As a result of careful observations and interpretations of performance under practical conditions, the natural organics (seed meals, manures and processed sewage sludge: came to be recognized at an early date, as valuable additions to the group of materials available as sources of nitrogen.

The development of the Ureaform plastics, following the 2nd World War, made available a third class of materials which differed in certain characteristics from those used in the past. This created added problems in attempting to devise good programs for nitrogen use. And, it further emphasized the need for critical studies of the characteristics and best methods of handling the various materials, and stimulated the development of projects at Agricultural Experiment Stations and other research institutions to obtain the needed information on them.

The progress and accomplishments of these efforts are illustrated in the accumulated results of 5 series of experiments conducted at the Pennsylvania Agricultural Experiment Station over a 10 year period. These studies, together with similar ones at other places, have provided much needed basic information on the response of turf to the various forms of nitrogen and have helped to provide a better understanding of how they can be used most efficiently.

Today's most effective programs for the use of nitrogen on turfgrass recognize the basic differences in the total nitrogen content of different products, the rate at which it normally becomes available from each, the conditions which may modify its action, and the necessity of correlating all of these things with rates and frequences of application. The development of a good program for its use will take into account the influence of such things as the kind of grass and intensity of management, soil and weather conditions, severity of wear and other sources of injury, irrigation practices, and other factors which are likely to affect normal turf growth. All of these things have a bearing on the way grass will respond to any given material. And, adjustments of specific programs always will be necessary, regardless of the type of material that is used.

The increasing popularity of and demand for the more slowly available forms of nitrogen have resulted from recognition that their use entails a far less delicate adjustment of applications to the many conditions affecting nitrogen supply than is required when programs are based primarily on the use of quickly available forms. But, at the same time it whould be recognized that each class of materials has its limitations. Although we recognize that even moderate quantities of the quick-acting forms may act too fast; in contrast, the response to natural organics and ureaforms may be so slow, that, unless large quantities are applied, there will not be sufficient growth stimulation from them to produce the desired results.

Recognition of this fact has led to the use of combinations of slow and quick acting materials, to compensate for the limitations of each. At the present time many fertilizer manufacturers are offering products of this type. They are receiving general acceptance, and when mixtures are in the right proportions, they are doing a good job. The best information available at the present time indicates that the total nitrogen they contain should be in the ratio of about three parts coming from slowly available sources and one part from quick acting materials. There is some modification of this when mixtures are prepared which contain only natural organics and ureaforms. In such cases the ratios used are about one part of nitrogen from the organic material to two parts from ureaform. It should be emphasized that any program for the use of such materials must be based on definite knowledge of the exact proportions of each type of nitrogen they contain. Products labeled only as "containing organic nitrogen" or "ureaform" are always subject to suspicion.

The most recent development in the field of nitrogenous fertilizers is the attempt by the fertilizer and chemical industry to control the rate of release of nitrogen from the cheaper inorganic materials by the use of coatings, or by combining them with substances that resist decomposition. Some of these are being produced commercially in limited quantities, and several Agricultural Experiment Stations are making critical tests of them. At the present stage of our knowledge of their performance they should be used with caution. Their ultimate value will depend on whether they can give us the gradual release of nitrogen which is becoming so generally recognized as being desirable for turfproduction, and whether they can do it more economically than the materials available at present.

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KEEPING A TIGHT BENTGRASS TURF

Norm Kramer, Supt., Point O'Woods C. Club
Benton Harbor, Michigan

I have been asked to present my program of trying to improve our fairway conditions at Point O'Woods Golf and Country Club near Benton Harbor, Michigan. Briefly, here is what brought about the change and what we did about four problems.

1. The main problem was compaction
2. Air and light drainage
3. Fertility level
4. Strain of grass

1. COMPACTION. We grew crops of knotweed and crabgrass like you have never seen before. What brought on the compaction? This piece of property was in most places a solid wood, with tall trees, underbrush and vines. This resulted in clearing, with large equipment, 69 acres for fairways, tees and greens. Besides clearing and leveling with large equipment, the most damaging work was rotating to a depth of from 10 to 14 inches mixed in the blue clay and subsoil. After this we had cement - not topsoil.

What did we do? The first year program of aerifying with coring spoons was started in 1958, and we used the same program as in 1959. The third year we did the same, but we were not able to improve on our establishment of bent. Meanwhile, we had worn out two aerifiers and 8 sets of coring tines - it seemed an impossible task. By the spring of 1962 we could see some definite results from the aerifying program, but not enough.

Let's go back to #2 - AIR AND WATER DRAINAGE. Due to the fact that it was a thick woods with underbrush, we started to clear out all brush and vines. Then, the man above took over and the elms started to die, and up to now 800 or more have been removed to further reduce the shade and air drainage problem. We still have many trees, but comparatively good air and light drainage, which has helped reduce compaction problem for the soil can dry out now.

3. THE FERTILITY LEVEL was low. After a soil test I went to a typical 12-12-12 analysis at the rate of 400 per acre in the spring of 1959, and followed this through the season with urea 45% at the rate of 100 lbs. per acre during June, July and August, and back to 400 lbs. of 12-12-12 in the fall. This program remained the same in 1960 and 1961. In 1962 the levels of potash and phosphate were built up, so I changed and went to a 2:1:1 ratio fertilizer at the rate of 350 lbs. per acre, continuing with urea and back to the 2:1:1 in early October. My program was the same in 1963.

Now, this brings us to the one thing that was hard to sell to the board - the strain of grass which I wanted to change. When constructed the entire course, except the greens, was planted in Highland bent - even the roughs. Due to the soil and drainage problems the Highland did not adapt to the area. The greens had been seeded with Seaside bent, which was doing a very fine job of adapting to soil conditions. After proving my point with the board, the next step was to find a tool which would prepare a seedbed, plus cultivate and help break up compaction. After looking at the machines that were available and making sure it would do the job, I decided to purchase an Aero-blade and a sweeper. May I further remind you that this may not be the program for your particular area, but I feel for incorporating the seed in established turf, plus getting rid of any thatch problem you might have, this method seems to be the finest available at the present, plus the slit will stay open during the winter months.

Time - 1962 - third week in August
1963 - third week in September - result - less wilt in September

1. Make certain soil moisture content is just right - reason - if too wet the machine will not bring up any soil. If it is too dry the grass will tend to wilt easily.

2. Mark the fairway valves with dolimitic lime so that valves are easily seen and not hit with the slicer.
3. Slice fairways with machine.
4. Broadcast seed over sliced area - we applied Seaside bent 30# per acre.
5. Drag mat with piece of chain link fence 22 ft. x 10 ft. long
6. Sweep fairway to pick up grass clippings
7. Mow
8. Water. The first time make certain you have soil moisture content as close to full field capacity as possible when you finish watering. Continue to keep areas moist to get good germination.

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MAINTAINING A TIGHT BLUEGRASS TURF

Donald Clemans, Supt., Norwood Hills Country Club
St. Louis, Missouri

There are five points of significance in my maintenance program: fertility, mowing and watering practices, selective herbicide program, fungicide program and thatch removal.

Fertility: I seem to be prejudiced toward a 2:1:1 ratio fertilizer for my fairway fertilization. A broadcaster type spreader has ease of application and is time saving so that 18 holes can be fertilized in less than five hours. Since this is possible, I can pick an afternoon, say before a weather front moves past with rain, fertilize the fairways and have it watered in on the same day.

The first application of fertilizer is applied about April 1, and may or may not need to be watered in by irrigating. At this time I apply about 1 pound of actual nitrogen, plus $\frac{1}{2}$ pound of P & K per 1000 sq.ft. Very shortly after spring, summer arrives, rapidly warming the soil, but the air is now what might be termed "hot." Neither situation is optimum for the growth of bluegrass, to say nothing of the fact that this also is the most competitive part of the growing season.

The second application is applied about 8 weeks later, by about July 1, at the rate of $\frac{1}{2}$#N/1,000. The soil moisture is very likely to be a critical factor at this time. Therefore, more than likely I will try to irrigate immediately. This application method takes longer, but it pays off in eliminating turf damage.

The early fall application is applied by September 1, and again may or may not need to be watered in by irrigating. The soil has been warmed by the sun all summer and will retain the warmth for some time. Now the plant has an environment which is optimum for growth and should last 8 to 10 weeks.

My late fall application is $1\frac{1}{2}$ lbs. of N and $\frac{1}{4}$ lb. P & K. I feel that the plant has a greater ability to utilize the additional fertilizer best at this time. This brings the seasonal total to 3 lbs. of N and $1\frac{1}{2}$ lbs. of P & K.

MOWING: First, I feel that the mowing height should never vary from $1\frac{1}{4}$ inches. I maintain this height by mowing fairways at least 5 times per week. The average golf course 18 fairways should contain between 40 to 50 acres. I found that with two 7-gang mowing units that my fairways could be mowed in about 4 hours. By mowing this often I always had the grass plant maintained at a near constant height. Also, the size of the individual leaf clippings are small and they will filter into the turf, leaving little or no debris on the surface.. Another advantage of small clippings is that it becomes possible for the clipped grass to get next to the soil more easily and speed up the decay process and thus cause less thatch accumulation.

WATERING: Water, in my opinion, should be used as a maintenance tool to insure against drouth and thus maintain active growth. Obviously, soil and water holding ability of the soil on every golf course differs. But, in my case it was necessary to water some fairways with good moisture retention only 6 times a season; yet, others needed 12 or 15 irrigations. There is no way to say that you should water every given number of days.

SELECTIVE HERBICIDE PROGRAM: The broadleaf weed control program was based on a "home-brew" mixture of 2-4,D Amine and 2,4,5-T. I always use 1 lb. of 2,4-D per acre, and vary the 2,4,5-T from none to 1 lb. per acre. And, I always treat both the fairways and roughs. Dandelions and buckhorn are not too hard to control.

Knotweed is a different type of problem. By timing the application so that knotweed is in the two leaf stage (in late April) satisfactory control can be gotten. Meanwhile, the bluegrass was able to grow, thicken and begin to compete. In all applications a wetting agent was used to enable greater leaf surface wetting, and sprays applied with a 21 foot front mount boom.

The next phase of selective herbicide control was a crabgrass control program. I prefer a Tri-calcium arsenate program because of its fine residual effect. Once crabgrass control was established, annual additions were made at one-fourth recommended rate in the spring with success. With control of broadleaf weeds, knotweed, and crabgrass, my fertilizer program was benefitting the desirable turf only.

FUNGICIDE PROGRAM: My attempt here is to control leafspot on bluegrass in late spring and early summer. Anything that weakens the turf in the spring will undoubtedly affect its ability to withstand the stresses of summer. One season two applications of Parzate, plus iron sulfate, were used. This material was sprayed from a boom jet nozzle covering 40 feet at a time. This allowed us to treat all fairways in 6 hours. Another season I used one application of Acti-dione RZ, plus iron with the same equipment. Each season will determine the number of treatments needed. But, I feel confident even one application times properly is of great benefit.

THATCH REMOVAL PROGRAM: On bluegrass a thatch removal operation is preferred before the early fall fertilization. This process allows the fall fertilizer to get into the ground readily. It also makes watering and fall rains much more effective by decreasing run-off. If there are any thin spots in the fairways they are seeded at this time with a 50% Delta bluegrass, 50% Common Kentucky bluegrass mixture. Briefly, the operation has been to thatch, broadcast the seed, drag with a chain-link fence mat, and then remove the thatch. By fertilizing and watering immediately after I have had good germination in 7 to 10 days. Even if seeding is not necessary, thatch removal is beneficial. I have observed new growth and tillering from this severe vertical mowing operation. I have been thatching as deeply as possible which in my case is about one inch into the soil. This really does a root rhizome cutting job, and completely covers the existing green grass with thatch and soil.

This whole series of programs have proven successful to me; yet, I'm always looking for ways to improve them.

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KEEPING TIGHT TURF - BERMUDA GRASS

Ernie Schneider, Supt., Bellerive Country Club,
Creve Coeur, Missouri

Several years ago most of your criticism regarding long or fluffy turf came from your professional golfer. Today even the 100 shooter wants to play on closely mowed, tight turf. We are spending more time and money maintaining tees and fairways today than we are on greens. This was not true in the past.

I believe that a good mowing practice is essential to well-groomed fairways. Our mowing starts early in the spring for we do have a weed problem, such as Poa annua, chickweed, etc. These, of course, come on before the Bermuda greens up. The height of cut is as low as the mowers can be set. This height is maintained throughout the mowing season, from April 1 to November. One of the most important things in mowing Bermuda turf is to mow often, three to four times a week. I usually try to mow when the grass is reasonably dry, to get a good scattering of the clippings. There is nothing more unsightly on fairways or tees than a heavy cutting of clippings.

Three years ago I tried out a set of five-gang, ten-blade mowers. At first I was unhappy. It had more clip per inch, pulling them at the regular speed as we did our other mowers; it would raise up; the back roller would come up off the turf; then when the roller came down it would bite into the turf, making an unsightly cut. After we got rid of our thatch and slowed the speed of the tractor, it did a beautiful job. This mower is much heavier, has more tension on the back roller, which enables it to cut a little closer than a six-blade reel type mower. We pulled them a whole year before we bought them. I try to get over all the fairways at least once a week with this ten-blade. This mower gets more of a workout than the six-blades as it is cutting somewhere at all times.

