PROCEEDINGS

of the

20th Annual Northwest Turfgrass Conference

October 26, 27, 28, 1966
Gleneden Beach, Oregon

NORTHWEST TURFGRASS MEMBERSHIP DUES

	Annual dues
Golf Courses—	
Less than 18 holes	$20
18 holes or more	40
Nursery, landscaping and ground spraying firms	20
Architects and engineering firms	20
Equipment and material supply firms	20
All others	20
Cemeteries—	
Less than 400 interments per annum	20
400 to 600 interments per annum	25
600 to 800 interments per annum	30
More than 800 interments per annum	40
Park Departments—	
Less than 150 acres total area	20
150 acres or more	40

1. Annual Dues payable on or before May 15th each year. Dues are based on annual due date nonprorated.
2. Membership includes registration fee for one person at Annual Turf Conference. Other persons from member organization registration fee $5.00.
3. NO INITIATION FEES ARE CHARGED.
4. Nonmembers may attend the annual Conference by paying $10.00 registration fee. For further information on dues, contact Northwest Turf Treasurer.

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HARVEY JUNOR

It has been an honor to serve as President this past year. I want to thank all the board members and committees for their combined efforts that has made this position one of enjoyment.

This being our 20th Conference of the Association, I would like to pay tribute to the group of men who worked hard to get this organization started. The increased growth of the Association each year shows the benefits derived from these programs and that more people each year are becoming aware of the progress in the turf field.

NORTHWEST TURFGRASS ASSOCIATION

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*New officers for 1967 will be elected at the Annual Membership Meeting to be held on October 27, 1966.

TABLE OF CONTENTS

Public Relations for You--Warne Nunn.................... 3
More Land for the People--Alvin G. Law.................. 9
Weed Control in Ornamental Plantings--Arthur S. Myhre... 15
The Action of Applied Herbicides--Arnold P. Appleby..... 17
Survey of Oregon Golf Facilities--Norman R. Goetze...... 21
Panel Discussion, Fungicides--How to Use Them Most Effectively - Stan A. Frederiksen, Ken Putnam, John A. Zoller, and Charles J. Gould.................. 28
Physiological Drouth - As Influenced by Fertilizer Salts--Charles G. Wilson.............................. 48
The USGA Green Section - Past, Present, and Future-- William H. Bengeyfield................................ 52
Weed Control Related to Leaf Surfaces--A. J. Renney and D. J. Ormrod.. 58
Ice Sheet Injury to Turf--S. Freyman and V. C. Brink.... 64
Frost Protection--J. R. Watson.......................... 68
Panel Discussion, Properly Constructing Putting Greens and Athletic Fields--Roy L. Goss, Ken Putnam, Glen Proctor, Henry Land, Sr., and Milt Bauman............ 74
Agronomic Research Report 86
Turfgrass Diseases - A Research Progress Report-- Charles J. Gould.. 88
Minutes of the Research Committee Meeting............... 91
Northwest Turfgrass Association Membership.............. 97

Public Relations For You

Warne Nunn[1]

I am particularly pleased to talk to you today on the subject of public relations. This is an area of our business lives that is fast becoming a key factor in every decision. We don't make a move without considering its effect on our customers, our employees, or for that matter the community where our plant or office is located.

Years ago, some business could adopt a public-be-damned attitude and get away with it....for awhile. But as long ago as the 1920's businessmen began to learn that it pays big dividends to learn what motivates people and how to employ that knowledge to their own ends. Sometimes the employment of that knowledge brought discredit, but generally, the conduct of the PR profession and its assimilation into the every day business scene has not been exceptionally disorderly.

The hit and miss approach, that was part and parcel of the field's development, though, is fast disappearing. The complexities of business and a complicated social structure vastly expanded by phenomenal growth demands a deeper knowledge of people and a complete understanding of how to communicate with them. How well you do the job may decide your future just as much as your advertising, sales promotion and merchandising practices. And gaining the support and cooperation of others through persuasion, I might add, is more than a part of the day to day business of commercial firms. It is also an important function of labor unions, universities....even welfare agencies.

While few businessmen will debate the essentiality of PR today, there seems to be a virtual forest of ideas of what it entails. This reflects the fact that the field is

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[1]Executive Assistant to Governor Hatfield, State Capitol, Salem, Oregon.

still in a fluid state with the function embracing whatever it is assigned to do. Some of you think of PR in terms of press releases and nothing else. Others equate the function with the after dinner speech, or the institutional paper, or house organ, sales promotion, lobbying and a host of other things. Actually, it embraces all these....and sometimes they are not too clearly defined. This leads to confusion.

Basically, a college professor will define PR as the management function which evaluates public attitudes, identifies the policies and procedures of the organization with the public interest, and executes a program of action to earn understanding and acceptance. In plain words this boils down to simply good performance, publicly appreciated because you have gotten your message across.

I think Inger Christensen, Deputy Manager of PR for the Scandinavian Airlines, put it best when he said:

> "If when a boy meets a girk, he tells her how lovely she looks, how much she means to him and how much he loves her, that is SALES PROMOTION. If instead, he impresses on her how wonderful HE is, that is ADVERTISING. But, if the girl seeks him out because she has heard from others what a splendid person he is, that is PUBLIC RELATIONS."

How do you achieve an image and a reputation that causes the public to seek you out in a competitive world? Simply by telling your story to all your publics in an honest, forthright and believable manner long enough to make truth, integrity and trust synonymous with your name. Your tools are words....simple, easy to understand words, and communications. This you may say is over-simplification. But it isn't. You must learn to express your message in the people's language and to make it accessible to them. Jesus was the first known master of this technique. He spoke simply and used parables to get his ideas across. No one yet has come forth with a better way for all our sophisticated knowledge that can launch a man into space.

Public relations, like charity, begins at home....with your employees. The employee, not your customer or the people in the community, is your primary public. You must make him aware of your aims and objectives, of market conditions, of the part he plays in the big scene. You have to have his confidence, and his support and you win it by employing the PR function internally. You use the plant bulletin board, meetings, pay envelope insert, posters or if you are large enough, the company paper to get your message to him. It takes time to build company spirit in the employee and it is worth every minute you invest. Through such programs he learns to tell the company story from your point of view. He learns to speak out unhesitatingly about, and more important for your firm, at home, at meetings or to individuals wherever he goes. So then does his family, his grocer, his mechanic, his doctor and all the rest of his contacts.

The points of contact between your firm and your customers will vary, depending on the nature of your business. There may be many or few opportunities for your employees to meet the public. But each contact they make is important, trivial though it may appear at first. And the employee does not have to be in the public relations department or have a college degree to qualify as a public relations representative. If you have had good internal PR, the secondary communication process will automatically go into action and your reputation will be enhanced. If not, well....the switchboard operator who handles incoming calls, the secretary who writes your letters, the salesman who calls on customers, even the bookkeeper discussing his job with his friends -- all have real opportunities to affect the public image of your firm.

I recall a story I once heard that makes my point in this area of the employee and PR. It was about a store owner back in the days when people called in their orders and had them delivered. The self-service chain store hadn't yet gained a real foothold. Most people did business with the independents because it was the easiest thing to do and prices were competitive....fiercely competitive. Yet this store was immensely successful. Its owner was the envy of all those in the business. What was his secret? Internal PR! In an effort to get more business in the face of the toughest possible competition this man instead of turning to cheaper quality merchandise and trying to operate with fewer employees, held periodic meetings with his employees. They were kept informed. Grievances were aired and solved. Each employee learned the what, why and wherefore of the business. But there was a special emphasis put upon the people who answered the phones and of all things, upon the delivery boy....especially the latter. These were the people that were in contact with the customer. The delivery boy was the last person to see and the only person to make a personal contact during a transaction. Hand picked, well trained, courteous and efficient, the delivery boy was the image of the store, not the building or the man who developed the enterprise. Times have changed. The delivery orieted store has all but disappeared. The techniques learned by this man, however, remain, expanded, refined and widely recognized.

They are employed extensively in state government. You see the result in our state parks. The attendants are neat, courteous and informed. Certainly they are human and we occasionally learn about moments of indiscretion. But in the vast majority of cases of reports received from visitors, the internal PR program practiced by this important division of the State Highway Department really works. It has to. Many tourists use the parks and their business contributes much to Oregon's economic well being. Last year out-of-state tourists spent $250,460,000 in Oregon. Nearly three-fourths of that figure came from the 5,792,375 tourists that came by automobile. The people count and the dollars they spend here with our businesses have increased every year. Preliminary estimates show that the count is up again this year. So our parks PR is working and paying off....and will continue to do so as the program is improved and refined.

As members of the Northwest Turfgrass Association it will interest you to know that apart from coming to see our parks and many natural scenic wonders, these millions of tourists came also to play the nearly 100 golf courses located around the State. The city of Portland now has more golf courses per capita population than any city in the United States. The courses are beautiful and go hand in hand with our State's invitational program, "Oregon--Cool, Green Vacationland." Our visitors are drawn to Oregon and to our parks and golf courses by advertising it's true, but the reception they get here, our good or our bad PR, will be the deciding factor in getting them to return year after year. It's up to us to see that they go back happy and satisfied....radiating the good word to all the home folks.

The Governor is acutely aware of the important part PR plays in the development of the State's economy. He has initiated such programs as "Beautiful Oregon" and "Operation Company's Coming" to expand this awareness to the local communities. He repeatedly calls attention to the fact that well-kept "Oregon Green" lawns are critical elements of the image we want people to have before and after they visit this state.

The Governor called attention some years ago to the need to provide the vacation complex or total facility as a means of attracting conventioners as well as to satisfy the more sophisticated tastes of the out-of-state visitor. This convention is located in one of the state's finest examples of that kind of facility. Salishan is self contained....it offers the finest of dining, golf, swimming and loafing facilities. It provides for the children - so often forgotten, and the entire complex is beautifully and tastefully landscaped. They evidently do their internal PR judging from the spontaneous response from visitors and travel editors remarks in out-of-state newspapers and magazines.

What I have told you here today is not new. The state of the art as it exists today leaves ground for great latitude in understanding and application of the communication process. However, I think I have touched on the most elemental and important element, internal PR. If you do a good job with your internal program -- you're ready to tackle the public. When you do you will find the same principles apply -- that is "X (the deed) plus Y (the interpretation of the deed) equals Public Attitude."

More Land For The People[1]

Alvin G. Law[2]

World-wide famine is here now. It will affect everybody. It must be recognized as a real threat affecting the people of this and the next generation.

Current newspaper headlines read --- "U. S. Surplus is Gone." As a result of growing exports, especially to the countries of the Far East, the Food For Peace program, and various restraints on production, excess stocks of most foods in the United States have now declined to levels below that needed for our own reserves. The Secretary of Agriculture is seriously considering limits on wheat exports. Corn and rice reserves are dangerously low. The only crops in surplus at the present time are cotton and tobacco. Neither of these, of course, are of use in the war on world-wide famine.

International Minerals and Chemical Corporation, Skokie, Illinois, has assessed the world-wide famine - population problem and have concluded that right now, today, nearly 1/2 of the world's population does not get enough to eat. This means that more than one and one half billion people in the world are either undernourished or actually starving.

Where are these hungry people? Certainly, generally speaking, not in the United States nor in Canada, probably not in Western Europe; they can be found in the underdeveloped countries of India, adjacent China, --- in this area of Eastern Asia and in some Latin American Countries.

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[1]Paper presented at the Annual Pacific Northwest Turfgrass Association Meeting, 1966.

[2]Agronomist, Washington State University, Pullman, Washington.

To understand the problem it is necessary to look at the world situation as far as population is concerned. The problem stated simply is that there are too many people in the world and they are increasing too rapidly. Presently, there are roughly 3 billion people living in the world. United Nation's population estimates show that there will be 4 1/2 billion people by 1980 and by the year 2000 there will be between 5 and 7 billion people. Most population experts, including the United Nations committee to study this problem, place the estimate at 6 billion people. This means that from now till the year 2000 the population in the world will double. In 36 years there will be twice as many people on the world as there are now. It took approximately 100 years from 1850 to 1950 for the population to double. Prior to that it took 200 years from 1650 to 1850 for the population to double. Stated simply, human population tends to increase on a geometric basis, that is 1, 2, 4, 8, 16, etc.

This is what the Reverend Robert Malthus tried to tell the world 200 years ago. This truely is a decade of crisis, a decade in which mankind must establish that it can organize its collective forces to assure its food supply on a world-wide basis so that everyone will have essential nutrition.

Why are there suddenly too many people in the world? For one thing, we are enjoying a longer life span. This is particularly striking in the less developed country of India where from 1946 to 1966 the life expectancy of the average person in India has increased from 27 years to 48 years. Medical advances have also reduced mother mortality and infant mortality to a striking degree in many of the under-developed countries.