To maintain good tight turf thatching is important. We had a very dry spring in 1963, less than a half inch rainfall during April and May. June was normal; July and August excessive moisture, and the fall was exceptioally dry. I only thatched three times this past season due to this unusual weather. I thatched in April, June and August. When used the thatching machine is set as deep as possible. This enables us to tear out thatch, dead as well as live material, and also cultivate too. We are trying to create a healthier turf by slitting and tearing - you are making the grass start new shoots. In the grooves where this cultivating action takes place the grass is healthier and is a much brighter color. After thatching,all loose material is picked up by a sweeper, and hauled away. Then, the fairways are cut with the ten-blade mower and swept again. The following day they are cut again, and this gives a real smooth appearance.

After the fairways are de-thatched, they are fertilized -- the first time with a 2:1:1 ratio, at the rate of 300 lbs. per acre. I fertilize three more times during the season with Urea 45. Each application provides one pound per 1,000 sq.ft. - just enough fertilizer to keep the grass in good color. With this fertilizer program I do not get a lush, fast growth.

The winter of '62 and '63 was one of the most severe that Kentucky has ever had. Also, we had below normal rainfall. Fairways at Big Spring County Club came through in fine shape with less than 5% winterkill. Also, we had less spring deadspot than noticed the previous year. Zoysia is plugged in damaged areas. At times I wish I would have had watered fairways. To me this would have been very important last year and this year both going into the winter season on the dry side.

Now that I have mentioned a fairway watering system, I think that I should tell you that I do not believe in over-watering Bermuda. Once every three weeks, if we do not have rain, is usually sufficient. This past season a water system would have come in very handy when I wanted to spray for weeds. After I thatched and fertilized in April, there was an invasion of crabgrass in some areas, but I had to wait for a sufficient amount of moisture to do the spraying. From past experience, spraying when it is too dry does discolor the grass and retards its growth. For control of the crabgrass I still have the best results by using disodium methyl-arsonate with 2,4-D, and I have increased the amount of wetting agent. The rate used - "on the hot, dry side for turf", and 4 ozs. of 2,4-D and 1/2 gallon of wetting agent to 150 gal. tank. I try to spray on a Monday when the crabgrass has had a chance to get some leaf growth over the weekend. Then, I usually cut these areas on Wednesday, and repeat the spraying on Thursday -- I come back the following Monday with another spraying. With this method I have always had real good results.

This may sound like a lot of work to you, but the members of Big Spring Country Clud would not trade their U-3 Bermuda fairways for any other type of turf. Good tight turf makes any golfer's game more enjoyable.

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THATCH AND RENOVATION EQUIPMENT

W. H. Daniel, Professor, Dept. of Agronomy
Purdue University, Lafayette, Ind.

During this Conference you have had several presentation on thatch and its control. Without a doubt there is still much to be learned.

Currently over 20 models from over 12 manufacturers are designed to rake, comb, pull, or cut thatch, old leaves, new leaves, runners, etc., from near the soil surface. Our 1963 Field Day report characterized equipment into 3 groups, depending on their action and speed of operation -

1. High speed - rigid blades - cuts whatever touched.
2. Slow speed - rigid blades - combing and pulling.
3. Slow speed - flexible - combing and pulling.

Manicuring

Manicuring is the grooming of growing plant parts. It is usually light, frequent, partial and cautious. Manicuring should not interfere with the use of the area. It may be intended to just thin out the crabgrass; thin back the creeping bent; take out the old dead leaves of bluegrass; smooth up the uniformity of the area.

On bluegrass this is most frequently done in mid-fall. On Bermuda and Zoysia it may be as the grass is growing vigorously.

Rejuvenation

Rejuvenation could be similar to renovation, but is less drastic. In rejuvenation the idea is to provide room for new growth, remove competition, to give the grass another chance. For this reason cutting into the soil may be desired, cutting through the rhizomes, the runners, the thatch; bringing soil up on top of the existing grass. And, definite thinning - up to 50% removal of grass may be desired.

Generally fertilizing at the same time is also favored. Sometimes overseeding may be added. Generally rejuvenation should be done under favorable weather conditions- not when there is unusual plant stress already present. In either case above, there is one key idea. There should be green growing points remaining after the renovation is completed, otherwise brown areas may be too severe and extensive.

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WHAT IS ENOUGH?

Ernie Schneider, Supt., Bellerive Country Club
Creve Coeur, Missouri

In 1959 my front yard was planted with a mixture of Tifgreen and Sunturf Bermuda. I maintained this as a putting green at a 5/16" cut. By the next spring this was a beautiful piece of turf. That year I fertilized it as it needed it, but the following year I kept the turf very lush, using 16 lbs. N. per 1,000 sq.ft. That winter I lost 90% of this putting green. I plugged it with the same kind of turf - by August it was back in shape. From then on, I watched my rate of nitrogen. The winter of '62 and '63 was very severe,but there was no loss of turf. Every spring I would de-thatch it very severely, removing all the dead grass and stems down to the ground. This putting green received a lot of traffic from the neighbor children, caddies, etc. It had six putting cups in it. I received a lot of newspaper publicity from this lawn, then many inquiries and calls from persons wanting a backyard putting green. When I would mention that it had to be mowed every other day, this would discourage most of them.

I try to encourage people to thatch grass at the proper time - bluegrass in the late summer or early fall, and Bermuda and Zoysia grass during the early spring just when it greens up. I know of an instance where a man thatched his Zoysia lawn heavy in the fall and seeded it to ryegrass. The next year his Zoysia did not recover until late in the summer due to the severe thatching so late in the season.

On the golf course I thatch the Bermuda fairways on the average of three times a year, but never later than August. I mow 3 to 4 times a week. I think that is sufficient for well-manicured turf.

Whether you are a homeowner, or you make your living maintaining turf, the problems are increasing. Some of the southern weeds and grasses are moving farther north and vice-versa. In the past few years I have found creeping lovegrass and dallisgrass on the golf course - one from the north and one from the south - where they came from I do not know.

The cost of controlling weeds and insects in turf can be expensive. For preemergence material, the two which I have had the most success with on both small and large areas, have been calcium arsenate and granular chlordane. I have areas on the golf course where the residual was good for four years on Bermuda and bluegrass, with one application of calcium arsenate at the rate of 10 lbs. per 1,000 sq.ft. on the Bermuda and 15 lbs. on the bluegrass.

As far as granular chlordane, I have had wonderful success preventing goosegrass in greens. I have used it on bent and bluegrass for the past four years, and I have seen no damage - only near perfect control There have been some reports of damage from other areas where this chlordane was used -- I have not seen this myself.

I did have one puzzler. To control chickweed and crabgrass we applied calcium arsenate to two lawns - one neighbor across the street and one next door to me. Both were applied in September - one received no control, and the other was perfect. The neighbor who received no control gives his yard good care with regular fertilization, etc., and the other is rather haphazard about his lawn care. I do know the material was applied properly as I put it on myself. (Editor's note: Heavy fertilization builds up phosphorus to high availiabity which over-rode arsenic toxicity. On unfertilized lawn arsenic was toxic since less phosphorus was present.)

I often puzzles me as to how much really is enough - whether it be fertilizer, insecticides, or herbicides. I have had many excellent results, and some not too good.

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GREENS - MY IDEAS

John McCoy, Supt., Cincinnati Country Club,
Cincinnati, Ohio

The theme of this morning's Conference is - "Turf, Ready for Use." From the previous speakers you have heard thatch discussed and how superintendents keep a tight fairway turf with different grasses. I have been asked to express my ideas of keeping a tight turf on greens through management and the use of topdressing.

In the majority of cases today the golf course superintendent arrives at a course knowing little of its construction or maintenance history. It has been designed by an architect, built by a constructor, and probably been maintained by one or several different superintendents over a period of a few to many years. Whenever a superintendent takes over a new or different course, he faces a breaking-in period of two or more years before he intimately knows his new course. First, he must know the type of maintenance the club desires, and then he must make his plan of operation.

Most golfers desire a putting green that is smooth, dense, or tight, upright in growth, disease-free, uniform in color both as to individual greens and throughout the season - one that is free of grain and one that will hold a well-played ball. Putting speed of greens varies with different clubs,depending on type of play, or rather players. With these requirements how are we to plan our maintenance program to produce greens meeting these conditions and carry it out without undue interference with the players?

Watering is probably the hardest and yet the most important job to accomplish. Grens vary much in structure, in soil, in contour and in type of grass. I prefer hand-watering of greens in early morning. We use sprinklers also, but not in critical weather periods. Water should never be applied faster than the soil will absorb it. Too wet a green will cause the turf to lay flat, which is a start for mat or thatch formation, as well as other troubles. I have never been able to solve over-watering the center of a green when using sprinklers - that being the main reason I prefer hand-watering.

Fertilization is another very important management practice. I do not believe in pushing greens to a fast growth in early spring when growth is naturally fast. We hold off fertilizing the putting area until the early lushness is gone. I prefer dry applications to liquid applications of fertilizer because I can secure a more even application and use materials with slower nutrient availability. I use frequent light applications, the materials and analysis of my choosing. Sewage sludge, ureaform, sulfate of ammonia, and muriate of sulfate of potash are the principal ingredients; the sulfate of ammonia being used in very light amounts.

The amount of elements used is varied to suit seasonal and weather conditions. I believe that some readily available phosphorus is desirable for short cut turf. Also, that it is better to apply ureaform fertilizer in several light applications per season rather than in one or two heavy applications. Light fertilizer applications do not promote rapid growth, but a very uniform growth pattern which is favorable in keeping thatch from forming. May I add that our fertilizer applications are made with a rotary spreader powered from a light garden type tractor. The spreader is very easy to handle and gives a very uniform spread with our mix.

Vigorous brushing of greens is very important,and along with regular cutting helps keep grain and thatch from forming by pulling up blades and runners. I do not like brushes attached to a greens mower for this work. I prefer flat steel wire brushes separately mounted on a two-wheel type tractor. Our brushes are 4 ft. in width, 4" thick, with 5-inch long wires. The brushes are mounted behind the power wheels. An adjustable castor wheel behind the brush controls the pressure put on the brush, and also raises the brush for transport. The best brushing is done when the wires are kept in a nearly vertical position. With this type of equipment one man can brush greens faster than three can cut. Early morning brushing before cutting removes dew and when fertilizing we try to do it immediately after brushing.

In my program topdressing is a must. Topdressing should be done frequently, at least six times a season, with light applications and throughout all the growing season. Topdressing will improve putting by keeping the turf tight. It helps reduce disease by applying fresh soil material at the soil surface. It aids in decay of organic matter by giving soil bacteria a place to work as I don't believe they work in organic matter above the soil line. Topdressing maintains present soil characteristics, or can gradually modify soil structure, depending on the mixture used. Root growth is deeper. There is less wilting in hot and humid weather. Also, air and water penetration being improved.

I prefer about one eighth cubic yards of dressing per 1,000 sq.ft. of putting surface per application; the material having been screened before applying so that all material can be worked into the surface with no tailings to be removed. With mechanized operations, a power spreader, power driven brushes to work the topdressing in (the same brushes used for brushing at other times) twenty greens can be topdressed in six hours. Cut after topdressing and lightly watered, the greens are in very playable condition. In cool weather greens are cut after topdressing and before watering; in warmer weather watering precedes cutting. By using two brushes on a green and varying directions of each operation, a mower is starting to cut a green as the spreader is finishing applying topdressing to that green. Two or three times over the green with the brush incorporates this amount of topdressing in a tight green.

Vertical mowing is a help in preventing thatch formation, but it does not work into my program. It is a slower operation than brushing and I consider it a means of correcting a thatch condition more than in preventing it. It may disturb putting to the point that players complain.

Aerifying helps in maintaining subsurface soil conditions and thus aids in thatch control through better growth conditions. Any method of aerifying produces a roughened putting surface. To my mind the time greens need aerifying most is in late May or early June after they have been compacted during the usually more moist spring season by humans and equipment. This is also the hardest season of the year to accomplish this work. I have long felt that the best type aerifier for use in spring or summer was the drill type as it disturbed the putting surface less than punch types, either with open or closed punches or spoons. A light brushing and a cutting after drilling left a good putting surface with little or no complaint from players.

Another management practice is use of fungicides and insecticides. Following my program as outlined, disease and insect control are relatively easy. My main idea here is to apply in concentrated form. I never apply over two gallons, generallyless, of a fungicidal and insecticidal mixture per 1,000 sq.ft. of green, including collor or apron, and never water it in. I can see no reason for applying diluted solutions. It is not difficult to train an employee to apply this amount if you select the proper type of equipment.

The ideas I have mentioned have produced for me greens that the players like. Our cutting height is a nominal 1/4 inch, a height my Chairman does not want changed and the height remains the same throughout the season. Frequent light applications of fertilizer maintain a uniform growth, and the grass has a healthy appearance and good color at all times. Topdressing keeps a tight, smooth surface with good ball holding and putting qualities free from grain and thatch. Disease prevention and control are kept at a minimum. All operations are performed with the player in mind so that they can have an enjoyable round of golf at all times.

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GREENS - SOME OBSERVATIONS

James L. Holmes, Mid-Western Agronomist
U.S.G.A. Green Section

The periodic loss of some turf on putting greens is becoming less of a problem yearly. More technical data is being made available and golf course superintendents develop superior maintenance skills. At most clubs in the Midwest, members can expect to play on adequate putting surfaces at all times during the playing season. We have progressed considerably in construction methods of putting greens which include design, soils, technical abilities and knowhow in using the information we have.

As a result of information derived from sound research and continuous observations, reputable and knowledgable architects and builders now insist upon constructing greens so that adequate surface and subsurface drainage is accrued at all times. This drainage includes both water and air. Specific information in this regard is available as a result of work done here at Purdue with soil additives, and research sponsored by the USGA Green Section.

In order to assure proper drainage, the relationship between capilary, noncapilary and total air space must be properly determined for each specific soil used. Where greens have been constructed with drainage principles protected, turf has developed well and observations indicate that it will be possible to maintain adequate putting surfaces at all times with a minimum of "headaches." It has been determined that water infiltration rates between 1/2 and 1 inch per hour, when the soil is compacted, are optimal by USGA Green Section recommendations when using only soil, sand

and peat. It is important to note that this infiltration rate must be assured even when soils are compacted. This is paramount because putting green compaction is an extremely serious problem and one which has caused the golf course superintendent considerable chagrin.

If one is to be assured of a proper infiltration rate, or an infiltration rate which can be effectively controlled, a perched water table relationship is essential. In perching water tables, one must be extremely careful that excess water is not held. If so, the infiltration principle is destroyed. It has been my observation that if one does not use the proper percentage of sandy materials, it is usually better to use no sand whatsoever; but, rather simply use the soil present and construct greens so that surface drainage is assured. I have observed repeatedly that greens built with native soils produced excellent putting qualities for a number of years. Therefore, if the entire concept of the sandy soil construction is not followed - exactly - I suggest that the native soil present on the building site be used. Naturally, I am aware that numerous authorities on this subject would violently disagree. Nonetheless, this has been my observational experience.

Overwatering, or water-saturated soil conditions continues to be one of the most serious problems in maintaining greens which cannot or do not drain. If all the technical improvements currently known are incorporated when greens are constructed or rebuilt, this serious factor will become less of a problem. When one considers the tremendous amount of work done and equipment used to "aerate" green soils, he immediately becomes aware of the necessity for and lack of drainage - both air and water. Perhaps we are guilty of throwing out the baby with the wash water.

Developments in improved bentgrasses have been extremely slow since the results obtained from selections made in the pie green work sponsored by the Green Section. At the present time the majority of grasses used for putting greens are still those developed in this testing work. Developments in this field are limited primarily to Penncross bentgrass. However, new selections, such as Evansville, are being released and I believe it is only a matter of time until superior bents are available.

Poa annua is the last serious weed problem in putting greens. Of course, there is always the question of whether *Poa annua* is a friend, or foe. I believe as a result of the severe damage done to *Poa annua* during recent winters, this plant must be considered a foe in this part of the country on putting greens. Presently work is being accomplished in enzymatic control of various plants. Surely, it is only a matter of time until we can eradicate *Poa annua* without running the chance of seriously damaging desirable bentgrasses.

Many golf course superintendents continue to apply lead arsenate, or calcium arsenate to putting surfaces in an effort to retard *Poa annua* vigor as well as grub and worm-proof the soil. It is my opinion that this is an excellent practice.

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HOW BLUEGRASS DEVELOPS

Tim Gaşkin, Warren's Turf Nursery
PalosPark, Illinois

When a bluegrass seed falls on the ground, either naturally or through a seeder, it starts the cycle of development of a bluegrass plant. There are various stages of development of bluegrass from the seed to the flowering plant. There are also changes through the seasons in a mature bluegrass sod, such as leaf development, rhizome production, flowering, etc. All of these occur year after year. Each of these factors contribute to the development of a bluegrass sod and to the appearance of a bluegrass lawn.

Development of a Bluegrass

Most bluegrass seed, when it first fall from the seed stalk, or is harvested in the seed field, will not germinate. It is alive, but dormant. That is, given the proper treatment and conditions it will germinate and produce a seedling. These conditions are either letting the seed age for several months, or a period of alternating hot and cold conditions when the seed is moist. The reason for this is to prevent the seed from germinating as soon as it falls to the ground in July. Then the conditions for germination and establishment of a seedling bluegrass are very poor with hot weather and periods of drouth. When the warm days and cool nights of fall come, the seed will germinate when conditions are the best for establishment of bluegrass plants.

When the seed germinates a primary root is formed which penetrates the soil, and first one and then later leaves will be formed. If the seed germinated in the fall, the cold weather of winter will stop further growth. At this time, the young seedling will consist of several tillers (usually three) each with 2 to 5 green leaves.

In the early spring additional tillers will be formed. Leaf growth will increase. Before June or July, the rhizomes will start to grow. The plants must be of a certain size before rhizomes will be produced. Usually about two rhizomes are formed. These will grow undergound and then come to the surface and produce new crowns. The new leaves and these rhizomes will increasd the density of a stand of seedlings which may look thin in the fall.

The warmer weather in summer may slow down growth of both rhizomes and leaves. This is one of the reasons why bluegrass lawns appear the poorest and why diseases cause the most problems during July and August. Very hot and very dry weather will stop growth completely and the grass will turn brown. Root growth is best when the soil temperature is about 60° F. and stops at 80° F.

As the days get cooler, bluegrass beings to grow again. This a period of less leafgrowth as compared with rhizomes growth. New rhizomes are formed from the old rhizomes. Many new rhizomes are developed during October of a normal season. The rhizomes formed at this time do not form new crowns by growing upward to the surface, but stay below the ground until spring.

In the spring there is a flush of leaf growth, as described earlier, some form new tillers and some from the new crowns produced from rhizomes developed in the fall. Unless the shoots or tillers flower (as described later) the cycle of growth of leaves and later rhizomes occurs year after year in bluegrass sod, although in old sod fewer rhizomes are produced.

Leaf

The leaf of the bluegrass is the organ which comprises the most visible part of turf. After all, a lawn is just a collection of grass blades and tillers. Each tiller has about 3 green leaves. Leaves are formed in the spring about every 10 to 12 days. In the summer there is a new leaf every 17 days; the fall every 19 days; and winter about every 81 days. These figures are, of course, easily altered by a change in the weather. After the leaves first appear, they will grow during the summer for 3 weeks. After that, the leaf will be green for another 6 weeks in a normal season. One can see why a bluegrass lawn takes so much mowing in the spring and summer. The leaf blades in the spring grow successively longer, and in the fall the leaves as they are produced are shorter than the next older leaf. This is apparently related to the length of day.

Another effect of the length of day is that in the summer the shoots and leaves are upright, while in the winter the leaves and shoots are spreading and decumbent. Also, the number of shoots is greater in the winter or shor days, even in controlled climate chambers. The length of day also will determine when the flowering will occur.

Leaves may last 9 weeks in the summer. Shoots and tillers, which are composed of leaves, grow until the shoot flowers in the early summer,and after the seed is ripe the shoot will die. Since not all shoots will flwoer, those that don't will grow for one more season - they rarely last longer.

Rhizomes

The rhizomes or underground stems have two functions. One is to allow the plant to spread vegetatively. This occurs mostly in the spring and summer. The second function of rhizomes is as a storage organ. Various studies have shown that following leaf growth in the spring, there is storage of reserves in the rhizomes. The same thing occurs in the fall when there is little leaf or shoot growth and food is stored in the rhizomes for the winter. The rhizomes in the summer are longer, and stay underground longer than those in the fall. It has been reported that rhizomes will not grow to the surface if the air temperature is below 50° F., while the best temperature for root and rhizome growth is 50° to 60° F. One half the rhizomes formed in June will emerge by fall; the rest will emerge the following year.

Flowering

Everyone has seen bluegrass flowering on roadsides and in waste areas, and others have noticed flower stalks of bluegrass in lawns in May before the mower cuts them off. These flower stalks are the result of a process that started in the previous fall. During the cool, short days (less than 9 hours of daylight) the flowering stalk was initiated in some of the tillers of the plant. Only about one-third of the mature tillers will produce flower stalks. Instead of a vegetative bud which would produce more leaves in the spring, a bud is formed which will produce a flower stalk. The time of the winter this flowering bud is formed depends on the variety. Common Kentucky bluegrass usually has about half of the flowering buds formed by the middle of December, while in Merion that stage is reached by the end of January. Of course, Merion flowers in the spring later. As the weather becomes warmer in spring, the flower stalks elongate and by May the plants are in flower. If the plants are mowed the stalk is cut off and the base of the stalk, which is not cut off, usually dies. These dead stalks and some short flower stalks, which for some reason or another are not mowed off, detract from the appearance of the lawns at this time of year. Newport, a heavy seed producer, is noted for its numerous seed stalks even under turf conditions.

Two weeks after the flowering stalk appears, the plants flower. These plants shed pollen from 5 A.M. to about 10:00 A.M., unless unfavorable weather checks the flower's opening. The seeds are mature when the flower stalk turns yellow.

The process of the development of the seed need not concern us here except that in the improved commercial varieties of Kentucky bluegrass, the seed is produced asexually through a process called apomixis. This means that almost all of the seed (95%) or more) is exactly like the parent plant. They are the same as if you divided the parent plant into two plants. Thus, these strains are quite pure, much purer than many field crop seeds.

Environmental Factors

There are several things that a person can do which will affect the number of rhizomes and tillers, or shoots. Naturally, one would want the greatest number of tillers for the best appearing lawn, while a large number of rhizomes will allow turf injured by diseases or insects to recover quickly.

Fertilizing as is well known will increase the growth of lawns. As can be seen by the chart, the number of both rhizomes and shoots increased with fertilization. However, nitrogen fertilization increases the shoots and leaves relatively more than the rhizomes.

NO. SHOOTS AND RHIZOMES PER 1 SQUARE FOOT

			No Fertilizer				Fertilized*			
			Unmowed		Mowed**		Unmowed		Mowed**	
Shoots	1939	July	368		279		603		789	
		Aug.	395		221		543		816	
		Sept.	300		306		643		817	
		Nov.	300		294		706		924	
	1940	April	429	360	334	285	776	654	1405	950 Average
Rhizomes	1939	July	254		279		35		390	
		Aug.	286		321		366		401	
		Sept.	236		306		414		407	
		Nov.	252		294		498		447	
	1940	April	256	255	333	306	443	351	423	418 Average

* $NaNO_3$ at 200 lbs. acre April and July 1939.

** 1 inch cut

From "Kentucky Bluegrass" Ohio Sta Bull. 681, 1949.

Mowing will also increase the number of shoots and will increase the number of rhizomes where one doesn't fertilize. In fertilized lawns there is no increase in number of rhizomes; in fact, close mowing (less than 1 inch) reduces the relative number of rhizomes per shoot.

There are many other factors (rainfall and irrigation, disease, insects,etc.) which will affect the growth of bluegrass. The kind of bluegrass is important too. These must be taken into account in developing a lawn program.

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RESEARCH FOR BETTER BLUEGRASSES

C. W. Lobenstein, Dept. of Plant Industries
Southern Illinois University, Carbondale, Illinois

Much progress is being made in the development of techniques for maximum performance of presently available turfgrass varieties. However, for continued advancement in turfgrass culture, improved varieties are essential. This is especially true in the case of Kentucky bluegrass. We could take the view that present varieties are adequate if properly managed. We could also say that present model cars, tractors, and mowers are adequate. This does not cause us to turn away from still better designs, or improved performance -- there is always room for improvement.

One phase of our work at Purdue is seeking improved Kentucky bluegrass varieties involved making some specific measurements of the rates of growth and sod formation by several different selections. Most of the selections had come from patches in established mowed turfs. They had formed denser, thicker turfs than the common types. The principal question we tried to answer was, "What characteristics do these types have which permit their superior performance?"

In some cases the selections were lower growing. Perhaps they flourished because of less injury from low mowing. Surely all potential varieties for fairways should be evaluated for this feature. Some were not attacked as severely by the more damaging fungous diseases. This remains a major goal in new varieties. Other selections were very aggressive and formed sods over larger areas much more rapidly than common varieties inspite of severe disease attacks and upright growth habits. The increased rate of spread and sod formation resulted from production of greater numbers as well as increased length of rhizomes.

In four separate tests nine test selections produced, by growth from single shoots during periods of 120 days or more, an average of one new rhizome per day. This represented slightly more than 3 inches linear rhizome growth per day. In the same tests Merion and three Common types averaged only 0.3 rhizomes, or approximately 3/4 inch rhizome growth per day. Comparisons of the average number of newly emerged shoots per day showed almost 3 times as many for the 9 vigorous selections. Differences between Merion and the other standard varieties were generally not significant.

Measurement of the area occupied by growth from single tillers during the summer of 1962 showed an average for the 9 experimental clones of 16 square inches for 120 days and 50 square inches for 180 days. Average for the Merion and Common types were 6.3 and 28 square inches during the same periods. Initially the Merion types had slightly larger numbers of shoots per unit area, but at the end of the first year's growth, sods of aggressive types were generally as thick as Merion.

The observed differences in rhizome development appears to arise from variations in the physiology of the plants rather than from structural or morphological differences. Results of this study suggest that such aggressive types have the capacity to accumulate greater energy reserves more rapidly and possibly with more limited foliage area. Such possibilities need to be examined on a larger scale because of the implications regarding mowing practices and disease problems.

Studies of regrowth into barren areas in 3-year old sods showed that the virorous types maintain their aggressive characteristics even in mature sods. While the measured differences were not as great, they were still threefold, or greater than Merion or Common.

The superiority in rhizome growth and recovery potential observed in this group of experimental selections could imply several possibilities for the future development of improved bluegrass varieties. Should not rhizome potential and rate of sod formation be weighed more heavily in evaluation of new varieties? Does greater rhizome development permit certain types to escape or recover more rapidly from disease attacks, or mowing injury? May satisfactory stands be established with lower seeding rates? Will sod fields regenerate more rapidly after cutting? If apomixis and other plant breeding problems prevent introduction of greatly improved varieties from seed sources, is the possibility of establishment by vegetative means completely unrealistic for certain areas?