Where actually is the population problem the most serious? It is most serious in the Eastern Asis countries of India, China, and the adjacent smaller countries. It is serious, also, in the Latin American countries and in Africa. International Minerals and Chemical Corporation people estimate that by the year 2000 the combined population of Asia, Africa, the Near East, and Latin America will exceed 5 billion people. If this is true, this means that more than 80% of all the people on the earth will be living in Asia, Africa, the Near East, and Latin America by the year 2000. These are the so-called less developed countries, at least agriculturally. These are the countries where starvation is rampant. These are the countries where the present intake of food is roughly 60% of the intake level in the United States. Even more serious, these are the countries where the intake of animal protein is less than 12% of the level in the United States.

What then can be done to stave off disaster, disaster which faces us certainly by the year 2000 when we are faced with the chore of feeding twice as many people as now live on the earth?

Two things must be done if mankind is to survive and prosper on the earth: 1) The birth rate must be brought under control throughout the world, and 2) World food production must be vastly increased.

The first problem, that of birth rate, has deep and serious sociological and theological implications. Birth control in a positive way at least, strikes at the very foundation of culture of certain nations and certain religions. Nevertheless, assuming we escape the holocaust of nuclear warfare in the next several decades, birth control must be given most serious consideration.

Let us turn to the problem of food production which is receiving tremendous attention throughout the world at the present time. There is currently under cultivation in the world 3 1/2 billion acres. International Minerals and Chemical Corporation estimate that we can increase the acreage under cultivation by 2 1/2 billion acres. This means if we apply all of the technology that is now available to mankind and if we develop new technologies in the next two decades we can possibly add 2 1/2 billion acres to the total arable land in the world. Thus, by the year 2000 we would have about 6 billion acres of arable land; the equivalent of one acre for each person on the earth. This is a careful estimate by IMCC based on a comprehensive survey of the agricultural lands of the world. This also presupposes the development of vast networks of canals for moving water from areas where it is a surplus to areas where it is needed badly. It presupposes the development of a vast tropical agriculture, something that has not yet been accomplished.

Let us review the facts briefly at this point. We currently are cultivating 3 1/2 billion acres of land. World population is currently slightly in excess of 3 billion people and half the world is hungry today. If we double population by the year 2000 and if we increase the arable acres by only 2 1/2 billion, it is clear that more than half the people will be hungry in the year 2000.

What can be done about food production? In the developed countries of the world, such as western Europe, North America, Japan, Australia, and New Zealand, we have seen in recent years an almost 1:1 relationship between population increase and food increase. This means that yield per acre of food crops, wheat, rice, even animal products in these developed countries has been increasing at a rate almost the same as the population increase in these developed countries. This yield "take-off" has been made possible through the efforts of plant breeders, fertilizer specialists, disease control experts, and all of the science and technologies that have developed in rapidly developing countries such as the United States. It presupposes a vast background of scientific knowledge plus the ability to apply this scientific knowledge and the willingness to change rapidly when new innovations are discovered. It presupposes a great deal of financial backing to permit the utilization of vast amounts of management input such as fertilizers. Also, in these same developing countries birth rates are much below the birth rates in the less rapidly developing countries. For example, in the United States we have a rate of increase in yield of agricultural products of 3.7%. Our population increase is 1.7%. India, on the other hand, has a percent increase in agricultural production of .7% per year with a population increase per year of 2.2%. Therein lies the problem.

Can the more developed countries such as the North American continent, Western Europe, Japan, Australia, and New Zealand feed the rest of the world? Without major breakthroughs in the way of new developments in food production, obviously we cannot feed the rest of the world. What are some of the breakthroughs that may be possible? It has been suggested that we develop synthetic foods much the same as we have developed synthetic fibers. These would be supposedly developed from the world fossil mineral reserves, since these fossil reserves are largely hydrocarbons and can be modified by chemists into many, many products. However, when we are dealing with fossil reserves such as crude oil and coal we are dealing with products which in themselves are limited. We are currently using these fossil hydro-carbons at a rate that will see the depletion of the known reserves of crude oil, at least, within the next 100 years or so. We have perhaps a 600-year supply of fossil fuel in the form of coal. However, if the less developed countries start developing their technologies similar to that of the United States, we will witness a very rapid increase in the use of these fossil fuels. Thus, it does not appear that the permanent solution to the food supply is the development of synthetic foods from the hydro-carbons stored during the formative eons of the world's origin.

It is possible to develop more crude production per acre by the use of leaf proteins from plants such as alfalfa with new techniques for harvesting and for preservation. With the elimination of livestock populations and the direct consumption of leaf proteins, some people have estimated that we could double the production per acre from the arable lands of the world. This is not a pleasant prospect to anyone who enjoys an occasional T-bone steak.

Given enough time and unlimited research, perhaps we can harness sunlight through the photosynthetic process in green plants to produce a greatly increased amount of food in the world. Perhaps also we will have developed nuclear energy to the place where we will not need to use fossil oil fuels at the present rate of 320 billion barrels per year. We should also make vast strides in developing a food production industry based on "farming" the sea but only if we direct unlimited energies to the effort.

At the same time we must realize that food and land shortages are not our only problems. Today automobile wastes far out distance all other sources of air pollution. Exhaust modifications can reduce contamination from unburned petroleum but the nitrogen oxides from the motor and the long chain hydro-carbons given off from tires at the rate of hundreds of tons per day in Los Angeles alone remain major unsolved problems.

Carbon dioxide, the principal product of combustion of fossil fuels, threatens to stiffle the world. It is estimated that by the year 2000 the CO_2 content of the air will have increased by 25 percent. This will have a major effect on world climate but no one will hazzard a guess as to what that effect will be.

Add to these woes the problem of water supplies and it becomes clear why we oldsters talk longingly about "the good old times." Hydrologists tell us that only in the Pacific Northwest are there major streams yet uncontaminated by human wastes. Drinkable water is becoming more precious than uranium and, in fact, may become a major factor limiting population.

However, all evidence presently indicates that if we are to permanently silence the floomy ghost of Malthus, we must do so by a combined program of world-wide family planning plus world-wide development of food production utilizing every bit of technical knowledge at our disposal. Only by a combined approach to this problem can the world survive in it's present form.

What has this to do with golf courses and turf specialists? There will likely be 12-15,000 golf courses in the United States by 1975 compared to 8,123 courses in 1965.

This will involve at least 500,000 acres; over 7.7 million people play golf annually.

Freeways, suburban homes, and shopping centers are gobbling up agricultural land at the rate of 150,000 acres a year in California alone. In the United States it is estimated we are covering with concrete and asphalt over 6 million acres per year. At the same time we are moving toward a 4-day or perhaps even a 3-day work week with the consequent greater leisure time. This in turn means more people looking for room to play golf, to camp, to fish, and hunt. Unless present trends are drastically modified, these areas will not be available. Only by a vigorous program of population regulation, natural resource conservation and increased agricultural efficiency can the United States survive, let alone help other nations.

Weed Control In Ornamental Plantings

Arthur S. Myhre[1]

Pacific Northwest's moderately cool summer temperatures, relatively warm winters and abundant moisture cause weeds to grow and spread so rapidly that much time-consuming and back-breaking effort is necessary to keep weeds under control. Weed control experiments under way at the Western Washington Research and Extension Center, Puyallup, Washington, have definitely established the value of certain pre-emergence herbicides for killing weeds in ornamentals.

Excellent control during the summer and fall of annual weeds such as pigweed, lambsquarter, groundsel, pineapple weed, chickweed, smartweed, wild mustard, shepherds purse, annual bluegrass, etc. is possible by applying these type

[1]Associate Horticulturist, Washington State University, Western Washington Research and Extension Center, Puyallup, Washington.

herbicides in spring or early summer. If applied in the fall, good winter and spring control of the weeds can be obtained.

In our tests, herbicides are applied by machine to ornamental nursery stock grown in field rows so that uniform and accurate distribution of material is obtained. This is extremely important with broadleaved evergreen shrubs since some are sensitive to certain herbicides if applied above recommended rates. It is possible to apply them by hand to ornamental planting around the grounds and buildings of golf courses, parks, arboretums, etc. However, if applied in this manner, extra precaution should be taken to obtain uniform distribution of the desirable rates.

With most pre-emergence herbicides, it is important that the soil be prepared so that no standing weeds remain prior to application since they generally are most effective in killing small weed seedlings. Best results are obtained when water is applied directly after herbicide application in order to activate the chemical and to direct it to the roots of germinating weed seeds. Soil thereafter should remain undisturbed.

Of the herbicides tested during the past nine years, Simazine, Herban, and Casoron have shown much promise and will do a fine job of controlling many kinds of weeds with little or no damage to a wide range of ornamental plants. Simazine 80 W has long residual life and will give excellent all summer control of annual weeds. Used at proper rates no damage has occurred on such coniferous evergreens as Arborvitae, Cypress, Yew and Juniper. Continuous yearly applications has caused some damage to certain broadleaved evergreen shrubs, however. Herban 80 W has fairly long residual life and has given good to excellent summer control of most annual weeds with no injury to many ornamental shrubs. Certain azaleas and boxwood, however, have shown sensitivity at the higher rate. Herban has appeared very promising for such herbaceous perennials as chrysanthemum, Shasta daisy, and Ajuga. Casoron has fairly long residual life and has given fine summer control of annual weeds with no damage to most plants tested. Casoron is most effective if it is lightly incorporated into the soil after application. Casoron has given excellent control of field horsetail, a common perennial weed in western Washington and also shows promise in our tests of controlling quackgrass when applied under certain conditions.

Paraquat, a contact herbicide, has been under observance and shows promise. Contact herbicides are those that kill plant tissue to which they are applied. They are effective in killing small annual weeds but will only burn off the tops of perennial weeds. Care must be exercised to apply them as a directed spray around ornamental shrubs at moments when air movements are quiet. Because there is no residual activity, further spraying is necessary to kill weeds that emerge later. Tests are being conducted in which Paraquat is combined with pre-emergence herbicides to further increase their usefulness.

The following chart shows amount of plant injury from Simazine, Casoron, and Herban sprays. These were applied at two rates each spring for a period of 4 years.

The Action of Applied Herbicides

Arnold P. Appleby[1]

For purposes of discussion, herbicides can be classified into foliage-active compounds and soil-active compounds. Of course, many herbicides can act both through the foliage and through the soil. Often knowledge of how these herbicides are taken up and moved within a plant and how they produce their toxic effects is of direct practical benefit to those using the materials. This paper will be a

[1]Assistant Professor of Agronomy, Oregon State University, Corvallis, Oregon.

Estimation of Plant Damage*

Plant	Chemical (Formulation lbs/A)					
	Simazine 80 W		Casoron 50 W		Herban 80 W	
	2.0	4.0	6.0	12.0	4.0	8.0
Broadleaved Evergreen Shrubs						
Arctostophylos uva-ursi - Kinnikinnick	0	0	-	-	-	-
Buxus sempervirens - Boxwood	1	2	0	0	1	2
Cotoneaster horizontalis - Rock Cotoneaster	0	0	-	-	-	-
Erica darleyensis - Mediterranean Heather	0	0	-	-	-	-
Ilex aquifolium - English Holly	0	0	-	-	-	-
Ilex crenata - Japanese Holly	0	0	0	0	0	0
Laurocerasus zabeliana - Zabel Laurel	0	0	-	-	-	-
Osmanthus Delavayi - Osmanthus	0	0	0	0	0	0
Pieris japonica - Japanese Pieris	0	0	0	0	0	0
Rhododendron - pemakoense	0	1	0	1	0	1
" - Bowbells	0	0	0	0	0	0
" - Blue Diamond	0	0	0	0	0	0
" - Cynthia	0	0	0	0	0	0
" - Jock	0	0	0	0	0	0
" - Sapphire	0	0	0	0	0	0
" (Azalea) - Caroline	1	2	0	1	0	1
" " - Hinodegiri	1	3	0	0	0	2
" "" - mollis	1	2	0	0	0	1
" " - mucronatum	0	0	0	0	0	0
" " - Rosebud	0	1	0	0	0	0
Viburnum Davidii - Viburnum	0	0	0	1	1	2
Viburnum tinus - Laurestinus	0	0	-	-	-	-

Estimation of Plant Damage (continued)

Coniferous Evergreens						
Chamaecyparis Ellwoodii - Ellwood Cypress	0	0	-	-	-	-
Chamaecyparis Cyano viridis - Blue-green Cypress	0	0	-	-	-	-
Chamaecyparis Plumosa - Plume Retinospora	0	0	-	-	-	-
Juniperus Pfitzeriana - Pfitzer Juniper	0	0	-	-	-	-
Taxus baccata - English Yew	0	0	-	-	-	-
Taxus b. Repandans - Spreading English Yew	0	0	-	-	-	-
Thuja Globosa - Globe Arborvitae	0	0	-	-	-	-
Thuja Umbraculifera - Dwarf Arborvitae	0	0	-	-	-	-
Perennial Ground Covers	2.0	3.0	6.0	12.0	4.0	6.0
Euonymus radicans - Wintercreeper	0	0	0	0	0	0
Hedera helix - English Ivy	0	0	0	0	0	0
Hypericum calycinum - St. Johnswort	0	0	0	0	0	0
Pachysandra terminalis - Japanese Spurge	0	0	0	0	0	0
Sedum spathulifolium - Stonecrop	0	0	0	0	0	0
Thymus serphyllum - Creeping Thyme	1	2	0	0	0	0
Vinca minor - Periwinkle	0	0	0	0	0	0

*Plant damage ratings: 0 = no damage; 1 = slight; 2 = moderate; 3 = severe.
- = plant has not been tested with this chemical.

general discussion of some of the fundamental principles involved in the use of both foliage-applied and soil-applied herbicides.