For the many varied turf situations and geographic locations in which Kentucky bluegrass is expected to perform, I personally doubt that one single variety can ever be found to fill the entire bill. Maximum performance in most field and vegetable crops has usually been due in part to the use of specific varieties for certain areas, or conditions. Why should we expect our crop of turfgrass to be different?

Finally, the results of this study and subsequent observations lead to the conclusion that the potential for more satisfactory bluegrass varieties just from selections of naturally occurring Kentucky bluegrass ecotypes is still very great.

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RESEARCH IN BLUEGRASS

Charles D. Berry, Graduate Student
Purdue University

The question is, "What should be done?" There are so many ramifications to be considered that one must pick a phase and move forward with it. Myself, being interested in genetics and in re-combining of attractive characters exhibited by various sources, would like to approach it by controlled cross-pollination. Now, your comment could be - "what good is cross-pollination going to do for everybody knows bluegrass is highly apomictic." Most bluegrass populations are highly apomictic, but clones are being found which reproduce sexually. When found these can be included in breeding programs, possibly crossing with apomictic types in order to reclaim the apomictic character to stabilize any segregates which are found having the desirable characteristics. We have set up an ideal circumstance, but how will we recognize these plants that are products of cross-pollinations? For this one must have genetic markers, or highly heritable characters which can be recognized in the individual arising from such cross-pollinations. To do this, tests must be made of the heritability of various characters.

In my/Master's program during the winter of 1963, 15 selected seed sources were planted in mass in greenhouse containers from which 100 individuals of each source were selected at random quite carefully and planted in individual four inch pots. The 1440 seedling plants were carried to the field on May 10, 1963 where they were planted in an 8 replicated, randomized, block design, as space plants on 2 foot centers. These were then maintained at 2" cut to compensate for the soil mounding under space planted conditions, with 1 lb. of actual nitrogen per month fertilization, and with watering when the least drouth tolerant showed the characteristic black color when wilting starts due to moisture stress. To round this out the grasses were maintained under as uniform and desirable management as was practical.

The width of the leaf on individual plants ranged from 3 to 7 mm. This was done by selecting several mature leaves in the clone and recording the average of the measurements. Next the plants were scored for growth habit, prostrate to upright; this measurement offering some idea as to the type rhizome emergence and type of tillering. Leaf angle, using the third leaf down from the newest formed as a standard, was scored from narrow to wide, narrow being about 10 degrees and wide being about 90 degrees. Why? In a dense stand of turf, leaves of a wide angle shade other leaves ultimately causing some of the lower leaves to die. A very narrow leaf angle will probably leave less leaf area following mowing, especially close mowing.

A crude measure of total spread was then taken by calibrating a scoring device on which the maximum was the spread of the most vigorously spreading type; the minimum was the spread of the least vigorously spreading type, and the length between was divided into equal increments. A measurement of spread for two directions was then taken, averaged and recorded as the spread for each plant. This character, of course, gives one an idea as to the extensiveness of rhizome formation.

Immediately following the above measurement the spread or area covered (that could be considered dense enough for turf) was measured in a similar manner for each clone; the correlation of which, with the total spread,score will indicate the relationships of total rhizome vigor with ability to fill in or produce a dense turf.

In early September an individual plant score for rust susceptibility, based on 10% of the leaves having rust pustules being resistant to 100% of the leaves having pustules, was made. The value of such a score needs no explanation.

Now we have a bunch of data - what are we going to do with it? The data has now been put on I.B.M. cards and an analysis of variance and correlations among these characters will be computed. From the above analyses the broad-sense heritability of these characters can be obtained and some idea about whether any of these characters are genetically correlated can be seen. As one can readily see, I lack considerable work completing this experiment. I hope to be able to report to you on the products of these analyses in the near future. Meanwhile, the research on bluegrass is expanding. I'm building on the research work of Lobenstein and Melkerson, former students.

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SOD GROWING NOTES - DISCUSSION

Ray Freeborg, Acting Secretary
Link's Nursery, St. Louis, Missouri

Seeds and Seed Control

Seed dormancy in Merion bluegrass has been quite evident in harvested crops the year of harvesting. It is suggested best to buy or have one year old seed. There may be a slight loss in viability due to this one year storage period, but this is offset by the greater total percentage germination.

New selections of bluegrass have developed new problems in sod development and maintenance. An example would be the clumpy character of several new varieties that have proven superior in disease resistance, etc. Their sod-forming character is not so good that good dense sod would be formed. It may be necessary to include several varieties in one planting to assure the proper sod density. Or, heavier seeding may be required to correct this problem.

Sod thickness is always of concern to the sod grower. Work completed by Tom Hodges (see Purdue work) has given support to the development of a sod thickness that is 3/4" to 1" thick. This thickness permits the newly laid sod to become attached to the ground more rapidly.

Plant patenting was discussed. The most recent subject is the Scott patent on the Windsor variety of Poa pratensis. The abstract of this patent is as follows (taken from government patent No. 2364). Victor A. Renner, Marysville, Ohio, assignor to The O. M. Scott & Sons Co., Marysville, Ohio, a corporation of Ohio. Filed January 22, 1963, serial number 253,234 1 claim (Cl. Plt. 88). "The variety of bluegrass plant, substantially as shown and described herein, characterized particularly by dark green color and prolonged retention of color through summer and into fall, dense growth, less vertical growth, high resistance to common grass diseases, and ability to survive under drouth conditions."

Vegetative methods of planting some grasses are considered necessary. These grasses would include the Zoysias, hybrid Bermuda and bentgrass clones.

One approach to vegetative plants of Zoysia was proposed by Link's Nursery, St. Louis, Missouri. This method involves the use of two Rogers units. First, the Aero Blade, a vertical cutting unit, has blades set about 1" apart. This unit is run over the established Zoysia sod set about 1" to 1-1/2" deep; then again run over the turf at right angles. The resulting small 1" sod squares are kept moist and permitted to remain attached to the soil for a one week period. Then, a sod-cutter, set to cut about 1/2", is run over the area, skinning the ground and releasing the sod squares. These can be picked up with a shovel and placed in a hopper spreader, or spread by hand over the area to be planted. The second unit has 3 parts - a tiller, vertical press disks, and a roller.

The small plugs should firmly set into the soil. Water to assure survival and fertilize to push the grass as desired. Also, a good weed control program, either pre- or post-emergent should be developed. There are many pre-emergents that can be worked into this program. We prefer the post-emergent AMA + 2,4-D at 8 oz. + 1/2 (40% active) 2,4-D as a weed control on Zoysia. This rate may be too phytotoxic for use on the bents, or bluegrasses.

Another method proposed was that of hydr-seeding, or actually hydro stolonizing. The stolons would be mixed with a mulch, a small amount of fertilizer, and water. They are then sprayed over the area to be planted.

One problem that should be taken care of involves the mulch wrapping around the stolons and preventing the stolons from touching the soil. They are then subjected to drying and subsequent loss. This can be corrected where light rolling is practical. The wet mulch is definite benefit to the stolon establishment. A preferred treatment was to use mulch after stolons were planted.

Some time was devoted to the discussion of a central body for the development and preservation of foundation planting stock that would be for sale to a potential consumer as sod growers. The need for this is apparent when you see the many various strains of bentgrass that are sold as Toronto, Cohansey, and Washington. This is true for the other superior strains of solonized bents. The certification program for Evansville Creeping Bentgrass is a desirable step.

An organization, The Sod Growers of Mid-America, formerly the Sod Growers of Illinois, is interested in many of the problems we have discussed. This group is open to membership. Information may be received from Mr. Ben Warren, Warren's Turf Nursery, Palos Park, Illinois.

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HUMAN COMFORT OUT-OF-DOORS

James E. Newman, Dept. of Agronomy
Purdue University

What are the conditions that produce human comfort out-of-doors? If you should ask ten different individuals what each considered to be ideal weather for being outside, you would probably get ten different answers. Often individual responses will vary according to his or her likes and dislikes for outdoor activities. Also, there are real differences among individuals as to how each responds to the weather elements.

To gain some insight, in a scientific way, as to when an individual is comfortable outside, let us examine what constitutes human comfort. First of all, periods of rainfall can be eliminated, since most people prefer to avoid being all wet, both figurately and actuvally. Secondly, one must ask what combination of weather elements produces the kind of outdoor conditions that lead to human comfort and activity. From recently reported bio-climatological research in Europe, we learn that human comfort outside is related primarily to four environmental factors, or weather elements. They are (1) the temperature, (2) the humidity, (3) the amount of sunshine or solar heat striking a person, and (4) the amount of wind.

Figure I pictorially diagrams how these four major weather elements interact to produce an environment under which various out-of-doors human activities can take place in comfort. Most individuals are comfortable in a shaded area, out of the wind, with temperatures between 70 and 80° F., and relative humidity between 20 and 80%. These combinations of sensible temperatures and relative humidities, in the absence of direct sunlight and wind, are known as the "human comfort zone." This zone is the same indoors and out. It is represented by a heavy, dark line surrounding the combination of temperatures and humidities in both Figure I and Figure 2. In fact, Figure 2 elaborates on some of the ideal pictures in Figure I.

As shown in both Figures, ideal human comfort in average household or street dress covers a range of temperatures and humidities. This is proof that individuals vary in their response to environmental factors both indoors and out. Some are so-called warm blooded, while others are more cold-blooded. Thus, each person may require somewhat different combinations of temperatures and humidities for comfort. This is particularly true when the individual is at rest, or relaxing.

When temperatures rise into the 80's and 90's a fan or air-conditioning is needed indoors. Light winds add to human comfort outside when temperatures climb into the 80's. In fact, a wind is necessary for comfort if humidity stays above 50% and the sun is shining. As temperatures drop below 70° F., heat must be added indoors and some direct solar heat is necessary outside for comfort. Temperatures between 50° and 60° under full sunlight are nearly ideal for active sports out-of-doors.

Further, the comfort zone in normal street clothing can drop as low as 45°F. under full sunshine and little or no wind. Then, too, the comfort zone can shift up to the low 90's at night under clear skies with light winds and low humidities. Therefore, Figures 1 and 2 simply relate the proper combination necessary to create range of environmental conditions out-of-doors.

Figures 3, 4, and 5 illustrates the average percentage of time during the year that temperatures and humidity relationships can be expected to fall within the human comfort range. Such illustrations, relating how temperature and humidity vary throughout the year, are referred to as climographs. These three climographs portray hourly temperature-humidity distributions during a ten year period for Indianapolis, Indiana (Figure 3), Minneapolis and St. Paul, Minnesota (Figure 4), and Jacksonville, Florida (Figure 5).

The human comfort range, as outlined by the double dark lines, has been defined as any combination of temperature and relative humidity between 45 and 90° F., and 20 to 80%. Note the similarity to the percentages of time during the year falling within the defined comfort range at these three widely scattered geographical locations. At Minneapolis-St. Paul, on the average, 38% of the time during the year falls within the comfort range. At Indianapolis this value turns out to be 39%, while at Jacksonville it is 46% of the time. Preliminary calculations show that these figures seldom fall below the 35%, or go above 50% for any large geographical location within the continental limits of the 48 states. Therefore, on a yearly basis, the amount of time one can spend out-of-doors and be comfortable in normal street or light work dress, does not vary appreciably for most geographical areas in the United States.

In contrast climates differ greatly on a seasonal basis. It is the seasonal difference between geographical locations that is so striking. For example, in Figure 4, nearly six months of the year (47 percent) is too cold, or both too cold and too humid at Minneapolis-St. Paul. However, at Jacksonville only 6% of the year falls in the same category. Yet, Jacksonville, being a sub-tropical location near the Atlantic Ocean, has nearly half of the year too hot, or too humid for human comfort. On the other hand, Minneapolis-St. Paul has only 15% of the time during the year falling in these same categories. There is as much justification for air conditioning buildings in Jacksonville as there is for heating systems in Minneapolis.

At Indianapolis (Figure 3) nearly 5 months of the year is too cold or too humid; another 2 months are too hot or too humid. Yet, all of these seasonal climates at these assorted geographical locations have between 4 and 5 months of the year falling within the ideal comfort range. For Jacksonville, the season of human comfort occurs generally during the colder half of the year beginning in October and ending in late May. At Minneapolis-St. Paul, the out-of-doors season generally begins in mid-June and extends into late October. The enjoyable out-of-doors season at Indianapolis occurs over a 7 month period beginning in mid-April and lasting through mid-November, with much of July and August being too hot and too humid.

In summary, the nearly ideal human comfort range for out-of-doors weather conditions occur mainly during the cooler half of the year in the southern areas of continental United States. Such weather conditions are largely concentrated in the warmest four to five months in northern continental United States. The ideal out-of-doors season for comfort and activities are confined to a four or five month period during late spring and early autumn in the mid-continental United States. The total length of time during the year when an individual finds comfortable outdoor weather conditions does not vary greatly from one geographical area to another within the continental 48 states.

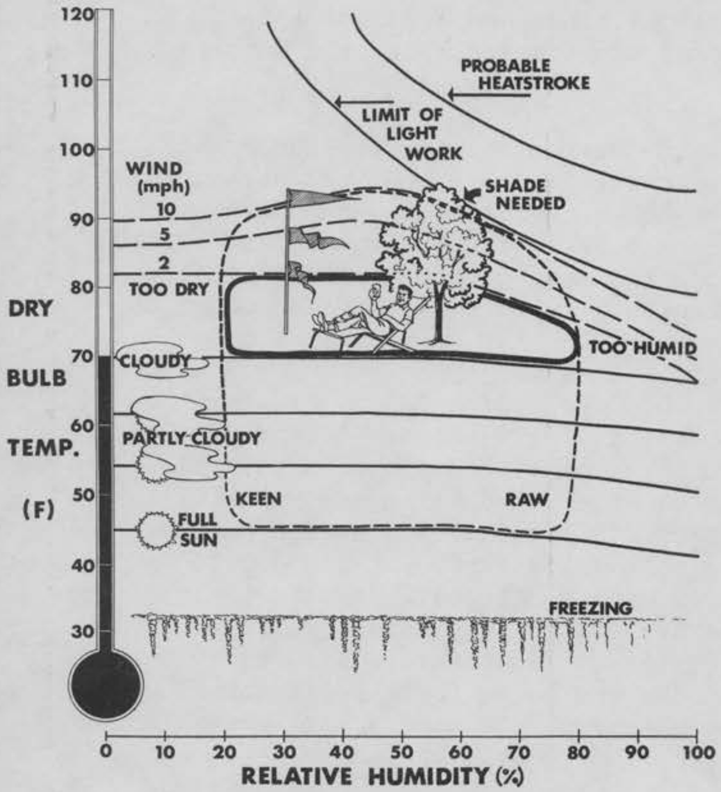

Figure 1. Heat balance and human comfort out-of-doors.

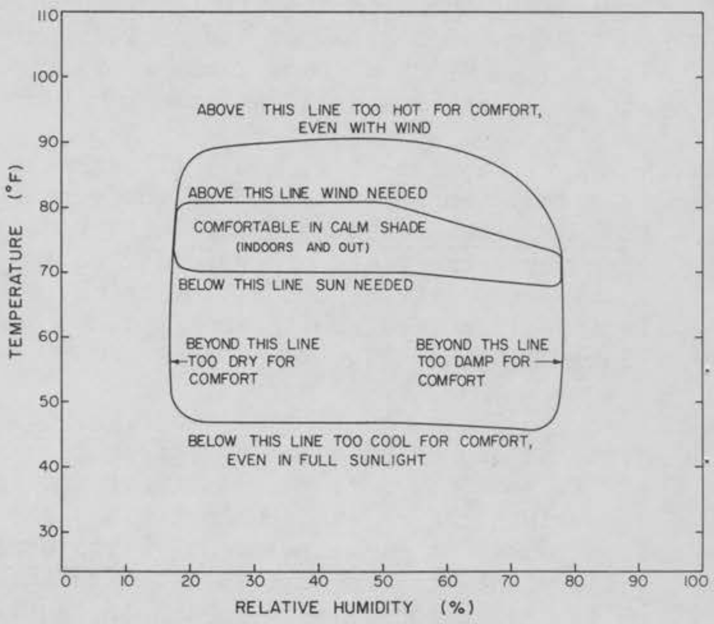

Figure 2. Bioclimatic chart for determining human comfort conditions out-of-doors as related to four environmental factors: sensible temperature, relative humidity, solar radiation and wind.

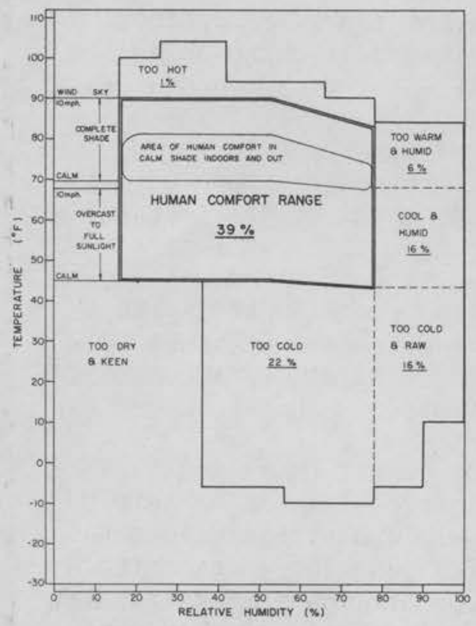

Figure 3. Climograph for Indianapolis, Ind.: the total distribution for 10 years of hourly temperature and relative humidity values.

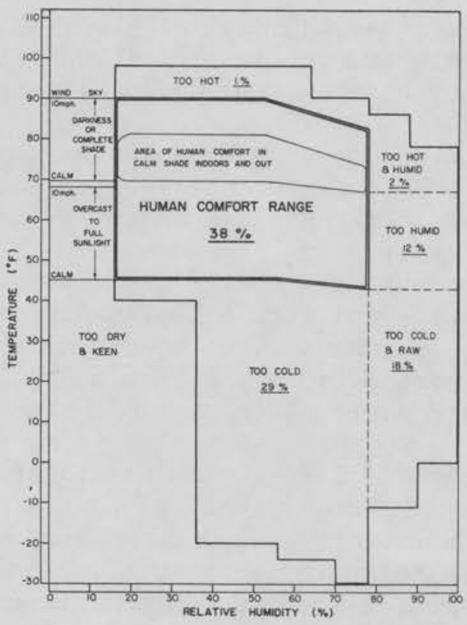

Figure 4. Climograph for Minneapolis-St. Paul, Minn.: the total distribution for 10 years of hourly temperatures and relative humidity values.

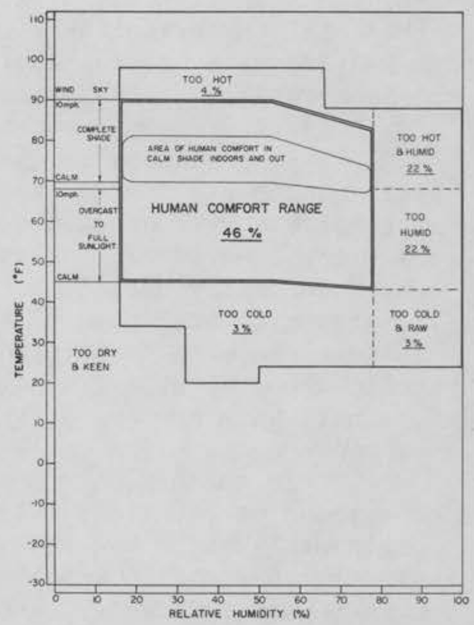

Figure 5. Climograph for Jacksonville, Fla.: the total distribution for 10 years of hourly temperature and relative humidity values.

TRAINING THE NEXT MAN

Ted Woehrle, Supt., Beverly Country Club
Chicago, Illinois
(Moderator)

Why train the next man? Do you realize that in 1963 there were over 400 golf courses constructed? It is predicted that in 1964 there will be over 600 courses going into operation. Where do we find qualified men to fill these 1000 or more jobs? In many cases these positions are not filled by qualified superintendents. It is our responsibility to help train these men - yours and mine. The universities certainly play a major role in helping us, but it is still the superintendent that puts the finishing touches on the product - the trainee.

In Philadelphia we were told that in 1970 there will be over 12,000,000 people playing golf. There simply will not be enough golf courses to accommodate these people. Every club will be over-taxed. More and better ways of growing grass and keeping it will have to be found. Our job is a big one. The next man does not necessarily have to be a college man. He may be someone from your present ranks. He may be a caddy, your son, or some other interested person. It is up to us as individuals of this profession to make sure that we keep our standards high by "training the next man."

This morning we have the distinct pleasure to have with us three of the top men in the job of "Training the Next Man." Taylor Boyd - Taylor began in this profession by working for his father in 1920 at the Highland Country Club, Indianapolis. In 1924 he built the Meridian Hills Country Club in Indianapolis. In all he was responsible for building one 36 hole course and an 18 hole course.

In the middle of the thirties he moved to the Cincinnati area as a golf course superintendent and remained there until 1962 when he moved to the York Country Club, York, Pennsylvania, as the superintendent. He has been active in this organization since its inception. He has been a Director for a number of years, and also served as the President of the Midwest Regional Turf Foundation. Taylor has been active in the function of his local associations as well as the National. He is respected by all of us and is looked up to by the younger generation of Golf Course Superintendents as a man that knows his subject well.

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Midwest Turf
NEWS AND RESEARCH

DEPARTMENT OF AGRONOMY
PURDUE UNIVERSITY

No. 28 March 1964

Electrically Warmed Soils for Sport Turfs--a Progress Report

W. H. Daniel 1/, J. R. Barrett, Jr. 2/ and L. H. Coombs 3/.

Introduction

Under turf conditions most perennial grasses, including Kentucky turfgrass, tend to grow continuously except when limited by climatic extremes. Research indicates that the continuous use of turf areas is possible in Indiana, which is within the cool humid region, by applying supplemental heat to the rootzone of turfgrass plants. This keeps the soil from freezing, promotes root growth, keeps the turf greener and melts snow. Improved turf conditions would reduce injuries and increase the precision of late season football and early season baseball games. Numerous outdoor activities such as horse racing and golf could be extended beyond the normal seasons.

Escritt of the Sports Turf Research Institute at Bingley, England has reported on test installations used to determine the feasibility of using electric cables to thaw turf areas prior to sports events. The severe winter of 1962-63 has further stimulated interest in soil warming in the United Kingdom. Soil warming systems are used under a few areas for football, rugby, horse and greyhound racing in England, Scotland and Sweden.

Early Work at Purdue

Investigations to determine the requirements for installation and management of electric soil-heating cable systems to maintain suitable turf conditions for sports activities during cold weather are being made cooperatively as Agricultural Experiment Station Project No. 1346 by the Purdue University Departments of Agronomy and Agricultural Engineering, and the Farm Electrification Research Branch, Agricultural Engineering Research Division, Agricultural Research Service, USDA. This research program is endorsed by the Indiana Electric Association.

Preliminary soil warming studies were begun on a 20-by 50-foot plot in February, 1962, to examine the possibilities for a turf-heating research program. Variations included (a) comparison of cable coverings including aluminum, cooper and poly-vinyl chloride on single conductor cables and poly-vinyl chloride on dual conductor cables; (b) six different cable

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1/ Turf Specialist, Purdue Department of Agronomy.
2/ Agricultural Engineer, Farm Electrification Research Branch, Agricultural Engineering Research Division, ARS, USDA.
3/ Agent (Agricultural Engineer), Purdue Department of Agricultural Engineering and USDA (same as 2/ above).

spacings at one cable depth; and (c) use of a clear plastic ground surface covering. Constant soil heating produced soil temperatures of 65^{0}F. resulting in excessive bluegrass growth within a 10-day period in early March, while unwarmed turf remained dormant on frozen soil.

Second Phase of the Experiment

After reviewing this work, an improved experimental facility was designed and installed in late October 1962. The main objectives were to prevent soil freezing and maintain turf vitality without causing excessive blade growth. Because 20 to 60 watts of heating capacity for each square-foot are recommended to promptly melt snow on concrete, snow melting was not considered a major factor in the 1962-63 studies. The first winter of research to ascertain the minimum supplementary heat necessary to sustain a thawed soil under a bluegrass turf was one of the most severe in more than 60 years.

Figure 1. The warmer soil areas free of snow as a February 1963 snow is melting.

Installation: Cable depth grades were established by removing soil from an area 20 by 60 feet just west of the Agricultural Engineering Building. Cables were placed at 4-, 6- and 8-inch depths with spacings of 6, 12, 18 and 24 inches. This established wattage densities ranging from 0.8 to 10 watts per square foot. The soil was replaced and packed, moisture indicating blocks were installed, soil thermostats were installed at 1-inch depth, power cables were buried and bluegrass sod was laid over the entire area.

Temperature data was recorded to test the effectiveness of the controls and to compare heating characteristics of the area covered with 4-mil clear polyethylene with the uncovered turf areas. Energy consumption, soil moisture content, rainfall, relative humidity and snow melting information were also recorded.

Controls: Soil thermostats installed just below the sod, at 1-inch depth, did not give adequate anticipation of changing weather conditions to keep the turf thawed at all times. Occasional soil freezing between cables occurred and was related to a combination of lack of sensitivity of controls and insufficient power capacity. Uncovered low heat plots sometimes had one-half inch of frozen surface crust, but this persisted only in continued cold periods. Late in the season, to sense abrupt changes in weather, air thermostats were wired in parallel with soil thermostats allowing either to operate the cables.