The process of absorption of the herbicide into a plant leaf, although sounding rather simple, is really a rather complex procedure. Environmental conditions before, during and after spraying; herbicide formulation; volume of carrier; surfactants; etc., can all have a considerable bearing on the performance of foliage-applied materials. Herbicides can enter the plant leaf either through the stomates or through the cuticle. Although under some circumstances stomatal entry can be of some importance, it is generally agreed that cuticular entry is more common. The cuticle and outer wall of the epidermal cells consist of four materials: waxes, pectin, cellulose, and cutin. The properties of these materials directly influence the manner in which a herbicide can penetrate the leaf. Waxes are oil-soluble and are readily penetrated by many organic solvents but generally resist water. Pectins and cellulose are hydrophylic; that is, they can absorb water or other water-soluble materials. Cutin is a sort of hybrid material that is partly oil-soluble and partly water-soluble. It can act as a binding agent between the lipophilic wax and the hydrophilic pectins and cellulose. It would seem at first glance that a water-soluble herbicide would have a very difficult time getting into the plant leaf because of the wax barrier. Fortunately, however, this waxy leaf generally has many cracks, insect punctures, mechanical injuries, etc. Also, some areas of the waxy layer are impregnated with cutin which has the ability to absorb a certain amount of water, offering a pathway for the water-soluble herbicide to travel in passing through the waxy barrier. Pectins and cellulose can likewise absorb water, causing them to swell and allowing a much easier penetration of water-soluble herbicides. This partially explains why greater activity is often observed with water-soluble herbicides under high humidity conditions. Oil-soluble herbicides can move through the cuticle primarily through the waxes and oil-soluble part of the cutin. Water-soluble herbicides, then, transverse an "aqueous" route and oil-soluble herbicides follow a "lipoidal" route.

Once inside the plant a herbicide can move in a number of ways. Sometimes a heavy rate of herbicide can be so toxic that the translocating tissue is destroyed and movement is stopped. This can happen, for example, on broadleaf weeds treated with 2,4-D ester. 2,4-D ester is usually less effective on field bindweed than is 2,4-D amine simply because less translocation to the root occurs. In this case the 2,4-D amine acts slower and moves to the roots in greater quantities.

Although the application of foliage-applied herbicides can offer some complex problems, those problems involved with soil-applied herbicides are perhaps even more complex. A great number of things can happen to a soil-applied herbicide to prevent it being taken up by the weed. Herbicides can be lost by volatilization, breakdown by soil microbes, leaching, adsorption on soil, photodecomposition, and chemical breakdown.

Soil adsorption can be defined as the chemical and physical attraction between the herbicide and soil particles. Several things can influence the extent of soil adsorption including soil moisture content, the texture of the soil, temperature, and perhaps most important of all, the organic matter content. When a herbicide becomes tightly adsorbed to the soil it is unavailable to the roots of plants and, therefore, is rendered ineffective.

Soil moisture can be an extremely important factor in the effectiveness of soil-applied herbicides. Too little overhead irrigation or rainfall can result in the herbicide being left on the soil surface and not available for uptake by plants. Excessive irrigation can force the herbicide deep into the soil, often too deep for uptake by shallow rooted weeds but available for uptake by desirable shrubs.

An important factor in determining the persistence or the soil life of a herbicide is the activity of soil microbes. Some herbicides are extremely susceptible to breakdown by soil microbes while others are quite resistant to breakdown. In general, herbicides will remain intact in the soil under cold, dry conditions and will be broken down most rapidly under warm, moist conditions.

The mode of action of herbicides is a very complex subject and one that cannot be discussed completely here. Often our understanding of the mode of action of herbicides is limited by the fact that we do not yet know exactly how the normal plant metabolism operates. No one knows yet exactly how 2,4-D kills plants. Evidence is being accumulated to indicate that a major part of attack of 2,4-D is on the nucleic acid metabolism, specifically RNA. However, only time and a great many more experiments will completely clarify this. Amitrole inhibits the formation of chlorophyll, giving treated plants the characteristic white color, but its major mode of action appears to be in purine metabolism. Many herbicides (ureas, triazines, uracils) inhibit the Hill reaction in photosynthesis, in effect starving the plants to death. However, it is generally agreed that some other mechanism(s) must also be inhibited by these herbicides. The processes involved in the successful use of both foliage-applied and soil-applied herbicides are very complex and as yet incompletely understood. A great deal needs to be learned. However, it can be said that certain fundamental principles apply and that as our knowledge of these principles increases, our effectiveness in using herbicides will also increase.

Survey of Oregon Golf Facilities

Norman R. Goetze[1]

Detailed financial information on the operation of Pacific Northwest golf facilities has been lacking. Recent

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rapid increases in numbers of golf installations and rising costs of operations have raised questions about the current financial strength of the units. The purpose of this survey was to determine the intensity of use of golf facilities, the cost of operation, the total capital invested in golf facilities, and the financial returns to capital and management for the use of the facilities.

Questionnaires were sent by mail to superintendents, managers or owners of all known golf facilities in the state in February 1966. Thirty-three useable replies were received from the 101 facility managements. Various totals for the entire 101 facilities in the state were projected by type of ownership and size, assuming that the useable replies were typical of their group. The facilities can be characterized as follows:

Type	Number of facilities	Number of holes
Private courses		
9 holes	17	153
18 holes	16	288
27 holes	1	27
Public courses		
9 holes	38	342
18 holes	20	360
36 holes	1	36
Par 3 or pitch and putt courses		
9 holes	3	27
18 holes	5	90
Total	101	1323

The intensity of use of golf facilities is shown in the following table:

Type of facility	Range/year	Average	Total number facilities in state	Oregon projected total
Public				
9	6,000-36,000	15,492	38	605,796
18	20,000-60,000	43,333	20	866,660
			Sub total	1,472,456
Private				
9	2,400-36,900	16,800	17	285,000
18	900-85,000	60,128	16	962,048
			Sub total	1,247,048
Others*				1,114,618
			Total 9-hole rounds	3,834,122

*Includes all par 3 facilities and any facility with more than 18 holes.

The range in number of rounds per year varied from 900 to 85,000 per facility. Also, notice that the average number of 9-hole rounds per facility is more than doubled on 18-hole courses in both public and private categories. The projected annual total rounds of golf played in the state was 3,834,122. Assuming the minimum age of persons playing golf to be 10 and the estimated 1965 Oregon population of 1,556,026 persons 10 years or older, there were approximately 2.5 rounds of golf played per eligible person.

The estimated projected value of the entire golfing facilities in Oregon, on the basis of the questionnaire, was found to be $28,694,294. This total value consists of land, service and maintenance buildings, and machinery and equipment. (Note that all clubhouse and pro-shop facilities were excluded). Considering an equal value for all types of golf facilities, the average value of each of the 1,323 holes would be $21,689.

The individual and total projected operating costs for the various types of golf facilities were calculated. Total cost contained five components: (1) interest on investment which was 5% of the total inventory, (2) depreciation which was either taken from the questionnaire or if calculated was 10% of the machinery and equipment, (3) the total payroll expense, (4) total materials and supplies expense, and (5) the custom work hired expense. On the basis of the questionnaire, the following table was constructed:

Estimated operating costs for 9 and 18-hole golf facilities

Type of facility	No. of holes	Estimate ave. oper. cost per facility	Estimate ave. oper. cost per hole	Estimated operating cost per 9-hole round
Private	9	$22,681	$2,520	$1.35
	18	81,635	4,535	1.36
Public	9	28,220	3,136	2.23
	18	64,813	3,601	1.49

State projected estimate of total operating cost* was - $4,602,274.

*This included all types of facilities (weighted averages were used in arriving at this figure).

Costs of maintaining the private 18-hole course was more than on a public 18-hole course. The costs per 9-hole round on these same courses were less because of the higher rate of use on the private courses. It is interesting to note the lower cost of operation on public courses having 18-hole facilities as compared to only 9. This again is partly a result of increased play and greater efficiency of labor and equipment.

The total charges for playing golf on these facilities were estimated to be $6,702, 672, exclusive of personal equipment used in the game. Charges made at private clubs more than offset the costs of the golf facility. The costs and returns at seven public courses are shown in Chart 1.

Costs of supplying a 9-hole round of golf varies from $1.25 to $4.10 among the seven courses. The weighted average fee charged was $1.48. Only one of the seven public courses had costs below that level. This was partly related to its second highest percentage of rounds played. Many of the facilities showing losses are actually realizing gains on a cash basis, but the operators have ignored total land values and equipment depreciation in their calculations of net returns.

If the public facilities in this study are to operate at a profit, the number of rounds per year and/or the charge per round must be increased. Possibilities for decreasing costs in the current economic climate appear remote.

Additional details on maintenance costs were obtained in the survey but will be reported elsewhere later.

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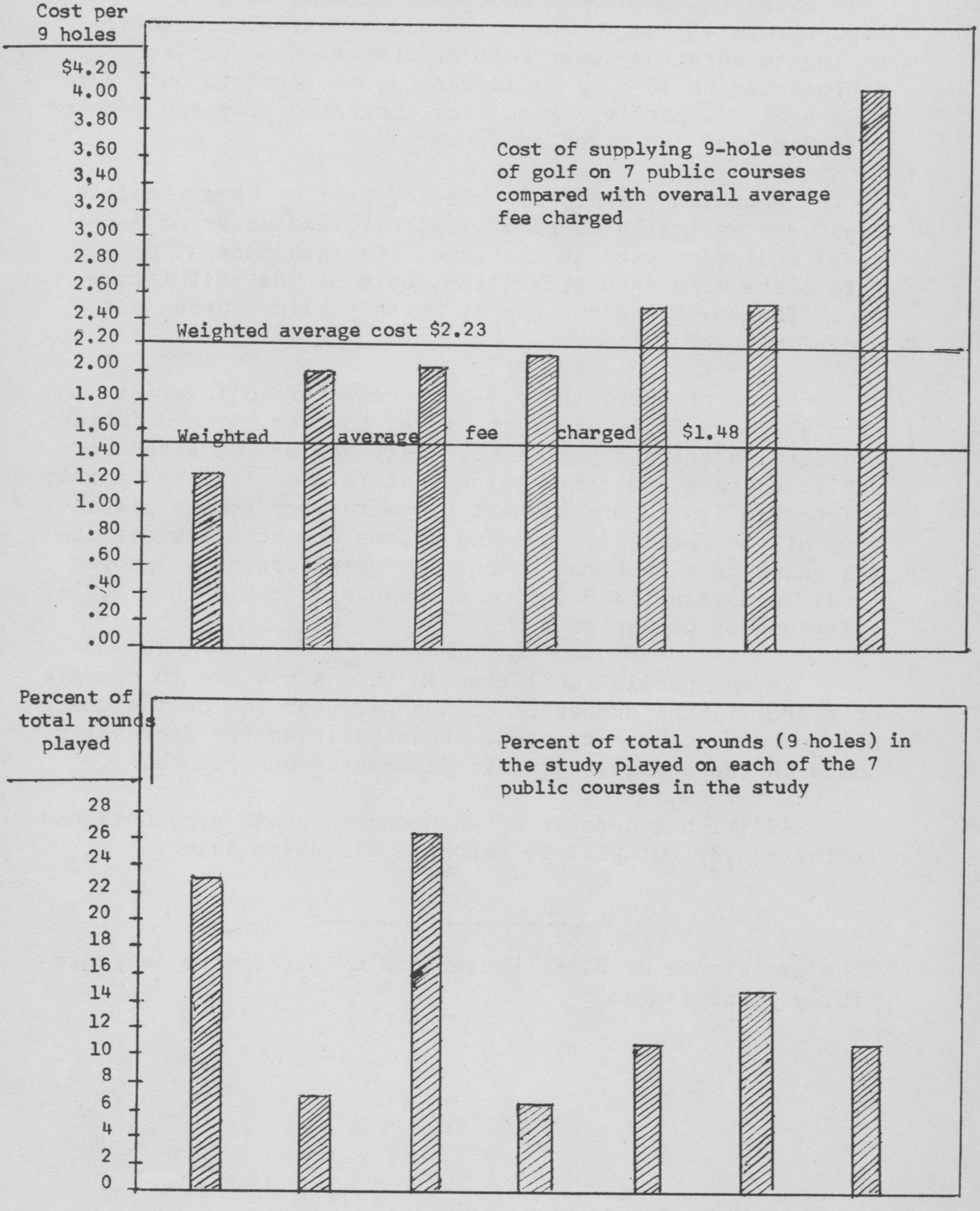
*The assistance of R. E. Fluter and C. D. Mumford is gratefully acknowledged.