Effect of Plastic Covering: The benefits of a 4-mil plastic covering, to utilize solar radiation in warming the turf and to reduce heat loss by both providing an insulating air layer over the turf and by acting as a barrier to reduce wind action, are shown in Figure 2. The temperatures were taken from plots with 12-inch cable spacings, 6-inch depth

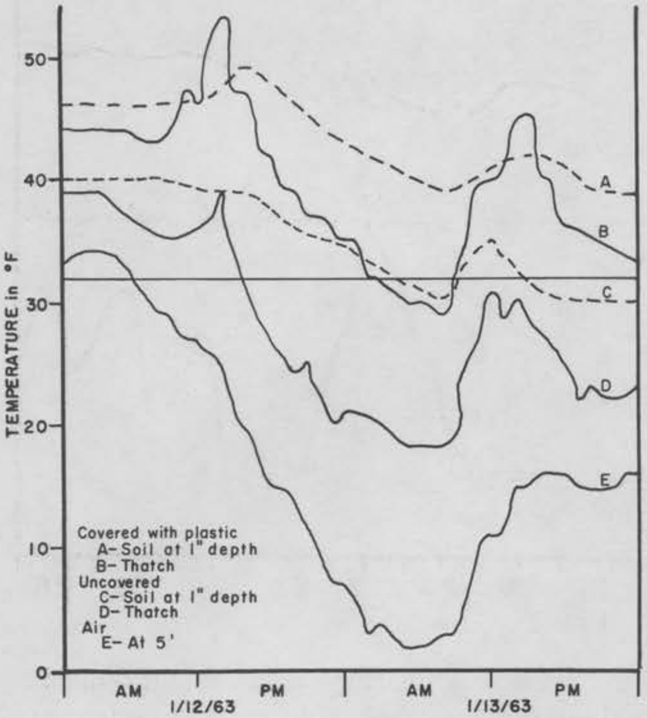

Figure 2. Thatch, 1" depth and air temperatures over electric soil-heating cables dissipating 1.2 watts/square foot at 12"spacing and 6" depths during a period with no snow cover.

and 1.2-watt-per-square-foot power input. These temperatures were measured from thermocouples placed on top of the grass mat(thatch) on both the plastic-covered and the uncovered plots, 1 inch deep inthe soil midway between two cables on each plot and in the air at an elevation of 5 feet. No snow cover existed on January 12-13, 1963. Observed benefits of plastic coverings were:

1. Grass blades did not desicate in cold dry winds and remained essentially a normal green even with-20°F. air temperatures. The continued greeness is readily observable in color pictures.

2. The plastic covering reduced energy use on a 10-watt-per-square-foot plot to achieve the same 1-inch soil temperatures as a corresponding uncovered plot. Energy consumption was not a major consideration with the lower wattage densities. These cables operated full time through most of the winter. Cables spaced up to 2 feet and wattage densities as low as 0.8 watt per square foot kept the soil thawed throughout the winter.

3. Rooting was earlier and more uniform under plastic covering.

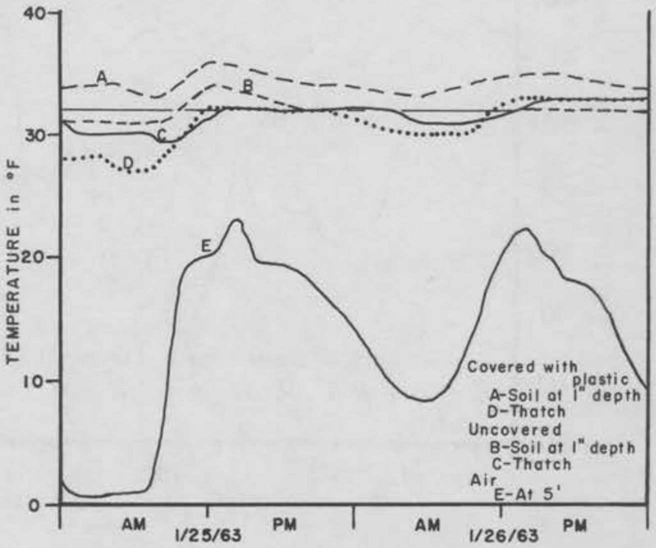

Figure 3. Thatch, 1"depth and air temperatures over electric soil-heating cables dissipating 1.2 watts/square foot at 12"spacings and 6"depths during a period with 1 to 3"of snow cover.

4. The turf grows more readily as any warm period arrives, responding much better to sunny weather and rising air temperatures than control areas.

Some disadvantages of plastic coverings are:

1. Plastic prohibits casual and sight use of the area.

2. Hot, sunny periods may force unwanted excess growth.

3. The risk of damage to growing foliage is increased when the plastic is removed in early spring. Extra care in management is needed to remove and replace coverings in variable spring weather.

4. Disease (leafspot) incubation on leaves may be favored by unusually high humidity and warmth under covers.

Effect of Snow Cover: Comparison of Figure 2 and 3 shows the insulating value of the 1 to 3 inches of snow cover that was on the plots during the period January 25-26. Similar to Figure 2, temperatures for Figure 3 were taken from 12-inch cable spacing, 6-inch depth and 1.2-watt-per-square-foot power

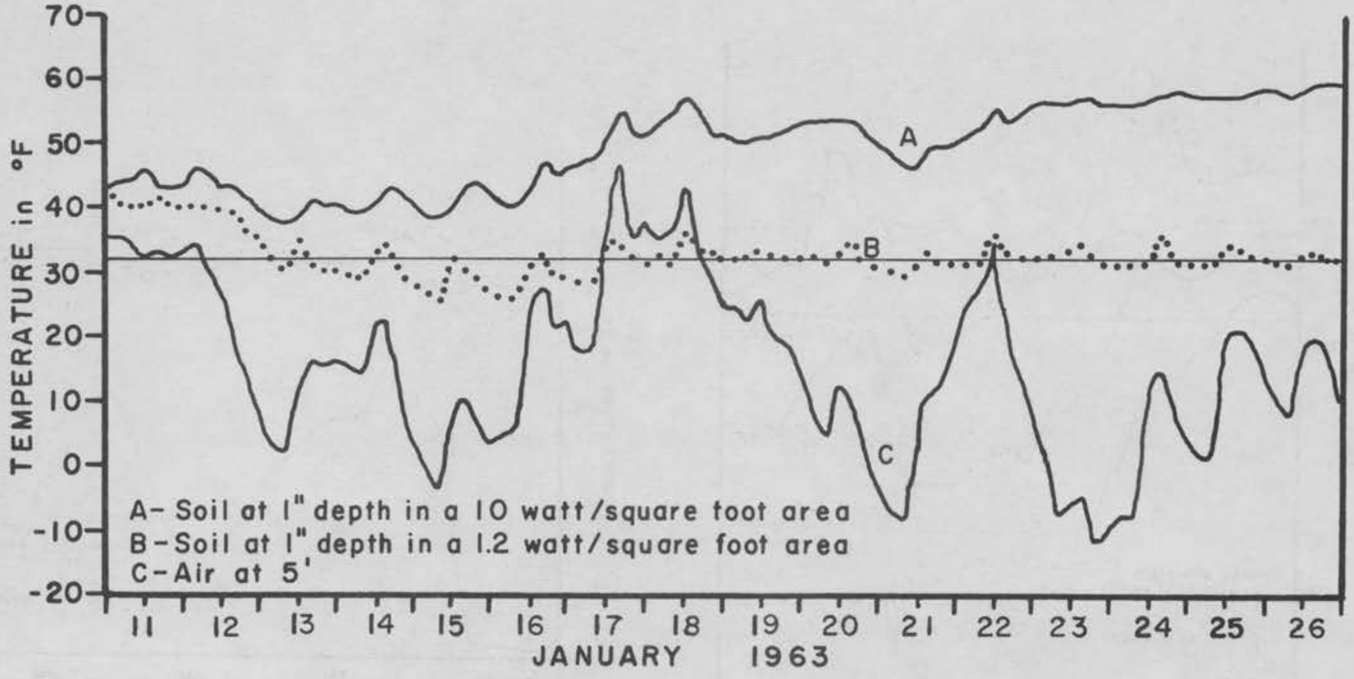

Figure 4. Temperatures at 1"depth and 5' in the air over soil-heating cables dissipating 10 watts/square foot at 6" spacing and 6" depth and cables dissipating 1.2 watts/square foot at 12" spacing and 6" depth with no plastic covering.

input. Under snow the temperatures show that both plots were less responsive to changes in air temperature and solar radiation than without snow cover (Figure 2). Snow pressure reduced the air layer under the plastic nearly eliminating the heat saving benefits of this barrier. The thatch temperatures under these conditions were esseantially the same as the frozen mass on top of the plastic.

Figure 4 shows temperatures at 1-inch depth in a 10-and a 1.2-watt-per-square-foot uncovered plot, and of the air 5 feet over the plots. The period from January 11 through 26 includes the times shown in Figure 2 and 3.

The poly-vinyl chloride insulated heating cable in the 10-watt-per-square-foot plot was at 6-inch depth and 6-inch spacing. The thermostat for this plot was set to maintain the 1-inch soil temperature at 45^{o}-55^{o}F. Similarly insulated cable was used at 6-inch depth and 12-inch spacing in the 1.2-watt-per-square-foot plot. In the latter the thermostat caused the cable to operate full time during the time interval shown in Figure 4.

Effect of Cable Depths: There was little observed difference in soil or turf condition above cables 4, 6 and 8 inches deep. Safety, protection from mechanical damage and cable laying methods would be considerations in depth selection.

Turf and Rootzone Benefits: Soil warming offers valuable rootzone benefits. A fresh-cut sod placed in non-warmed areas November 10, 1962 developed almost no new roots before winter. On heated soil new root extension was 3 to 5 inches by December 31 and was uniformly 5 inches by the end of February. By April 1 the new white, active roots were 9 inches deep in warmed areas, but only 5 inches deep in unwarmed areas. Such extensions provided new sources of nutrients and assured minimum damage from drouth or damage in use. Continued top growth, well into late fall and again in early spring, was readily noticed. One watering of new sod on the heated area was required during a dry period in early December.

Temperatures barely sufficient to keep rootzones thawed and porous did not produce obvious top growth until early March, 3 weeks ahead of unwarmed turf. Higher heat inputs to maintain 1-inch soil temperatures above 45°F. favored top growth in winter and late winter. Wattage densities of 10-watts-per-square-foot were adequate to keep the turf unfrozen at all times. Soil temperatures above 55°F. forced growth even during extended severly cold weather.

Sharp drops to low temperatures caused some tip damage to leaf blades of rapidly growing grass. Interestingly, warmed turf areas produced seedheads 6 weeks earlier than unwarmed areas indicating crown growth through the winter period. After soil warming was stopped, all uncovered turf areas looked normal in density and uniformity.

The additional root development and the continued tiller and rhizome development indicate improved playability for warmed turf areas. The warmed areas were never muddy, super-wet or slick from frost action. In fact, when snow melted on adjacent areas the warmed plots served as a drain to remove excess surface water from surrounding frozen areas.

The absence of observable disease or turf damage and continuous unfrozen soil condition under the sod are very encouraging considering the low-wattage densities under most of the trial area.

Snow Removal: Although snow removal was not a major factor in these studies, observations concerning this were made. In the plots with heat applied at 10-watts-per-square-foot, the snow melted rapidly when air temperatures were above 15°F. At lower air temperatures melting was slower, although the soil remained thawed and the turf remained green. Bridging of snow presented a problem in snow melting. Snow in the lower blade region of the turf would melt, leaving an air pocket with a crust of snow or ice supported on the tips of the blades. The rate of heat transfer through this region was reduced sufficiently to greatly slow additional snow melting. As a general observation, removal of heavy snow by machinery would favor quick turf clearance, if needed.

Heavy-Use Area Installation--1963-64

Five plots, each 10 by 120 feet, separated by 10 feet of unheated area, were installed in the Purdue varsity football practice field in August 1963.

Poly-vinyl chloride insulated, nylon jacketed, electric heating cables were laid 6 inches deep under existing sod using a modified sub-soiling tool. Wattage densities are 2.5, 4.5 and 9.0 watts per square foot with cables spaced at 7-1/2 and 15 inches. Soil thermostats, air thermostats and time-clock switches are included in the control circuits. The effectiveness of the heat treatments will be evaluated considering power consumption, temperatures and turf condition of the five plots and control area. The results of this endeavor to more effectively apply supplementary heat to turf using electric soil-heating cables with improved control systems will be reported later.

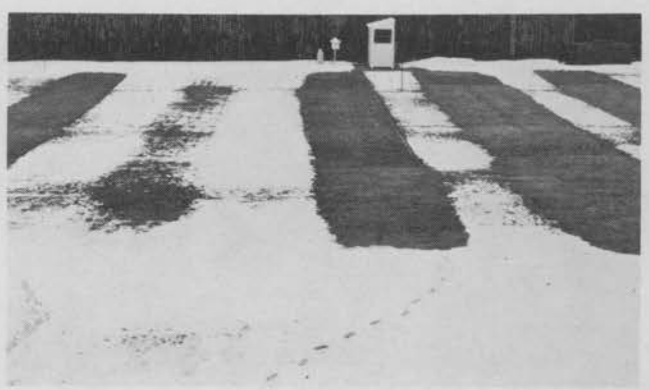

Figure 5. The Purdue varsity practice field, January 1964.

Summary

Turf areas warmed with electric soil-heating cables improved playability and had increased root growth during the winter, had extended growth period in the fall, had earlier growth in the spring and, in high-wattage areas, had growth throughout the winter. Plastic coverings over warmed areas reduced the electric energy required, maintained greenness in leaf blades and favored growth. However, extra attention to remove and replace covers to avoid excessively high temperatures and disease buildup was necessary during variable spring weather.

Having narrowed the design parameters in earlier work, a 5 plot heavy-use area installation in a Purdue football practice field is now being studied.

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TRAINING A NEW MAN

Taylor Boyd, Supt., York Country Club
York, Pennsylvania

Training a new man as superintendent of a golf club is a two-way road. If the trainer is qualified to train a young man in the art and profession of producing the world's finest turf he will learn as much as the man he is training - sometimes more. The trainer should make very sure the trainee is a gentleman first and foremost. He should be honest, have integrity, humility and a will to succeed.

The above statement is true more so today than ever before, because in the highest places in government and business there seems to be a growing disregard for honesty and integrity. This must not ever become a part of our profession. Also, there seems to be too many men who take the "Let George Do It" attitude in their work.

The Agronomy Colleges today are doing a fine job of teaching some very excellent young men who learn the technical aspects of turf. Colleges, for the most part, are not equipped to give the turf man the "on-the-job" training that is necessary. This can be done only on the golf course, under playing conditions, and in the approximate area in which the trainee expects to work as superintendent.

The trainer always has the question of who is trainable. My experience has shown me, over many years, that the trainee who gets to work on time or before, never is in too much of a hurry to go home, works on Saturday, Sunday and nights without grumbling is a good prospect. From there on, his personal appearance, quality of work he does, seeing things to do, his general mental ability and attitude are very important. I, personally, have never had any question as to whether a young man could do the job if I recommended him. I have wondered if he would. So far I've been lucky - they all have.

There are some - very few - college men who expect "the world with a fence around it" on his first job as superintendent before he has proven he is a golf course superintendent in the truest sense of the meaning.

Last and most important - the young college man is full of spirit and drive. The teacher must very carefully control the young spirit and teach him not to go too fast, but for goodness sake because you are older and experienced don't kill his spirit - you may learn something - I have.

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TRAINING THE NEXT MAN

Robert M. Williams, Supt., Bob O'Link Golf Course
Highland Park, Illinois

Motivation

My education as a golf course superintendent has been aided through the training I received from such men as Professor Dickinson, Norm Johnson and John McCoy. They had very strong convictions towards their own obligations to train superintendents for the future. I feel most privileged, fortunate, and grateful for their assistance. So, with such a background, it is only natural that I should assist others. In addition, I feel that each of us should attempt to put something back into the wonderful world of golf to make this form of recreation even more attractive and regarding in the future to both the golfing public and to those who will find careers in the golf industry.

Statistics

We have had 31 in on-the-job training at Bob O'Link Golf Club over the last 15 years. The statistics on these 31 young men are rather interesting:

- 2 high school graduates, no university training
- 6 10-week short course students
- 13 2-year Turf Management students
- 9 4-year students with Agronomy degrees
- 1 Master's degree in Agronomy

Of these same 31, their present status shows:

- 11 Now hold positions as superintendents
- 9 Still in process of training, or in school
- 3 Are now assistant superintendents
- 4 In Military service
- 4 Related fields, industry, parks, etc.

Of additional interest is the fact that 4 of our student trainees have been the sons of golf course superintendents.

Objectives

Our training program starts basically from four points. First, the club needs a staff of good workmen. Secondly, the hopeful young students from the universities need practical experience under the older superintendents. Third, I have a strong desire to return something back into golf, and finally fourth to try at the same time to elevate the golf course superintendent's profession for the future.

Procurement

With these objectives in mind, I find a real harmonious and regarding relationship for the student, for the club, for the universities and for myself, by participating in on-the-job training. This participation is initiated through close contact with the various turf schools, such as Purdue, Iowa, Penn State, Massachusetts and Rutgers. This is usually accomplished through personal conversation with men like Dr. Daniel, Dr. Duich and others at the International Turfgrass Conference, or at regional meetings. These teachers make recommendations to me on prospective student trainees and appreciate being kept in the picture of job placement for their students.

We use students from any of the 10-week, 2-year or 4-year schools. The 10-week boys are able to work with us full time except for January, February and March. The 2-year students are available for work from about the 1st of April to the 1st of October. The 4-year students are only available for work during June, July and August. We have used as many as 6 students at one time, but found this to be somewhat topheavy and restricted myself and my assistant from giving the boys enough personal time in day to day discussions. In our present evaluation we feel that three apprentice superintendents at one time is about the optimum for us.

Terms of Employment

The students receive an hourly rate the same as our regular labor, currently $ 1.75 per hour. We also have a dormitory room available for up to four students, although most of the young men prefer to live away from the club where they can enjoy more personal freedom. Students are given the opportunity to work at the many various tasks that are required in turf maintenance so as to give them a well-rounded acquaintance with all phases of the job. This includes everything such as mowing of all areas, fertilizing, chemical applications, cup placement, trap raking, and all the 101 other jobs that need doing. As for night watering, each student works approximately four weeks on this job for which he receives an additional 50¢ per hour.

Management

Another area of primary concern in the training program is the administrative and management responsibilities they will have to face in the future. We employ several means to teach this all important subject. First, we give each trainee copies of all of our communications between the club and myself, such as our annual budget, progress reports and financial reports. Each student also takes his turn as Recorder for our daily maintenance diary which makes him more aware of the over-all operation. We keep our planning charts and chemical application charts on the shop wall so that everyone has access to them. Fertilizer records and records of expenditures are available to the boys at any time. We also have large files of educational materials so that the boys can check out a subject in after hours study. Another management aid for the trainee is demonstrated by having our daily work schedule posted on our shop blackboard with an explanation to the entire crew each morning before we start work. Another daily ritual, prior to starting work, is a joint inspection of the turf on a green and fairway affecting decisions for the day's operations.

Job Descriptions

We have had considerable success in having the students write out job descriptions for the various tasks that they perform. For instance, our procedure for night watering, fertilizing, changing cups, and many other jobs has been completely written up in story form to pass along to the next man. So, when new students start with us they can review our procedure and techniques for most of the important assignments about the course. This saves in training and keeps improving upon the methods used. I try to make a point of asking questions of the boys to see if we are getting through to them. We encourage their questions as well.

Term of Training

We find that two years is about ideal for an apprentice to stay with us. Then, the student superintendent should advance along to a position with more responsibility such as a foreman, assistant superintendent, or as a superintendent at a club where the standard of maintenance is not too demanding. Even the four year student graduates are not ready for a demanding position as a superintendent until they have had time and experience in getting their feet on the ground.

Finding Future Employment

What about the procedure for these young men of finding employment? The problem lies not so much in finding jobs as in training the student so that his natural youthful impetuousness does not get him too far out on the limb before he is ready. We have a greater supply of job opportunities at this time than we have qualified men to fill them. Consequently, clubs keep asking the universities to send them their graduates. Fortunately, the universities are advising and expecting their students to get some practical experience before assuming the duties of a superintendent.

When a club is hiring a superintendent today they seem to go in one of two directions - either they try to find a middle-aged man with a good reputation (for which they are willing to pay a premium salary), or hire a young man who has attended one of the turf management schools, received some on-the-job training, and who appears to have a good potential. Of course, the student superintendent comes much less expensive and this is a factor with many clubs. Another point here is that when a good club is hiring an experienced man, they usually have to "pirate" him from another club. To avoid any local embarrassment on this score, clubs frequently will hire a good experienced superintendent from some other area.

Getting back to our own students at Bob O'Link, we have more requests from clubs than we can possibly supply. We can only count on about one each year being ready to go onto additional responsibility. Many of the boys must go into military service, and also, some of them only spend one season with us and go on to complete their training at some other club.

Results

Generally speaking, the results of improved training of the golf course superintendents are today quite obvious and our educational programs have gained considerable impetus since the war years. More superintendents are accepting more students for training today. The golfers are playing on better golf turf and better managed courses as a result of continued and improved educational programs for superintendents. I notice, too, that the golfing public is much more aware of the general advances and upgrading of our profession and the science of course maintenance.

Our training program at Bob O'Link has had enthusiastic reception by our Greens Committee, Board of Directors and membership. Without any question, student superintendents taking on-the-job training are a considerable asset to me personally and to the club. At the same time it is quite evident that the students who have trained with us have profited too. Most of you have had experience with teenagers either as youw own sons, or as employees and you know that it takes a certain amount of patience and understanding to get along with them. In a training program one must expect to give time to explanations, questions and character building. This effort on the part of the superintendent is well repaid with a higher calibre staff who are much more versatile and capable than run-of-the-mill labor.

All of the students do not pass our requirements with flying colors. When discharge has been the last resort, we have taken time to explain the reason to the student. We try to impress upon him that basic principles are a must in any endeavor. While there have been a few disappointments, there have been many wonderful successes. There is a great deal of satisfaction for my assistant and myself in watching these young men who will be the superintendents of tomorrow, as they come along through the universities, then through on-the-job training and eventually proving themselves on a job of their own.

Summary

Dr. Fred Grau ably summarized the whole training subject matter in the October '63 issue of Golfdom. It was so well done by Fred that it needs repeating and I feel it appropos for my summary: "It seems that the few turf schools in the country cannot possibly train enough young men eventually to fill the positions that are opening. It has been said many times that a man freshly graduated from a turf school is not qualified as a superintendent unless he had experience before taking over a course. Most graduates need on-the-job training."

When a good superintendent moves to a new course where the salary is higher and benefits greater, it still is common practice to advance the tractor driver, or the mechanic to his position whether or not he is qualified to assume the responsibilities of a superintendent. To this day we do not have enough men who are comfortably able to take guests to the clubhouse for lunch, to meet with the Greens Committee, successfully defend their proposals and to command the respect of pro, manager and club officials. Being a superintendent carries the responsibility of far more than growing grass. He must train himself so well on every subject that he will have no hesitation in "selling" a good program.

Let each man in this field ask himself: "Do I have a promising young man who deserves to be trained for the profession?" We need not only to train our own replacements, but to provide for the hundreds of new openings."

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TURF STRESS - WARM AND HOT CONDITIONS

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Milorganite Turf Service, Milwaukee, Wisconsin

This discussion involves a few of the known factors of stress on cool season grasses during hot weather. We are all familiar with the various occurrences, but a review of them can help us to better understand them and thereby reduce the hazard to turf during the coming season.

It is well known that roots of cool season grasses become shallow during hot weather. Wilt is familiar to all - both under moist and dry conditions. Just what this relationship involves has prompted the research to be reviewed. Reported in 1939, Brown's work in Missouri examined loss of roots in the summer. He reported that Kentucky bluegrass grew best north of the 60° Fahrenheit isotherm. It showed little vigor in July and August, whereas Canada bluegrass was less affected by heat.

Brown noted good Kentucky bluegrass regrowth after defoliation at a temperature of 60° F. At 80° F. regrowth was poorer, and at 100° F. many plants died within 6 weeks. Other workers were quoted that little growth occurred when soil temperatures were below 42° F. Rapid growth occurred between 42° and 47° when adequate nitrogen was present. Above 47° good growth was seen regardless of the nitrogen level.

Carbohydrate storage is reduced as temperatures rise. This is due to continuation of respiration at temperatures too high for photosnythesis to take place. Brown found that the best temperature for top growth was between 80° and 90° F. The best rhizome development occurred at 60° F. Chlorophyll in leaves was lost between 40° and 50° F. After a week at 100° F. growth stopped. Roots made maximum growth at 60°, declining at lower and higher temperatures. But, when air temperature was 100° and soil temperature was kept at 70°, the plants produced good top growth.

Stuckey (1941) working with Colonial bentgrass, made several references to various plants that made good groth at high air temperatures, provided the roots were kept cool. She reported that at high soil temperatures, roots matured more rapidly. Her conclusion was that at lower temperatures plant roots matured more slowly and hence remained more vigorous for a longer period of time. Plant death at high temperatures was due to maturity and death of the root system and the consequent stress on plant tops.

Brown (1943) reported also that maximum Kentucky bluegrass root growth occurred in April. In the fall, the most rapid growth began in September. After mid-June few new roots formed and there was no appreciable growth of existing roots until October.

Without irrigation bluegrass root growth reduction is soon followed by a reduction in top growth. Irrigation in mid-summer did not influence root growth, but did accelerate decomposition of older roots. This seemed to exert a beneficial effect, since these plots produced more herbage - even during the spring and fall when moisture was abundant in all plots. Summer irrigation, naturally, produced more clover and weed growth than in the non-irrigated plots.

He states that where summer drouth is short and not too severe, bluegrass plants were probably protected from excessive depletion of stored food reserves. Fall drouths were said to be altogether harmful because they inhibited root and rhizome growth as well as food storage during periods otherwise favorable for such development. Stored carbohydrate was decreased when turf was irrigated during the summer.

Mowing at reasonable height had little effect on carbohydrate storage. Storage of starch and sugar proceeded almost as rapidly during the autumn in the rhizomes of closely (1") mowed grass as in that which was not cut at all from May until November. He summarized that storage of organic food reserves in perennial grasses is essential to their normal functioning. Excessive carbohydrate production in the spring and fall is stored in the roots and rhizomes. During the late spring and summer there is a net loss of these reserves. Irrigation in the summer does not help prevent this loss. Reserves are also used during foliation in the spring.

Stuckey classified forage plants into annual and perennial root system groups. If the maximum production of roots occurred during the first year and they remained functional for more than one year, they were called perennial. If new root systems were formed every year, they were classes as annual.

Annual root systems	Perennial root systems
Timothy	Kentucky bluegrass
Redtop	Canada bluegrass
Meadow fescue	Orchardgrass
Poa trivialis	Crested wheatgrass
Perennial ryegrass	
Colonial bentgrass	

Beard's work reported at this Conference from 1958-60 showed similar root growth patterns in creeping bentgrasses. He found satisfactory root growth at 80° F. but only half as much at 90° F. Clipping reduced growth to more than half that in uncut treatments.

60° - Best top growth and root growth
70° - Most root branching
80° - Fastest initial root growth
90° - Very slow root growth

Growth was temporarily stopped if tops were severely cut back.

He suggested that soil temperature at a 6" depth was a major factor in predicting variation in root numbers. This indicates that soil temperature is probably the major factor in root development, or loss. It is the most consistent environmental factor controlling root growth. Light was secondary, but measurement facility was questioned. Soil moisture was of poor correlation since putting green plots were kept near field capacity at all times.