Chart 1

Individual costs, and average costs and returns per round of golf (9 holes), and percent of total rounds in the study played at each of 7 public courses, Oregon, 1965
(7 individual public golf courses, Oregon, 1965)



Fungicides — How To Use Them Most Effectively

-Panel Discussion-

The Development of Turfgrass Fungicides

Stan A. Frederiksen[1]

On a certain summer day in 1921, which would be about 45 years ago, George Smith, greenskeeper, went out with his greens chairman to look at No. 5 putting green. It had looked fairly good only the day before - but something certainly was wrong with it now! In various sized spots, the beautiful green had given way to ugly browns and grays - and the spots were rapidly growing larger. What was it? What was happening? George checked over his various maintenance activities during the past several days - watering, mowing, top-dressing, raking, fertilizing - all had been carried out in accordance with his pre-arranged plans, and as dictated by the maintenance practices of that time. Yet, George's beautiful grass was dying. Why?

George had heard vague comments, here and there, about superintendents "losing their greens" to a thing called "turf disease." The spots he saw on his putting green were no novelty - he had seen them before - had lost grass before - but had somehow always managed to overcome the difficulty by re-seeding, re-stolonizing, plugging, etc. George was one of the better greenskeepers of his day - it was not unusual for other greenskeepers to have putting greens completely without grass during the entire summer. George wondered how such disease could really be controlled. He had used lime, on occassion, with some effect. He had been told that Bordeaux mixture, a compound containing copper salts, was effective for "disease", and had tried it. He noticed that

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it did seem to control the "disease" over a period, but the residual copper component appeared to damage and thin back his good grass. George knew he really did not have good answers to the important question, "How can I control turf disease?"

Now we jump a span of 45 years, and briefly visit with Larry Johnson, golf course turf manager. The year is 1966, and again it is summer. Larry maintains an excellent 18-hole layout - it is always one of the best manicured courses in his area. When his greens chairman says "let's take a look at the putting greens", Larry is more than happy to oblige. When they tour the course, they find green after green in excellent condition - all of fine texture, beautiful color, and with not a sign of "turf disease".

Now, what had happened during the intervening 45 years? Why was turf disease a serious problem with George Smith 45 years ago, but not with Larry Johnson now? There are many reasons. Many commercial products were developed during those 45 years to help Larry Johnson maintain a better golf course than his predecessors. But the real answer to his disease-free greens lay in the growth and development of effective turf fungicides by that segment of industry which we call today "the turf fungicide business." This business is just another example of our "American way", in which free enterprise always finds the answers to problems, whenever those problems become known to industry's leaders.

Let's take a look at this "turf fungicide business", scanning it in its three big phases, that is, (I) where we have been, (II) where we are now, and (III) where do we go from here?

I. BACKGROUND OF THE TURF FUNGICIDE BUSINESS - Where have we been?

Back in George Smith's day, Bordeaux mixture was really the only turf fungicide worthy of the name. There were eminent plant pathologists at that time, just as there are now, but very few of them bothered to consider seriously diseases of turfgrasses. Most of them were concerned primarily with controlling the diseases on economic crops. Grass was considered to be of only secondary importance.

Then, in the early 1920's, came the first "break-through" in turf disease control. During these years, Dr. John Monteith, then of the United States Department of Agriculture, at Beltsville, worked with the inorganic mercury salts, and concluded that combinations of mercuric and mercurous chlorides gave really good control of a number of turf diseases. Dr. Monteith was not the first fungicide investigator, although he did some of the first work connected with turfgrass diseases. Actual work on fungicidal control dates back over 3,000 years. Dr. Henry Horsfall, in his book "PRINCIPLES OF FUNGICIDAL ACTION" sets forth some "land marks in fungicide history". He says that as early as 1000 B.C., the Greek poet, Homer, spoke of "the pest-averting sulfur" - Homer was describing the protection of plants with sulfur compounds. In the year 60 A.D., Pliny recommended soaking wheat seed in wine plus bruised cypress leaves, to control what he called "mildew". Throughout the centuries since then, work has been done with various compounds as plant disease fungicides. Bordeaux mixture had first been recognized as a fungicide around 1800 by a man named Proust. Lab testing of fungicides for specific purposes first started in the early 1800's.

Throughout the 19th century, progress in fungicidal control of plant disease was slow, but in 1920, the Crop Protection Institute, founded at the University of New Hampshire, opened the road for the first collaboration between public and commercial interests on fungicides and fungicide development. That is, state universities and business interests began, about that time, to get interested in working together on the marketing aspects of fungicides. It was about this time that Dr. Monteith's work with the mercurials brought recognition to turf fungicides as a field in which industry could play an important part.

In these early 1920's, Mallinckrodt Chemical Works, then already 60 years old, pioneered the commercial aspects of the mercurial turf fungicide, launching the famous Calomel-Corrosive Sublimate mixture under the name "CALO-CLOR". The original product was heavy - did not stay well in suspension, and was used primarily in dry form, with sand, and broadcast uniformly over the turf surface. Recognizing the need for a product that would suspend well in water, Mallinckrodt developed "SUSPENSION CALO-CLOR" shortly after, this material containing a special suspension agent, and being offered as a companion product to the original material. Later on, the original formula was dropped and "SUSPENSION CALO-CLOR" became "the" Calo-Clor, further improved, as to suspendability, about 5 years ago, when a new micropulverizing step was added.

During the late 20's and throughout the 30's, the mercurials were still the best of all turf fungicides, and did a fine job of controlling a number of turf diseases. However, 1939 brought the beginning of World War II, and the temporary end of the mercury supply. Uncle Sam preempted all the mercury, so that the mercuric-mercurous chloride compounds disappeared from the market.

Meanwhile, DuPont and other companies had been working carefully throughout the 1930's on the activity of the dithiocarbamate compounds. This work actually marks the beginning of the modern scramble for organic fungicides, although work with organic mercuries had been done in France in the late 1800's. As you know, this was the basis for the phenyl mercuric acetates and other organic mercurials.

DuPont's work hit real "pay dirt" during World War II, when, in the absence of the inorganic mercurials, they launched their tetra-methyl-thiram-disulfide, which you all know as Tersan. It did a good disease control job throughout the war years, and had continued to be a factor in turf disease control ever since. DuPont also developed its own organic mercurial, hydroxymercurichlorophenol, which you know as Semesan, about the same time, and both have become well known in turf disease control.

Around the mid-40's the W. A. Cleary Corporation helped pioneer the advance of phenyl mercuric acetate, both as a turf fungicide and as a herbicide, with a good degree of crabgrass control. Their PMAS gained in popularity over the years, and many PMA compounds are now available for disease controls of various kinds, but especially diseases of turfgrasses.

At one time the fungicide concept was largely along lines of contact control - that is, controlling the fungi by actual contact. An exception to this appeared to be the insoluble inorganic mercurous chloride component of such fungicides as Calo-Chlor, which seemed to have long residual effect, giving rise to the idea that the material stayed in the soil a long time, was broken down by bacterial and other action, forming "vapor phases", so that the slow release of mercury vapor over a period was said to form a fungicidal environment, giving good disease control.

Then, in about 1948, the Upjohn Company helped pioneer the new concept of antibiotic control, with their cyclohexamide, an organic compound which Upjohn offered commercially as "Acti-Dione". The ferrated and "RZ" types were both offered - good results were reported from many locations. The action of Acti-Dione was through the leaf areas of the grass, and into the plant tissues and plant systems, where it was said to do its work of combating the fungi.

About 1950, leading experiment stations including the University of Rhode Island, where the Department of Plant Pathology was (and still is) under chairmanship of Dr. Frank Howard, were able to determine that Cadmium compounds offered excellent control of the then serious disease, Dollar Spot. This work led to the development of Cadminate, by Mallinckrodt, in 1950. Liquid Cadmium compounds, such as Cleary's Caddy, Vineland's Vi-Cal, and others, soon followed. So effective have they become, that a standard phrase recently has said "when the cadmium compounds came in, Dollar Spot went out".

There were many variations and formula changes among fungicidal compounds during the early 1950's, until late 1954 and early 1955. About this time, it was recognized that there was a definite need for one fungicide to control a number of the major diseases. There were several reasons for this. For one thing, disease identification was difficult, even among the experts, so that no one could really be sure of what disease was troubling his grass at any one time. Also, many inexperienced men were handling fungicides, and such people, even under the guidance of expert golf course superintendents and managers, could get into trouble rather easily by overdosages of some of the more toxic compounds. A fungicide was needed that could be applied easily and which would readily control many diseases. It was at this time that the concept of the broad-spectrum turf fungicide was born, Mallinckrodt pioneering in this field with broad-spectrum Kromad. Shortly thereafter, DuPont responded with its Tersan-OM, combining Thiram and organic mercury, and Cleary with its Thimer, also combining Thiram with the organic mercurial PMAS. Soon Upjohn also was in the field, with Acti-Dione Thiram, combining their cyclohexamide (Acti-Dione) with the Thiram fungicide of commerce. More recently, Vineland, Chemagro, California Chemical Company, Rohm and Haas, Velsicol, Diamond Alkali and others have entered the turf fungicide business. All have made valuable contributions in this field.

Nor has activity been confined to the commercial companies. In the vast field of turf research, activity has been equally as vibrant. From the practically single-handed work of Dr. Monteith, in the 1920's the array of turfgrass plant pathologists has grown tremendously. Just a month ago I received a compilation of important turfgrass plant pathologists of the United States. They number into the hundreds and include such eminent men as Dr. Howard, of Rhode Island, Drs. Miller, McCain, Endo and others of California, Drs. Young and Wadsworth of Oklahoma, Sharvelle of Purdue, Britton and Butler of Illinois, Freeman and Mullen of Florida, Bean of Maryland, Schmidt of Virginia, Alexander of South Carolina, Wells of Georgia and a host of others. And standing out among the eminent plant pathologists here in the Pacific Northwest, is the fellow with whom I am proud to share this podium today, Dr. Charles J. Gould of Washington State.

These advances in research and in industry illustrate how the turf fungicide business has come about and has grown, filling a need, and solving much of the turf disease problem. At any International Turf Conference, the turf fungicide industry will be well represented. You will recognize that each turf fungicide product displayed is there only because you, the golf course superintendents and other turf maintenance people, at one time or another had disease problems that needed solving.

So far as the fine putting green turf market is concerned, the fungicide industry is not huge. But you'll agree it occupies a significant place in modern turf maintenance.

And, so today, we have a driving, pulsating industry - this turf fungicide business - with the various companies seeking refinements in their present products, looking for new and cheaper fungicides to replace present ones - even seeking ways to control disease without turf fungicides.

II. THE TURF FUNGICIDE INDUSTRY TODAY - Now, just a few words about what these turf fungicide companies do. What goes on, among these firms, and within each, that eventually results in the marketing or an acceptable effective turf fungicide? In general, the sequence is something like this:

1. A TURF DISEASE PROBLEM MUST EXIST - While pure research often leads to interesting new products, including turf fungicides, and while many companies are engaging in pure research, merely seeking the truth that will open the doors to wider horizons of the future, most turf fungicide companies are just as practical as they are theoretical. They have research staffs who are looking for answers to problems. There isn't a turf fungicide on the market today that didn't result from a disease problem of some kind. Perhaps there was a turf disease for which there was no known control, or only inadequate control. Or, maybe an existing control was effective, but was so expensive as to create a problem in economics. It is such problems that stimulate the turf fungicide manufacturer to start work, especially if he can see two end results - (a) a really tangible service to golf course superintendents and other turf maintenance people, and (b) the reasonable anticipation of a profit for himself.

2. THE PROBLEM MUST BE RECOGNIZED BY THE PROPER PEOPLE - ESPECIALLY THE TURF FUNGICIDE MANUFACTURER - Very often a golf course superintendent, or other turf supervisor, is perplexed by a turf disease problem. So long as he keeps it to himself, or shares it only with his quiet neighbor, there will be no solution. In order for work to be done, the superintendent must get this problem before the people who can do something about it - for example, the turf fungicide manufacturer.

3. THE PROBLEM MUST BE SIGNIFICANT ENOUGH TO WARRANT ACTION BY THE MANUFACTURER - In order for a manufacturer to take action, the problem must be big enough for him to spend time, money, and other wherewithal, in an effort at solution. It must be a significant problem - usually the kind that bothers either many superintendents, or at least some golf course superintendents in most parts of the country.

4. HAVING RECOGNIZED THE PROBLEM, AND ITS SIGNIFICANCE, THE MANUFACTURER MUST SEEK MORE DETAILS - He must make direct contacts with the golf course superintendents who are having the trouble, he must check just what the trouble is, must talk with them at conferences, must go over all the details of the environment in which the disease occurred, temperatures, soils, types of grass, etc. In other words, he must learn everything possible about the disease problems.

5. THE MANUFACTURER MUST ASSIGN THE PROBLEM TO HIS RESEARCH STAFF - In order to do a complete job, the research staff must study the disease organism, its habits, conditions under which it attacks grasses, what kinds or classes of substances are likely candidates for its control, etc. In other words, much basic information must be gathered by highly trained technical people before technical problems can be tackled properly.

6. THE MANUFACTURER MUST "SCREEN" COMPOUNDS - Sometimes he must check through many thousands of potential compounds, rule out those classes he knows will be unsuitable for further work - he may even consider products previously found unsuitable for other purposes (for example, unsuitable for use on food crops) - and he may come up with a few that show promise, and concentrate on

these. It should be borne in mind that a product unsuitable for use on a food crop may yet be a potential turf grass fungicide.

7. FROM AMONG THESE HE MUST SELECT SOME CANDIDATES FOR:

   a. Laboratory testing - the products will have to be tested in the laboratory, actually against the fungus organism that has created a problem.

   b. Greenhouse testing - once it has been determined the compound will kill the fungus, then it must be carried to the greenhouse and tested against the disease organism actually on various types of turfgrass.

   c. Field testing - when lab tests and greenhouse tests have proven one or two of the materials suitable for further work, they are then taken out into the field, and put in the hands of golf course superintendents. In this connection, you, the superintendent, will be asked to help. You'll readily recognize that this was originally your problem - now that the manufacturer has spent much time and money (sometimes up to 5 or 10 years and millions of dollars), you readily realize that some of your help here, in field testing, may well mean the difference between no control, and a new fungicide for your future.

Meanwhile, the manufacturer has been collecting all experimental data, since he first became aware of the problem, down through all of his lab, greenhouse and field testing. By this time, he has a stack of material perhaps six inches or a foot thick, with every conceivable type of fact that he has learned about the disease and its control.

8. DEVELOP COMPLETE INFORMATION AND SUBMIT TO U.S.D.A. - Having found, perhaps, a single fungicide that

will do the full control job, and after having calculated reasonable costs, selling prices, etc., the manufacturer must propose what he thinks is satisfactory labeling, and submit his entire data to the United States Department of Agriculture, for its approval. Many times this approval is refused, and the recent reaction in Washington against all pesticides has greatly hampered registrations. But if facts have been properly gathered and presented, and a satisfactory product has been developed, the U.S.D.A. approval is later forthcoming.

9. MANUFACTURER MUST DEVELOP PRODUCTION PROCESSES - First steps here are important. They are:

   a. Pilot Plant - usually a small pilot plant is built, to make small quantities of the fungicide, this plant being used to test facilities and to get the "bugs" out of the production cycle.

   b. Full Scale Manufacturing Process - when the pilot plant has been drawn to smooth operation, then experience with it is the basis for developing a full scale manufacturing plant, to produce the quantity of the product surveys have indicated will be needed for the market to be covered.

10. ADVERTISING AND MARKETING PROGRAM PLANS - These will next have to be developed by the manufacturer, since his plant full of completed material will do no good unless it is sold to users, where it will do the job of controlling their turf diseases.

11. MARKETING AND SELLING - These are just about the final steps in the process - all the mechanics of marketing the product to the ultimate consumer must now be invoked, in order that the product may reach the consumer for whom it is intended - that is, you, the golf course superintendents and turf managers. Only

when the product is properly used by you, giving you the successful disease control you want, is the manufacturers job complete.

12. FOLLOW-THROUGH - No reputable fungicide manufacturer can consider a sale complete until he knows he has served a satisfied customer. To make sure of giving satisfaction, the manufacturer must take a number of steps to follow-through, such as these:

   a. HE MUST BACK UP HIS PRODUCT - That is, he must be constantly on the alert for any problems or questions arising in connection with his turf fungicides - he must correct any deficiencies, find the reasons for the potential non-success of a product under any given circumstance, etc. Sometimes this is merely the result of the superintendent not following the label instructions, not knowing the size of his greens, putting on overdosages or underdosages, etc. At any rate, the manufacturer must stand behind his products under all conditions.

   b. HE MUST SUPPORT TURF ASSOCIATIONS, NATIONAL AND REGIONAL - Most of you are members of the GCSAA, and your own regional Northwest Turfgrass Association. Fungicide manufacturers recognize the importance of good support of these fine organizations, and you'll find these firms ready to work with your groups in any way possible.

   c. HE MUST GIVE OUT HONEST INFORMATION - This means, essentially, that he must advertise with honesty and integrity, giving out only those facts about his products which are realistic, and which will be honest and helpful. No over-selling will do him any good, because he knows modern golf course superintendents will "see through" any ads which do not tell the simple truth.

d. HE MUST WORK THROUGH GOOD DISTRIBUTORS - He knows that the middle man or distributor can be abolished, but the distributor's function, and the cost of that function, must be performed by someone. No manufacturer can do as good a job, in this case, as can the distributor. Hence, the distributor in your area has the turf fungicides of the best manufacturers, and is ready to serve you. The same distributor can be one source for all your golf course and turf maintenance needs. It is possible he may charge a few pennies more, for a given product, than a "fly-by-night" fungicide formulator or "manufacturer". But for those few pennies, don't forget you are buying the excellent services of the distributor, including practically 24 hour availability, and you are buying something of the research of those turf fungicide manufacturers he represents. In fact, you are investing in your own future by supporting the manufacturers who are working to solve your fungicide problem.

III. WHAT'S THE FUTURE FOR TURF FUNGICIDES - What will be the next big breakthrough? Manufacturers of turf fungicides certainly recognize that they cannot stand still. Many projects already in the "drawing board" stage are rapidly being pushed, and others will come. Some of the present plans, to give you disease-free turf with less effort and lower cost, for example, are these:

1. PREVENTIVE SPRAYING - Any plant pathologist will tell you "if you see it, it's too late". They will tell you "you cannot really cure a turf disease - you must prevent it". Manufacturers will continue to point out the many advantages of a routine preventive spray program, so that superintendents will do the best possible job. They realize that a superintendent or maintenance supervisor is paid not to correct problems, but to maintain his turf area so he does not have problems. Only through prevention can this be accomplished.

2. FAIRWAY FUNGICIDES - More and more golf courses find their members and officials demanding the same quality of turf on tees and fairways as on greens. And so, for any grass, regardless of where it may be, fairway spraying is being advocated more and more. Manufacturers, of course, will cooperate, by seeking better and better fairway fungicides, and at low costs. Some superintendents already are using PMA 10% solution at one quart per acre. Others are using Cadminate at one-half ounce per 1000 square feet, every six weeks. These and other fungicides are giving good fairway control of diseases.

3. COMBINATIONS - Already individual fungicides are now combinations of earlier ingredients, each of which was formerly considered an entire fungicide. Broad-spectrum fungicides, like Tersan-OM, Thimer, Acti-Dione, Thiram, Kromad and others are examples. Yet broader spectrum combinations are in prospect. Some firms, for instance, are seeking to combine fungicides with herbicides, or fungicides with soluble fertilizers, or fungicides with insecticides, or several of these in various combinations with each other. A single spray that is a "cure-all" is what they are really seeking, isn't it?

4. "BUILT-IN" FUNGICIDES - Some turf authorities and business interests have toyed with the idea of a soil component which is fungicidal, and which, when mixed with soils, used as seedbeds, will prevent fungus attacks. Such a component, for instance, might some day be added to the U.S.G.A. Green Section - recommended soil mixture, so that any grass planted on such soil, whether by seeds, stolons, plugs, etc., would never be subject to disease attacks.

5. FUNGICIDES TO CONTROL PREVIOUSLY "UNCONTROLLABLE" DISEASES - Most major turf diseases may now be con-

trolled by <u>good</u> turf fungicides presently available. Of course, some fungicides are more effective, or more safe, or more economical than others, but, by and large, there <u>are</u> controls for most recognized turf diseases. However, some fungi are persistent rascals, and resist all efforts at control. Others are controlled only at great expense, and with great difficulty. For instance, thus far Pythium has proved a worthy antagonist for the turf fungicide researcher. Until recently there has been no sure control - except sudden cold dry weather. Now several formulations are showing promise. Dr. Homer Wells, at Tifton, Georgia, has achieved results with Dexon in Pythium control on turf and this product is now commercially available. Other fungicides still in the experimental stage, also give promise. Field-testing, however, is needed to support greenhouse and lab test data, so it will be a year or more before we really know how effective such materials may be under actual field and playing conditions. Certainly another "uncontrollable" disease until recently has been "Spring Dead Spot", the blight that has been plaguing Bermudagrass greens and fairways throughout the Central Southwest, and eastward. Manufacturers have now produced highly effective controls for spring dead spot. In the Northeast a strain of dollar spot appeared two years ago that was absolutely resistant to cadmium fungicides. This year some organic fungicides have been developed which provide very good control.

6. <u>SYSTEMIC TURF FUNGICIDES</u> - The idea of fungicides which can be applied to the soil, either by injection or drenches, so that the active ingredients are carried throughout the plant by pick-up through the root systems, certainly is being seriously studied from many angles today. Several soil drenches are already on the market, and seem to be successful to a degree. A big question here

is how much is lost by leaching out of the soil through drainage, evaporation, etc. More study is being given to this area.

7. ANTI-ORGANISM CONTROL - One of the projects being considered at several experiment stations is the idea of developing turf organisms which are antagonistic to fungi. Such organisms in the soil actually would feed on harmful fungi, thus eliminating them. The future for this idea is highly nebulous - what degree of success it will have certainly cannot be predicted at this time.

8. SYNTHETIC PUTTING GREENS - Here is an idea that has generated some interesting speculation. The idea is that someone will invent and produce completely artificial putting greens - possible in the form of synthetic "rugs" or "carpets" that can be laid down over a prepared base, and removed, renovated and re-laid, as conditions may dictate - or possibly in some other form not yet even visualized. Because of some limitations this may be an impractical thing to develop. For one thing, no one yet has ever found a substitute for the living things of God's great outdoors, and this certainly includes living grass. Also, any synthetic putting green would likely be expensive, since only a limited number would represent the entire potential. Also, the acceptance by golfers would likely be very slow - they would feel that the game of golf was getting much too artificial and mechanical. Another thing - as several researchers have pointed out, when confronted with this idea - "synthetic greens won't repair themselves". Grass putting greens recover well from ball marks, mower damage, spike shoe damage, etc. Anything artificial would be subject to damage which would require significant types of repairs. Most people feel that natural grass putting greens are here for a long time to come, but you'll agree that the "day-dreaming" along the lines mentioned here certainly may bring about changes in the future.

This, then, is the story of the turf fungicide business - where it has been, where it is now, along with what the individual firms are doing to advance its service activity, and where it might go in the future. This industry is a real moving force in your maintenance of fine turf. You can help move it forward in several ways. First, you can make sure the industry knows of your turf disease problems, so that they can set to work to solve them. Secondly, you can purchase the fungicides of the manufacturers who are pushing their research for you. Make sure you buy these quality fungicides, and pick them up through your distributor. As said before, occasionally you might pay a few pennies more for a good product. But, you'll find that these few pennies will bring you the outstanding services of your distributor, and just a bit of the research of the turf fungicide manufacturers dedicated to solving your problems. When you buy and use the products of reputable turf fungicide manufacturers, you are investing in your own future - because these are the firms qualified to make that future a better one for you.

Fungicides — How To Use Them Most Effectively

-Panel Discussion-

II. Thoughts On Disease Control

Ken Putnam[1]

1. Too often fungicides are applied with too little consideration given to the equipment used or to the applicator.

2. The man applying the chemical must be dependable and able to follow orders.

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[1]Superintendent, Seattle Golf Club, Seattle, Washington.

3. The old adage, "If an ounce is good, two ounces are better", certainly is not true when applying fungicides.

4. Of equal importance is the equipment used. There is absolutely no substitute for good spray equipment. Even though the cost of this equipment may seem high, it is really the cheapest piece of machinery you can own. Good spray equipment assures you of the proper application of material in the shortest time.

Fungicides — How To Use Them Most Effectively

-Panel Discussion-

III. Disease Control At Eugene Country Club

John A. Zoller[1]

I would like to report on my experience with a disease problem that has plagued us at the Eugene Country Club and one that I have observed on all of the older courses that I have been on in the Northwest. More particularly, on courses that have a high percentage of annual bluegrass. I do not believe it to be a problem on greens that are predominantly bentgrass. The disease I refer to is loosely called 'melting out', 'fading out', or 'going out', but is more specifically identified by the labs as the Curvularia-Helminthosporium complex. In my opinion this disease has reached a status where it deserves more consideration and investigation.

In our case this disease becomes noticeable in late July and all through August when the grass growth and recovery rate are slow. It appears as a yellowing of the leaf without a definite pattern and a general thinning of

[1]Superintendent, Eugene Golf & Country Club, Eugene, Oregon.

the turf. It has never reached serious proportions with us, but I am always aware of it and worry about it. According to the texts, this disease first occurs in the spring as a leaf spot but the grass is growing so fast that we are not aware of any injury. Then, if not treated, it becomes a root or crown rot later on and the melting out or fading out occurs.

Up to this year I had stumbled up and down the whole range of fungicides from the specific materials to the broad spectrums without satisfactory results. Last winter I read of some accounts where the Zineb fungicide had been helpful in similar cases and I determined to try it. At the first sign of the disease last summer I started a program with Parzate C and in our case, the results were excellent. I used it all summer trying different rates and intervals. Satisfactory results were obtained at rates of 3 oz./1000 square feet at 5 to 7 day intervals. It seems to be a relatively safe product to use.