Jordan, reporting his work here in 1958 and 1959, showed that temperature was a primary influence in plant sugar production.

If high temperature is a factor in reducing a root system, what happens when other parts of the plant are subjected to demands for water? Since this is due to transpiration, we should consider what affects the transpiration of water from plants. Solar radiation, humidity, temperature, wind movement, soil conditions influencing water availability, and atmospheric pressure all play a part in the amount of water given off by a plant.

Solar radiation caused plant pores or stomata to open. Most moisture is lost through these openings. They do not open at night. Humidity affects the diffusion of water vapor out of the pores. It is thought that the higher the humidity the slower a plant will transpire. Temperature reaction is direct when in sunlight.

Wind effects are far from simple. We assume that wind movement increases evaporation. This is true if, in a still atmosphere, vapor given off by a leaf remains in the surrounding air and slows transpiration by increasing humidity. In nature, however, the air is seldom perfectly still. Another effect of wind movement is its twisting and bending effect on leaves. This movement constricts and squeezes leaf cells and forces the vapor from the leaf. A gentle wind is more efficient because high winds are thought to close stomata. The cooling effect of wind also tends to slow transpiration.

Soil conditions influencing transpiration are water availability, soil temperature, aeration and the solute concentration in the soil water. These may be direct or indirect, and as we have seen, may be due to their effect on the root system.

Atmospheric pressure has a minor role, but could influence the rate of evaporation. Under reduced pressure, plants can be expected to give up their water more readily.

Wilting occurs when plants lose their turgidity. This may happen in either wet or dry soils, as a result of higher transpiration than water imbibition. The totalvolume of water in the plant shrinks, although not equal in all tissues. The greatest loss is in the leaf cells.

There are several stages of wilting. On some days visible wilting does not occur at all, but incipient wilting is frequent. This corresponds to only partial loss of turgor by leaf cells. It is during such periods of incipient wilt that damage can be done by spray applications of even faintly caustic materials. Irrigation practices based directly on transpiration are syringing to cool the surface during hot weather, and irrigating in the early spring when soils are still cold, but air temperatures are high.

Roberts, reporting Iowa State work at the Wisconsin Turf Conference, said that during high temperatures (120° F.) fertility played a major role in bluegrass health.

High nitrogen alone, with phosphorus, or both phosphorus and potassium, were detrimental. Potassium with high nitrogen had some stabilizing influence. This, of course, is noted in all cool season plants that are allowed to become over-succulent during the summer through uncontrolled fertilization practices.

Oversucculence and weakened plant cells are ripe for attack by many disease organisms. It is during summer periods that Pythium, brownpatch and leafspot diseases are most prevalent. Traffic damage during the summer may not be a primary problem, but secondary. Both traffic and disease problems are more severe when the plants are weakened than during periods of active growth.

Since we can do nothing (yet) about the primary cause of weakness due to reduced root systems, we can do many things to reduce damage from other causes:

1. Develop the best possible root systems during periods of maximum growth - spring and fall. Aeration, adequate fertilization and proper mowing heights are most important.

2. Keep moisture additions to a minimum on bluegrass during hot weather. It may be best to wait for signs of wilt before irrigation. Merion bluegrass and Penncross bent tees perform beautifully as long as moisture is not oversupplied.

3. Manage hot weather fertilization to prevent over-availability of nitrogen. Nothing should be left to the vagaries of nature, or theoretical formulations. Adequate applications of fertilizers should be used in the spring and fall, but excess residual should be avoided. Periodic, light applications should be used to allow the turf manager to remain in control of growth during the stress period.

4. Maintain adequate, but not excessive levels of all other plant nutrients.

5. Assure good air movement across turf areas, especially putting greens.

6. Provide adequate sunlight, especially in the morning, to promote optimum growth of the grasses.

By making the most of the optimum growing periods, the plants will be better able to withstand stress during hot summer weather. A capable turf manager will consider all facets of plant growth and not simply react to a specific condition that crops up during a particular phase of growth. In so doing he is making his job easier and removing some of the stress on himself.

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CEREAL LEAF BEETLE

A New Insect Pest in Indiana

M. Curtis Wilson and Glenn E. Lehker
Department of Entomolgoy

The cereal leaf beetle is Indiana's newest insect pest. Not since the European corn borer invaded the State over 30 years ago has a new imported insect presented so great a potential for damage to cereal grains.

Where did it come from? What crops will it attack, and how serious could the damage be? How will farmers be able to recognize the beetle? What are its habits and life cycle? And what can farmers do to protect their crops from attack?

Research entomologists are finding answers to these and other questions about the cereal leaf beetle. This publication briefly relates what we know at this time. Chemical control measures that will protect a crop have been found and Purdue's recommendations are given.

ITS INVASION AND SPREAD

The cereal leaf beetle, Oulema melanopa (L.), has been a serious pest of small grains in certain parts of Europe and Asia for many years. In that time, it has adapted itself to a wide range of climatic conditions--from Siberia and the Scandinavian countries southward to Spain, Italy and North Africa. Now the beetle has found its way to North America, and more specifically, to southern Michigan and nothern Indiana.

It was first identified here in 1962, in an area 15 to 25 miles west and northwest of South Bend. A year later, it was found in 25 Indiana counties, 15 counties in Michigan and even in 6 counties of northwestern Ohio.

The cereal leaf beetle is the first important insect pest to be introduced directly into the Midwest from the old world. How it got here is not certain--maybe by ship coming down the St. Lawrence Seaway or by trans-continental airplane flying directly to Chicago or Detroit. In any case the fact that the beetle reached the midlands first causes entomologists to be concerned about the potential effects "jetage" travel may have on bringing in new insect problems.

DESCRIPTION

Adult

The adult is a hard-shelled beetle, measuring only 3/16 inch long. Its wing covers and head are metallic bluish-black, while its legs and front segment of its thorax (just behind the head) are reddish-orange.

Egg

Newly-laid eggs are elliptical, yellow and smaller than a pin head. Before hatching, they turn almost black. Eggs are deposited singly or in rows of up to three or four, but never in clusters. They are usually found close to the mid-rib on the upper surface of leaves of a host plant. An exception is corn, where eggs are often laid on the underside of leaves.

Larva

The larva is slightly longer than the adult and resembles a slug. Although its skin is actually yellow to yellowish-brown, the larva's black, slugs-like appearance is due to a moist glob of fecal material which it deposits on its back. The only time a larva is found without this excrement is immediately after a molt.

Pupa

The pupa, or inactive stage, is also yellow to yellowish-brown. However, the pupa is rarely seen, because it is encased under the soil surface in an earthen cell which the larva builds before pupation.

LIFE CYCLE AND HABITS

Cereal leaf beetle adults over-winter, usually in clusters, wherever they can find shelter--under the loose bark of trees, in old corn stalks leaves, in the cracks of fence posts, in chaff on the ground. However, they are found in greatest numbers in hedgerows or tree and shrub borders surrounding cultivated fields.

In the spring, usually when temperatures get above 60^{0}, the beetles come out of hibernation to feed. They first attack wild grasses, such as quackgrass and orchardgrass, near their hibernation spots. Then they fly to fields of winter wheat and winter barley. (Cereal leaf beetles are strong flying insects. They have been collected as high as 1,000 feet above the ground in traps attached to an airplane.) When spring oats emerge, the beetles quickly infest the young plants, where they both feed and lay their eggs.

This spring feeding period before egg laying is normally about 2 weeks. With warm weather, the eggs hatch in 5 days, and the larvae develop in the next 10 days. It is the larvae that do the worst crop damage.

Before pupating, the larvae rest for a day or two on the leaves of host plants. Then they descend into the top 2 inches of soil, where they form pupal cases and change into adults. The pupal stage usually lasts about 2 to 3 weeks before the new beetles emerge.

The new summer adults first seek food. In Michigan and Indiana, they feed mostly on corn, which at that time is about knee high and the only grain that is young and succulent. After feeding for about 2 weeks, the beetles go into summer hibernation for the rest of the season. As fall and winter approach, they work their way into deep cover for winter hibernation.

As nearly as research entomologists can determine, the cereal leaf beetle has only one generation per year in the field. However, under caged conditions, field-collected larvae have produced adults which, in turn, produced a second generation. Most of the spring adults die in June after they lay their eggs. But in Europe, beetles have been reported to live through a second season.

Weather's Effect on the Life Cycle

Weather has a tremendous influence on how fast the cereal leaf beetle goes through its life cycle. This was evident in the spring of 1963--a season of great fluctuation for the infested area of southwestern Michigan and northern Indiana. Temperatures were in the 80's as early as late March and fell to below freezing as late as mid-May.

Beetles were observed coming out of hibernation on March 27, and eggs were found on April 6. But no hatch occurred until May 2, and then did not reach a peak until 3 weeks later. Egg laying continued into June.

Both egg laying and hatching extended over about an 8-week period. And larvae were found in the field for the same length of time, some requiring more than 3 weeks to develop. In fact, all stages of the cereal leaf beetle's life cycle--egg, larva, pupa and adult--could be found as late as June.

Emergence of adults from the pupal stage also occurred over an extended period in 1963. The first beetles came out in early June and were already going into summer hibernation before the last new adults emerged. Peak of emergence was reached between June 25 and July 1, but new adults were still found up to late July.

HOST PLANTS

The cereal leaf beetle appears to feed only on plants of the grass family. Though it will feed on wild and cultivated grasses, such as orchardgrass, quackgrass and timothy, it prefers the small grains--especially oats and barley. In the laboratory, it did not survive on sorghum or pearl millet.

While corn is not a preferred host, the insect can develop on it. However, in the present infested area, corn is planted too late to be threatended by the larvae. Summer adults feed on corn, but the plants appear to outgrow this damage.

The cereal leaf beetle also prefers young, succulent plants. For example, in Purdue research experiments, twice as many eggs were found on oats 4 inches high as on oats 8 inches high. This means that, in Indiana, the beetle is a much greater threat to the spring-seeded oats than to the winter-seeded wheat or barley. However, it will infest the latter two, and if abundant, will cause loss in yield.

DAMAGE

Both adults and larvae cause damage by feeding on the host crop. The adult beetles eat longitudinal slits between the veins and completely through the leaves, and may kill the plant. The larvae eat only the outer surface of leaves, giving them a silver cast and the whole field a frosted appearance before the plants die.

In Europe, crop loss to the cereal leaf beetle has been reported as high as 25 to 50 percent. In Michigan, damage was so severe to several fields in 1962 that the fields were plowed under. And in 1963, a few fields in Indiana were plowed under because growers felt they weren't worth saving.

CONTROL MEASURES

Areas of Research

Michigan, Indiana, Ohio and the U.S. Department of Agriculture are cooperating to find ways of controlling the cereal leaf beetle and preventing loss to small grains. Through research, entomologists have already found chemicals that will protect crops from attack. However, the scientists are exploring other control measures to limit the need for chemicals.

For example, studies are underway to develop resistant small grain varieties, to find and import natural enemies of the beetle, and to investigate the use of chemical sterilants and radiation as means of bringing the insect into balance with nature.

Insecticides Found Effective

In 1963, two insecticides were found to give satisfactory control against the cereal leaf beetle--carbaryl (Sevin) and malathion. Carbaryl is preferred because it kills the egg as well as larva and adult, and because it retains its "killing power" for 2 to 3 weeks. Malathion is effective only against the larva and adult in the field and only at the time it is applied. Beetles flying into the field 2 days after application are not controlled.

CARBARYL (SEVIN) IS NOT REGISTERED FOR USE TO CONTROL THE CEREAL LEAF BEETLE AT THE TIME OF WRITING THIS PUBLICATION. However, it is expected to be registered some time in the spring of 1964.

When and How to Spray

Below are the malathion and carbaryl formulations and rates to use and the recommended time of application for best control.

In most cases, one application of carbaryl will be sufficient. However, in areas of heavy infestation (presently, only in parts of LaPorte and St. Joseph counties), an early application on oats soon after emergence may be necessary to protect the seedlings from adult beetles.

More than one application of malathion is probably needed in heavily infested fields. Wheat, oats and barley can be sprayed with malathion up to 7 days of grazing or harvesting.

REGULATION OF INFESTED AREAS

To help prevent the spread of the cereal leaf beetle, infested areas in Indiana, Michigan and Ohio are regulated under quarantines established in accordance with state laws. This means that many commodities moving out of these regulated areas must be certified as cereal leaf beetle-free. In Indiana, this regulatory action is enforced by the Entomology Division of the State Department of Conservation in Indianapolis.

Insecticide and formulation	Amount to use	When and how to apply
Malathion emulsifiable concentrate	One lb. actual toxicant per acre (e.g., 1/5 gal. of a 5 lb. per gal. concentrate).	Spray infested crop when many small larvae present or when they average about one larva per stem.
Carbaryl (Sevin) 50% wettable powder OR 80% flowable powder	One lb. actual toxicant per acre (e.g., 2 lbs. of 50% wettable powder or 1 1/4 lbs. of 80% flowable powder). For best control, ADD sticker WC-130 (Union Carbide) at 2 oz. per lb. of Sevin.	If using weed-type sprayer, apply with 10 to 12 gals. water per acre. If airplane spraying, apply with 1 gal. water per acre. Low level flying necessary when applying malathion.

ACKNOWLEDGEMENT

The authors wish to thank J. J. Favinger, State Entomologist, and others of the Entomology Division, Indiana Department of Conservation, for their assistance and loan of the color plates used in this publication.

Much of the information presented here was obtained through cooperative research with entomologists at Michigan State University.