I offer this as an experience in hopes that it may benefit others, but I caution that it is not a recommendation. I urge you to check with a qualified source such as the Western Washington Research and Extension Center or the Plant Clinic at Oregon State before proceeding.

Fungicides — How To Use Them Most Effectively

-Panel Discussion-

IV. Twelve Steps To Success

Charles J. Gould[1]

1. Examine your turf often so you will discover a disease outbreak before it becomes serious.

[1]Plant Pathologist, Western Washington Research and Extension Center, Washington State University, Puyallup, Washington.

2. Be certain that you are using the correct fungicide for the particular disease problem affecting your turf.

3. Adopt a year-round preventive treatment program.

4. Use the correct dosage. Calculate it carefully the first time, then mark the figure on a card posted near your fungicide shelf. Be sure to recalculate rates if you change from one formulation of a material to another (such as changing from a 10% formulation of PMA to 2% or 33%).

5. Use only clean water in making up the spray solution. Avoid lake, pond, or river water, which may contain organic matter, clay, and other materials that keep fungicides from killing fungi.

6. Do not mix a fungicide with anything but water -- unless you wish to experiment first on a small scale basis under your particular conditions. Addition of other pesticides, iron sulfate, or fertilizers may weaken the fungicide and/or increase the danger of burning.

7. Be certain that the sprayer, hose, and boom are free of rust and residues of herbicides and fertilizers.

8. Don't dilute the spray. Sweep or drag greens to remove dew or rain before spraying.

9. Don't guess at the areas of turf involved. Measure them carefully. Then record the figures on a card posted near the fungicide shelf.

10. Select a conscientious assistant to do the spraying if you can't do the job yourself. Pick someone who can and will do it as carefully as you would. Train your assistant to recognize the major diseases.

11. Be sure to get good coverage of turf with the fungicide. Apply half the amount of spray while moving in

one direction and the remaining half in a direction at right angles.

12. Follow Manufacturer's directions carefully. Reread them frequently, particularly when a new supply is purchased (manufacturers are constantly improving their formulations and updating their recommendations).

Physiological Drouth — As Influenced By Fertilizer Salts

Charles G. Wilson[1]

I am sure many of you have heard Dr. Goss' story on "Some Physiological Effects of Soil Salinity". If not, you should make it a point to read his paper on the subject. Roy covers the major salt problems and why they can and do affect each of you as turf managers. The primary culprits are poor water quality, low rainfall and poor drainage.

Despite the high rainfall experienced by many in the northwest, "physiological drouth"--too high a salt solution index--occurs more often than you have possibly been aware of in the past. In fact, it occurs to a greater or lesser degree every time you apply fertilizer. In inorganic or chemical fertilizer, salts are most troublesome, but salinity levels can also be influenced with some organic fertilizers, with manures stockpiled in feed lots, being the most notorious in this respect in the west. Organics, generally, provided one excludes the synthetics where urea is used, are the safest materials because they have the lowest salt index.

This does not mean that inorganics should be excluded from the fertilizing program. Where clippings are removed

[1]Sales Manager and Agronomist, Milwaukee Sewerage Commission, Milwaukee, Wisconsin.

and in initial seedings, they almost always should be used, especially with respect to potash and sometimes phosphorus. Soil tests are important for this reason alone with all professional turf growers.

However, you do have a choice in the form of chemical applied to supply the necessary element. And this choice can become quite important during hot or dry weather because some fertilizer salts have a decidedly greater tendency than others to cause burn or wilt.

Most fertilizer manufacturers are aware of this but have gone along with the idea that what you as a turf manager want, is the cheapest source rather than the best. Unfortunately, some of you may have actually encouraged such an approach by working under the assumption that all chemical 10-10-10's, for example, were the same irrespective of the source of fertilizer salts used to formulate the product.

Dr.'s L. F. Rader, Jr., L. M. White, and C. W. Whittaker reported on "The Salt Index. A Measure of Fertilizers on the Concentration of the Soil Solution" in Soil Science Proceedings, 55:201-218 (1943). The date is not without significance because it fell during World War II. Thus, few present day turf researchers or agriculturists are aware of the problem.

Here is what the author's had to say about the subject following exhausting laboratory research at the Department of Agriculture headquarters near Washington, D. C.

> "When applied in excessive amounts or when the soil is very dry, certain salts burn or cause plants to wilt more than others. Burning is measured by the salt index and is due to the effect the salt has in increasing the osmotic pressure of the soil solution."

When growth conditions are right, the highest concentration of fertilizer salts are inside the plant. Under these conditions, movement or intake of water, oxygen and nutrients is normal, and always toward the highest concentration of salts. This miracle of intake is called osmosis by plant scientists. Conversely, when the concentration of salts is higher on the outside of the plant "physiological drouth" (poor water intake) occurs and we notice it as wilt in its least severe form, or as fertilizer burn when some chemical has been applied excessively. The plant scientist refers to the severe condition as plasmolysis, or as reverse osmosis for the lesser stress.

In practice, this means that chemical inorganic water soluble fertilizers must be applied sparingly in any one application and watered in copiously to prevent burn. This you were aware of all the time, but unbeknownst to some, it also means that high analysis is meaningless, because the higher the analysis the smaller the amount that can be safely applied without waste. This is the reason that inorganic nitrogen sources are seldom suggested at a rate above one (1) pound actual nitrogen per 1000 square feet. Johnson in California found 70% of the nitrogen applied at 260 pounds actual per acre (6 lbs. actual per 1000 sq. ft.) from anhydrous ammonia, urea, 21-53-0 and ammonium sulfate was lost by leaching before the plant could utilize it. Interestingly, too, the work was done on a silt loam soil where nitrogen loss by leaching has been thought by some to be negligible. Thus, even if you don't burn the grass as a result of careful application and watering, it still pays to be judicious in the amount of water soluble fertilizer applied. As a matter of fact, it is only the low analysis natural organics, with a possible exception in urea-formaldehyde, where one is not only safe but sure in applying 3 pounds or more of actual nitrogen per 1000 sq. ft. in a single application.

The following table lists some of the fertilizers more commonly associated with the turf industry. The "salt index" is a comparison of the same weight of each material.

Salt Index

Salt	Salt Index
60% Muriate of Potash	116
Ammonium Nitrate	109
Sodium Nitrate	100
Urea	75
Potassium Nitrate	74
Ammonium Sulfate	69
Calcium Nitrate	53
Potassium Sulfate	46
Ordinary superphosphate (20%)	8
Gypsum	8
Organic Ammoniates	3.5

The organic ammoniates include a broad grouping of such materials as Milorganite, manure, cottonseed meal, leather tankage, etc. Actually, there are tremendous differences within this group, based on the way they are processed and their granulation. Wisconsin research in the 1930's showed a salt index of 0.0067 for Milwaukee's Activated Sewage Sludge, according to Noer.

One can draw many comparisons from the Salt Index Chart. For example, muriate of potash has double the salt content of sulfate of potash. Thus, it has twice the tendency to burn grass. Sulfur is a fringe benefit element in sulfate of potash that is absent in muriate (potassium chloride). Potassium nitrate (12% N and 44% K_2O) furnishes both potassium and nitrogen and may some day make inroads on the more commonly used urea and ammonium nitrate, that furnish only nitrogen at a higher salt index.

In summary, we might list the following:

1. Fertilizer salts complicate irrigation practices.

2. The higher the salt index, the greater the need for frequent and copious watering. This tends to waste water.

3. Where possible, the use of inorganic chemical salts should be confined to cool weather on wet soils.

4. Manufacturers of mixed fertilizers are using materials with a high salt index because they are cheap.

5. High analysis with chemical salts doesn't mean that you are using more of the fertilizer element. What they save is bulk in handling, but at the cost of poorer distribution.

6. A foliar fertilizer burn is dehydration. Even when carefully handled to prevent foliar burn, a high salt solution index in the soil solution, following applications of inorganic fertilizers, will impair water uptake. This can be noticed by an absence of dew and/or mid-day wilt as illustrated by the slides used following the talk.

The USGA Green Section — Past, Present, and Future

William H. Bengeyfield[1]

In 1894 it was amateur golf that caught the sports headlines of the day. There were no $100,000 tournaments or $50,000 first prize money for the "touring pros". There were no touring pros. The Wonderful World of Golf belonged to the amateurs and the Amateur Championship was THE tourna-

[1]Western Director, USGA Green Section, Garden Grove, California.

ment of golf. No surprise then that, in 1894, two "Amateur Golf Championships of the United States" were sponsored by two different clubs. There were two different "Champions". In other phases of golf there were no uniform standards.

That was why five clubs formed the United States Golf Association, on December 22, 1894. They needed a central governing body to establish uniform rules, to conduct championships and to develop the fine elements of sportsmanship in golf.

Twenty-six years later (1920) the USGA Green Section came into being. The need for such an agency was first recognized by E. J. Marshall, a Toledo, Ohio attorney. As Green Committee Chairman of the Inverness Club, Mr. Marshall was in charge of preparing his course for the 1920 USGA Open Championship. He brought together the USGA and the United States Department of Agriculture, which agreed to collaborate.

The Green Section was born on November 30, 1920 because USGA Member Clubs expressed the need for a turf research and advisory agency, impartial and anthoritative. Like all USGA Agencies, it operates today for service, not for profit.

During the early years, Drs. Piper and Oakly, who were then with the Department of Agriculture, established the first Green Section Office in Washington, D. C. A few years later the Arlington Turf Gardens were developed, across the Potomac River in Arlington, Virginia. The Pentagon sets on this site today.

Turfgrass diseases then ravaged putting greens each summer. This area was to receive major attention. During the late 1920's and through the 1930's, Dr. John Montieth became the first Green Section Director and his contributions from that time to the present have played a major role in advancing the science of turfgrass culture. Dr. Montieth's research in turf diseases was a monumental step forward and many of his control recommendations are still in use today. The mixture of Corrosive Sublimate and Calomel is a product of John Montieth's work. It is known today as Woodridge mixture, Calo-clor, etc. His Green Section Bulletin of 1932 "Turfgrass Diseases" is a classic and a collector's item today.

Dr. Montieth's research was continued at the Arlington Turf Gardens through the 1930's. It included nutrition studies, the importance of pH and liming, and the selection of many grass varieties from golf course superintendents throughout the country. It was at this time that the improved bentgrass selections known today as Arlington (C-1), Cohansey (C-7), Toronto (C-15), Congressional (C-19), Old Orchard (C-52) and many others were propagated and studied.

Bluegrass and bermudagrass selections were also made at this time. Two of the final products include B-27, now known as Merion bluegrass and, U-3 bermudagrass which is still one of the most winter hardy of all bermudas. These grass selections were sent to Dr. Montieth by interested and dedicated golf course superintendents.

The Green Section has also supported work in later years on the development of fine leaf bermudagrasses. From the work of Dr. Burton of Tifton, Georgia, we now have strains such as Tifgreen, Tifway and Tifdwarf. These names may not mean very much in the Pacific Northwest. However, the grasses have revolutionized golf course maintenance throughout the South. In addition, Dr. Victor Youngner of the University of California is now carrying on studies with combinations of bermudagrasses and the cool season grasses and this work is supported in part by a Green Section Grant. This can provide valuable turf in the so-called 'climatic transition zones' which might well include some parts of the Pacific Northwest.

Where would turf management on the golf course be today without these grass selections?

Occasionally, a research effort in one area finds greater application in another. This was the case with 2,4-D and its discovery as a broad-leaf weed control agent. Originally, 2,4-D was under investigation as a hormone material for use on fruit trees to aid in 'fruit set' and also for chemically thinning the fruit crop on the tree. This work was underway at the Department of Agriculture during World War II when Dr. Fanny Fern Davis was Director of the Green Section. With a scientist's eye, she noticed the hormone spray on the fruit trees was also causing weird growth patterns in the broad-leaf weeds under the trees. It was Dr. Davis who first realized the possibilities of using this hormone material as a herbicide in turfgrass management. Without question, it was the first major step in selective weed control as we know it today.

After World War II, Dr. Fred Grau took the reins as Green Section Director. The office moved to the new Department of Agriculture buildings at Beltsville, Maryland, where research was continued. One of Dr. Grau's interests was in a means of mechanical aerification. He encouraged industry to work on the problem as well as vertical mowing for turfgrass areas. We all know the success of this endeavor and what it has meant to turfgrass culture.

The Green Section, through Dr. Grau, was also instrumental in establishing grants and fellowships at universities throughout the country to encourage greater interest and work in turfgrass research. A number of today's top turfgrass scientists attest to the success of the effort. Men such as Dr. Jim Watson, Dr. Marvin Ferguson, Charlie Wilson, Al Radko, Jim Latham, Dr. Jack Harper, Dr. Bill Daniel and many others are the products of this educational expansion. Today, almost every State University has at least one staff member dealing with turfgrass management.

The Green Section's support of turf research is a continuing one. Let me tell you briefly about it. Studies are now underway on: Creeping bentgrass selections; Colonial bentgrass breeding; bluegrass selection and breeding;

Bermudagrass nutrition studies; overseeding Bermuda with winter grass; irrigation and salinity tolerance of bentgrasses; soil types and nitrogen loss studies; and the effect of pH, top-dressing materials and cultivation on Creeping bentgrass turf. Past studies have even included the effects of golf shoe spikes on soils, grasses and putting qualities.

A few years ago we published the "Green Section Specifications for a Method of Putting Green Construction". The work represents over 10 years of research and practical experience. Gradually, this method of construction is being accepted throughout the nation because it has proven to be the soundest approach known today.

In the early 1950's, the USGA felt there was a need for expanding the Green Section Staff and carrying out direct visits to USGA Member Clubs. Today, there are nine staff members visiting over 900 golf courses subscribing to the service in the United States. It is our goal to bring the experiences of others and the latest in sound research information to our subscribing clubs and to assist the golf course superintendent in every possible way. No man is "An Island". No one can long survive in the professional world without exchanging views and keeping abreast of new developments. It is here the Green Section Agronomist does his work.

Another Green Section publication is the book by H. B. Musser, "Turf Management". First published in 1950 and revised in 1962, this text is still the only authoritative book available on the subject.

The USGA Green Section has long recognized the valuable contribution of the golf course superintendent to the game of golf. In fact, the Championship Trophy of the Golf Course Superintendents Association of America is presented to that Superintendent with the lowest score in the Championship Flight each year. The Trophy is an exact replica of the USGA Open Championship Trophy and was presented to the GCSA by the USGA Green Section.

Starting in 1961, a new award "For Distinguished Service to Golf Through Work with Turfgrass" was presented by the USGA Green Section. One of the men to receive this coveted trophy was Mr. Joseph Valentine, former golf course superintendent of the Merion Golf Club in Pennsylvania. Other recipients to date include Dr. O. J. Noer, Dr. John Montieth, Dr. Lawrence S. Dickenson and Dr. Glen W. Burton.

At all USGA Championship Tournaments, the golf course superintendent always receives recognition of his contribution to the event.

Since its inception, the Green Section has spent over two million dollars on its operation. It is the one scientific agency constantly at work solely in the interest of golf courses. It was the pioneer and still is a chief authority. Green Section Agronomists are not super-superintendents or wonder workers. Rather, they are trained specialists who do a specialized job for the golf course superintendent and the green chairman. In countless cases, one small bit of information from the Green Section Agronomist has significantly contributed to better golfing turf at a club.

Today golf course conditions bear little resemblance to those of 1894, or even 1920. Indeed, the golf course superintendent, the 'professional' in turfgrass management, may well take a bow for being responsible (in part at least) for today's lower scores and increasing popularity of the game. He has improved "the setting". He has carved his notch in the game of golf along with the golf professional. Plainly, the Green Section has contributed to his work. Together they have provided better turf for better golf. And that, to be sure, will be their continuing mission on into the future.

Weed Control Related To Leaf Surfaces

A. J. Renney and D. J. Ormrod[1]

The use of herbicides to save labor and to improve yields and quality has been an established practice for many years. One of the main reasons for the importance of these chemicals is their usefulness as selective agents - the selective control of broad-leaf weeds in turf being a common practice. The selectivity of foliar-applied herbicides depends on many factors and interactions. Some of these factors are listed below.

Plant Factors

- Species
- Age and condition
- Leaf area relative to that of desirable plants
- Leaf inclination and topography
- Thickness and composition of cuticle
- Presence of superficial wax
- Number, size and distribution of stomata
- Presence and distribution of trichomes

Environmental Factors

- Temperature
- Relative humidity
- Wind velocity
- Light intensity and quality
- Precipitation
- Mechanical damage by insects, animals, man and machinery

[1]Associate Professor and Graduate Student, Division of Plant Science, University of British Columbia, Vancouver, British Columbia, Canada.

Chemical Factors

Formulation
Volatility
Polarity
pH
Surface tension
Size of spray droplets

Of the many approaches which can be taken in attempting to gather more information about this phenomenon of selectivity we have chosen to look at the matter of leaf surfaces and I wish at this time to report on some of our findings relative to the size, number and distribution of the stomata. Much of the information which follows has been taken from work done by David J. Ormrod, a graduate student in the Division of Plant Science.

In order to reduce variability a weed nursery was established on a turfed area at the University of British Columbia. The weed species were introduced during a 5-day period in May and allowed to establish before any sampling was done. One series of weeds was placed under slatted shade while a comparable group was allowed full sun. Sampling was done June 28-30 and again on July 29-30 taking a minimum of 6 mature, healthy leaves from plants 2, 4, 6, and 8 in a 10 plant plot, each of the 4 plants thus constituting a replication. Leaves were fixed in a 90:5:5 solution of 50% ethanol, formaldehyde and acetic acid for 24 hours then transferred to 70% ethanol. Leaves were then cleared, stained and mounted in Kleermount (Carolina Biological Supply Co.). This method permitted microscopic observation of both the upper and lower epidermis in any given field of observation and allowed definite fields to be selected for comparison. Ten microscope fields (X500) were counted for each slide with 20 stomata being selected at random during the counting procedure. Statistical analyses were carried out with the aid of an I.B.M. 7040 computer.

Let us first consider the number and size of stomata found in 8 of the sun grown species.

Table 1. Number and size of stomata of eight sun grown species. (Mean of both surfaces and mean of sampling dates).

Species	No./mm.^{2}	Size in Microns
dandelion	- 216.6	26.6
wild radish	- 215.4	25.5
b.l. plantain	- 190.8	25.7
stinkweed	- 144.5	25.4
spotted knapweed	- 137.3	29.2
hemp nettle	- 124.5	27.6
pineappleweed	- 88.5	34.5
yarrow	- 83.8	37.7

Although there was considerable variation when harvest date and surface effects were removed, it is evident from the above table that species differences in stomatal number and size are considerable. Except for yarrow and pineappleweed which had both the fewest and largest stomata, no close relationship seemed to exist between number and size of stomata in this group of weeds.

Table 2. Number of stomata per mm^2 on the upper and lower leaf surface at two sampling dates.

Species	June Upper	June Lower	July Upper	July Lower
dandelion	141.3	241.0	155.3	328.6
wild radish	219.3	195.3	201.3	231.0
b.l. plantain	125.3	172.0	217.9	247.9
stinkweed	100.6	148.0	121.3	207.9
spotted knapweed	137.3	128.0	131.3	152.6

hemp nettle	11.3	172.0	53.3	261.3
pineappleweed	118.6	60.0	120.6	54.6
yarrow	81.3	41.3	136.0	76.6
mean	116.9	144.7	138.2	197.2
	130.8		169.5	

As is the case with most plant species the average number of stomata in these weeds is greater on the lower than the upper surface. This was true both in June and July. Again pineappleweed and yarrow differed from the others in that they had greater density on the upper than on the lower surface. There were more stomata in July on the average than in June, all species showing this trend. Similarly all species had a similar surface x date interaction.

When the stomatal data of 29 species grown in shade and sun and sampled as above were compared it was possible to group the weeds according to the density of their stomata, i.e. very dense to very sparse.

One interesting observation relative to stomatal characteristics of the species examined concerned the family groupings into which they fell. In some botanical families, e.g. Caryophyllaceae, Cruciferae, and Gramineae the various genera appear to have similar stomatal characters, e.g. few or many, raised or sunken etc. while in other (Polygonaceae, Compositae) variability in these characters seems to be the rule. The 3 members of the Caryophyllaceae (pink) family-white cockle, mouse-ear chickweed and common chickweed, have average stomatal densities of 54.2 (upper surface) and 91.9 (lower surface) with average stomatal lengths of 41.4 microns. In contrast the 3 members of the Cruciferae (mustard) family have average stomatal densities of 172.5 (upper surface) and 267.2 (lower surface) and average lengths of 23.7 microns, with 3 members of the Gramineae (grass) family showing 76.4, 78.5 and 45.4, respectively. In the grasses the stomata occur in rows in depressions between viens. A spray droplet landing on such a leaf would tend to be suspended on the epidermis over the veins and would have less chance to contact the stomata. This may be one contributing factor to the successful use of selective sprays in cereals and turf.

Having assembled the stomatal densities one immediatly speculates as to the effect of herbicides on these weeds. 2,4-D has been most extensively assessed and consequently more information is available on this herbicide than is the case with others. In order to check this point we compared susceptibility categories with the density of stomata (on upper surfaces) for the 29 species for which information was available. We used the susceptibility groupings of the National Weed Committee (Canada) which have resulted from field data assembled over a number of years. We also used those which have been recorded in the most recent edition of the Weed Control Handbook from England.

Considering 22 of the weeds of interest to us in turf work the data compare as follows:

Species	No. stomata per sq. mm.	Susceptibility to 2,4-D
shepherd's purse	229.8	2*
wild radish	213.3	2
n.l. plantain	194.8	1
hedge mustard	176.6	1
b.l. plantain	171.6	2
blue bur	163.3	2
dandelion	148.3	2
cat's ear	135.7	2
red root pigweed	131.0	3
pineappleweed	119.6	3
lady's thumb	110.7	3
yarrow	108.6	4
prostrate knotweed	107.4	4
lambsquarters	79.8	1
creeping buttercup	58.9	4

chickweed	51.6	3
Canada thistle	45.9	3
mouse-ear chickweed	45.6	3
wild buckwheat	41.9	3
groundsel	40.9	3
sheep sorrel	39.6	3
hemp nettle	32.3	4

*1. = susceptible
2. = moderately susceptible
3. = moderately resistant
4. = resistant

There is frequently an exception to a rule but, if we exclude lambsquarters, the weed stomata and 2,4-D susceptibility seem to show fair agreement. We subjected all our data to statistical analysis using the Spearman rank correlation coefficient and obtained a value of $r_s = 0.38$ indicating a positive correlation which accounted for about 14% of the variation in 2,4-D susceptibility. Obviously there are other factors at work here. Such plant characteristics as cuticle and epidermal hairs are also quite important but we feel that part of the susceptibility of the different weedy species to 2,4-D may result from the variation in stomatal density on the leaf surfaces.

In order to assess the importance of the two leaf surfaces when spray was applied, 3 weed species, each having larger stomatal density on the lower surface than on the upper surface, were sprayed with 5 concentrations of picloram. These rates ranged from 0 to 1000 parts per million and were applied on separate groups of plants to the upper and the lower surfaces. Fresh and dry weights of the plants were taken in order to assess the effects. The results of this trial were somewhat disappointing although there was statistically valid evidence that the dry weights of the plants were reduced more when the spray was applied to the lower surface than to the upper. However, confusing factors such as the presence of a cuticular layer no doubt interfered with the interpretations and more refined techniques will need to be employed in future experiments.

A great deal more could be said regarding the influence of stomata on the intake of herbicides, and this brief statement has really just introduced the topic. Then, too, the role of the trichomes, cuticle and epidermal tissue must be assessed along with that of the stomata.

When one couples these surface features with those factors contributing to selectivity which were mentioned earlier, the extreme complexity of the situation is apparent.

Ice-Sheet Injury To Turf

S. Freyman[1] and V. C. Brink[2]

Damage to turfgrass, forages, and other herbaceous perennials, caused by ice-sheets is sporadic, but often widespread and devastating. For example, in British Columbia in the last 25 years, widespread damage is attributed to ice sheets which lay over large areas during five winters. Of these, by far the most serious was the 1940-41 ice sheet which blanketed the soil surface in open areas for many weeks from Terrace to Edmonton, Alberta - an east-west distance of over 400 miles, and south, erratically, into Washington State. Elsewhere in North America, particularly in the middle western United States and adjacent Canada, widespread ice-sheets are common. The winter of 1961-62 will be remembered as the worst winter for ice-sheet damage in the history of the Midwest. Damage was extensive from Chicago to Detroit.

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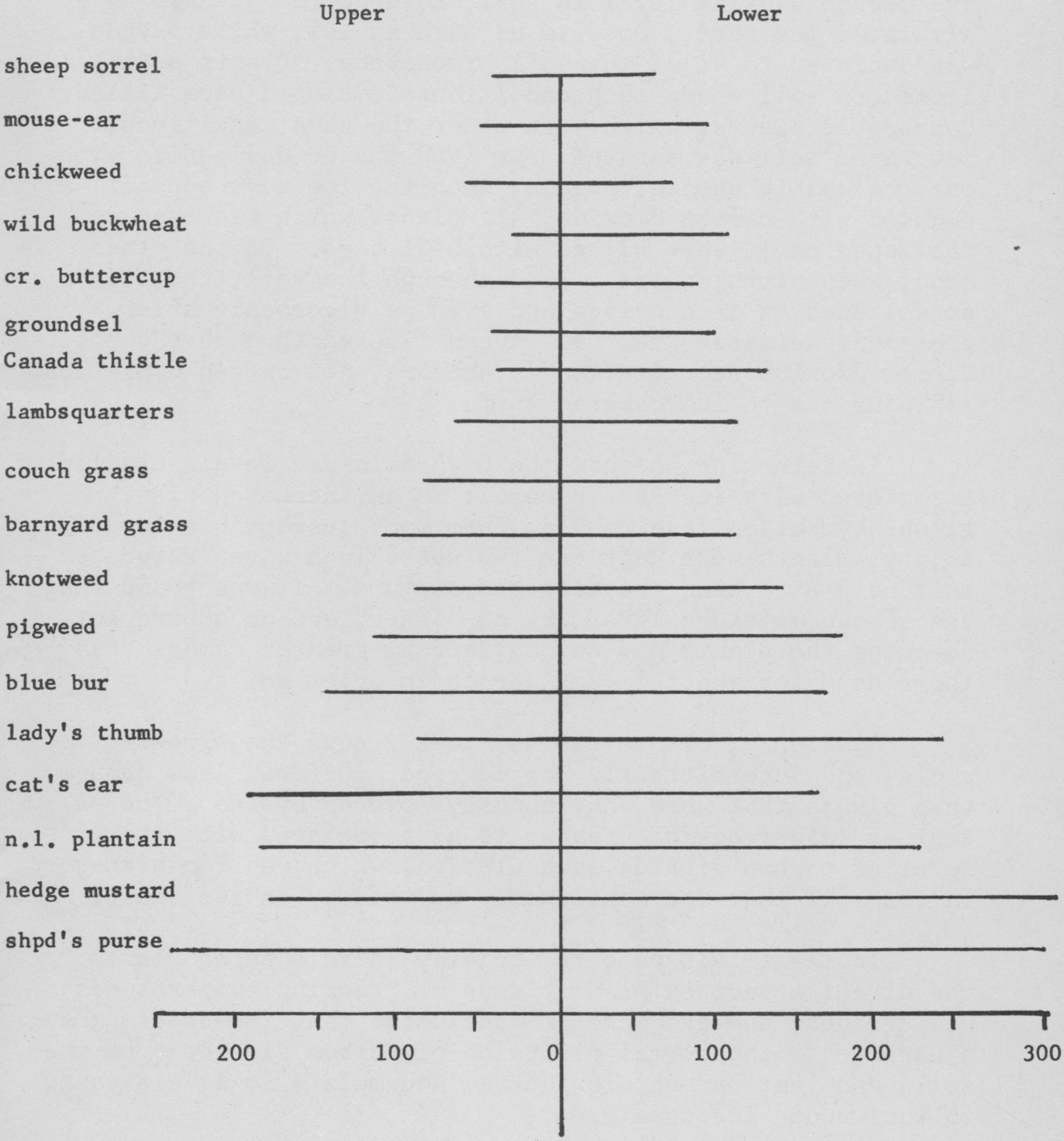
[2]Professor of Agronomy, The University of British Columbia, Vancouver, British Columbia, Canada.

Ice sheets form most frequently where drainage is poor and where, in winter, stagnant water freezes to form a continous sheet of ice. Ice sheets form less frequently as a result of freezing rainstorms, but when these occur, ice may cover everything regardless of topography. Ice sheets are also formed when snow cover alternately freezes and thaws; if snow falls intermittently under such circumstances, frequently ice and snow crusts may become several inches thick and melt very slowly with the advent of warm weather. These ice sheets often persist for many weeks or months.

Some research regarding the nature of injury to herbaceous plants under ice sheets of long duration has been carried out in recent years. Much controversy still exists today as to the real cause of damage. The most general reason given for ice sheet damage is suffocation or inability of the soil to exchange gases with the atmosphere because of ice impermeability. Many workers, however, question suffocation as a cause. For example, Beard (1, 2) recently carried out some experiments on the effect of ice covers on some common turfgrasses and suggested that combinations of freezing and thawing, possibly in association with high plant tissue moisture levels, may be of greater significance in winter injury associated with ice sheets than suffocation or accumulation of toxins. Beard feels that the high moisture levels normally associated with ice sheets result in increased hydration of plant tissues. It is believed that increased moisture content raises the temperature at which the tissues die; death follows intercellular ice formation and mechanical cell disintegration.

Recent developments in gas chromatography permit measurements of oxygen and carbon dioxide in soil and plant simultaneously and precisely. Accordingly, at the University of British Columbia a new attempt was made to establish whether or not oxygen deficiency or carbon dioxide toxicity or both, developed under ice sheets of prolonged duration over turfgrass. Plant temperatures at the lowest were not much below freezing and temperature *per se* would not be considered lethal.

Numbers of stomata on upper and lower leaf surfaces of some common turf weeds.



Results of the experiments which are fully reported in a doctorate thesis by the senior author, revealed that the carbon dioxide level in soil, covered for 50 days by a simulated ice sheet, rose to as high as 10%, while oxygen was depleted to 4% of the soil atmosphere. Plants established in soil where such conditions developed were killed. Comparable plants, which were under the same conditions, but where soil was aerated, survived the 50 day period without noticeable damage. Again, when the ice covered soil was flushed with carbon dioxide, all plants which had been established on it were killed within 21 days. On the other hand, when nitrogen was passed through the soil, the plants established on it survived and grew as vigorously after treatment as those that had oxygen flushed through the soil. Carbon dioxide accumulation it appears, not oxygen depletion, is injurious to ice covered turf.

To determine whether the high moisture levels usually associated with ice sheets result in an increased plant tissue hydration level making them more susceptible to cold injury, plants were kept for two weeks in a water saturated soil held at a near freezing temperature. It was found that the tissue moisture level was no higher, and on subsequent freezing the plants did not suffer any greater damage than those kept for the two week period in drier soils.

Similarly, plants exposed to a freeze-thaw-freeze cycle, and intermittently ice covered, suffered less damage than plants that were continuously covered by ice. The extent of injury again appeared to be associated with the level of carbon dioxide accumulation, which was far higher in the soil that was continually covered by an ice sheet.

In the trials reported briefly in this paper where the direct effect on plant tissue of freezing temperatures was avoided, the evidence is conclusive that ice-sheets are a barrier to the normal diffusion of carbon dioxide from the soil, and that carbon dioxide may accumulate to levels toxic to turf under ice sheets.

1. Beard, J. B. Effects of Ice Covers in the Field on Two Perennial Grasses. Crop Sci. 5:139-140. (1965).

2. Beard, J. B. Effects of Ice, Snow and Water Covers on Kentucky Bluegrass, Annual Bluegrass and Creeping Bentgrass. Crop Sci. 4:638-640. (1964).

Frost Protection

J. R. Watson[1]

Frost is formed when air containing moisture in the form of water vapor is cooled to below freezing temperature. The moisture condenses and collects as frost or lacy ice crystals on solid objects.

Frost is usually formed at night and in much the same way as dew. The earth is heated during the day by the sun. When the sun sets, the earth radiates heat into the air and cools off. The ground cools rapidly, and the moisture, held in the air near the ground as water vapor, condenses and collects in droplets or solid objects. When the temperature drops below freezing, frost is formed. Hoar frost is formed when air is cooled to freezing temperatures, and the moisture in it condenses on solid objects such as plants. It differs from ordinary frost in that the ice crystals are long and needle shaped. More frost is formed on a clear night than on a cloudy night because the ground cools faster on a clear night, resulting in more condensation.

The temperature at the soil surface may differ greatly from that a few inches above ground. In southern England, surface temperatures of 111 degrees F. have been recorded on a closely cropped lawn. Twelve inches above the surface of the lawn the temperature was 93 degrees F., a difference of 18 degrees. Night (clear) time temperatures showed about

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[1]Director, Agronomy, Toro Manufacturing Corporation, Minneapolis, Minnesota

the same difference except in the opposite direction -- 75 degrees at twelve inches and 55 degrees at the surface.

Plants

Plants vary in their ability to resist or tolerate frost injury. Many plants native to tropical or sub-tropical regions are killed or seriously injured by temperatures above their freezing points. Bananas are a good example -- the fruit may be damaged at 40 to 50 degrees F. This type of injury is referred to as chilling injury. Plants subject to chilling injury are usually killed by the first touch of frost.

The more common form of low temperature injury (and the kind with which growers of turfgrass are most concerned) is "Frost Injury". Frost injury may occur in all plants. Some may be frozen solid without damage; others may be killed at or slightly above freezing. Differences in tolerance among Bermuda, bent, bluegrass and rye on golf courses are readily apparent.

More important perhaps than the species differences is the fact that for a single plant the range of frost killing temperatures may be large depending on its physiological state. In any specie or strain, soft, succulent grass is easier killed than that which has permitted to "harden". This is one reason why fall (four to six weeks before the first killing frost) management practices are vitally important to winter survival.

Causes of Freezing Injury in Plants

A number of suggestions have been made regarding the possible causes of freezing injury to plant cells, the principal ones being the following:

(1) Ice formation in the intercellular spaces results in withdrawal of water from the cells. As ice forms, the moisture is pulled from the cell. The consequent

dehydration results in disorganization and death of the protoplasm (Molisch, 1897). The black water-soaked appearance sometimes observed when plants freeze is due to inability of the cells to reabsorb this water when the ice melts.

(2) The ice formed in the intercellular spaces results in mechanical compression of the cells which in turn causes deformation and death of the protoplasm (Maximov, 1914).

(3) Withdrawal of water from the cells due to the formation of ice crystals in the intercellular spaces results in an increase in the concentration of electrolytes in the cell sap which may have a "salting out" or other destructive effect on the protoplasmic proteins (Harvey, 1918, and others).

(4) Ice crystals may form within the cell, resulting in compression or laceration of the protoplasm or other destructive effects (Stiles, 1930, and others).

(5) Death occurs, not at the time of ice formation, but as a result of the subsequent thawing of the tissue. This idea, originally sponsored by Sachs in 1860, largely dropped into disrepute but has been revived by the findings of Lijin (1933) and others that some plant tissues which can withstand freezing are killed by rapid thawing. Death is apparently due to various types of mechanical disturbances attendent upon the entry of water into the cells upon thawing. Black water-soaked appearance often observed in frost killed plants may be due to this inability of the cell to reabsorb water.

Most modern workers seem to favor the concept that injury to protoplasm during freezing is fundamentally due to mechanical effects of ice formation either within or between the cells rather than to dehydration *per se* or to chemical effects. The ultimate effect of such mechanical disturbances is presumably the disruption of the delicate organization of the protoplasm.

Effects

In any given condition of growth, the frost killing temperature still depends on:

(1) Rate of freezing -- killing will occur at higher temperatures if freezing is rapid than if it is gradual.

(2) Rate of thawing -- greater injury may occur if thawing is rapid than if it is gradual. Of course, this is a factor only if:

(a) The plants were not already killed by rapid freezing, or

(b) The plants are so frost hardy that no injury occurs at any rate of thawing.

(3) Length of time frozen -- greater injury occurs after long continued freezing than after short freezing periods at the same temperature. Dr. Jim Beard shows that cool season grasses may remain frozen for long periods-- up to 90 days.

(4) Number of times frozen -- generally the more times, the more the injury because the plant may be weakened a little each time.

Frost Prevention or Protection

Four techniques will be discussed briefly: smudge, sprinkler irrigation, covers and mulches, and soil warming.

(1) Smudge - This is an established technique used in citrus orchards. Air that is heated will rise and be replaced with cold air. Smudging is a technique used to overcome this and takes advantage of incom-

plete combustion of oil to provide hot carbon particles that will hang close to the surface and give up their heat slowly. This technique would work on golf greens, but it is not practical.

(2) Sprinkler Irrigation - This technique is used to protect many vegetable and truck crops against freezes. It also may be used to protect turfgrass.

The principle involved is similar to smudging in that heat is added to the surface you are trying to protect.

The heat comes from that contained within the water itself, from the ground because the moisture forms a seal which prevents loss of soil heat, and from the heat of fusion (heat required to convert liquid to solid). Heat is required in one form or another to turn ice into water. In a like manner, when water turns to ice, heat is given up or released. This is known as heat of fusion. Heat of fusion is by far the more important factor involved in protecting against frost. By the time the water droplets reach the plant, they have been chilled to the atmospheric temperature thus adding relatively little heat. The heat absorbed by the plant surfaces from the added water is enough to keep the plant above its freezing temperature except when air temperature is very low or when heat is rapidly removed by a cold wind. Ice may not form if the frost is light. However, ice usually starts building up when temperatures are around 30 degrees F. and may accumulate from 1/16 to 1/2 inch depending on length and severity of the cold snap.

When ice does build up, water application should continue until the air temperature is above 32 degrees and all the ice has melted from the plants. Most of the experimental work in this area (sprinkler) has been conducted on truck crops. Many crops have been protected against temperatures as low as 20 degrees F. At lower temperatures, the ice builds up to a point where the stems and flowers are damaged, but this is not the case with turfgrass.

Obviously, for successful use on turfgrass, the soil must be well drained, both surface and internal, as irrigation may have to continue for two or three days. Water application procedure is different to regular irrigation. Sprinkler spacings may be greater, application rates low and droplet size small.

(3) Covers and Mulches - Polyethylene covers work effectively in preventing frost but considerable effort is necessary to install and to keep them in place. Frequent removal is necessary to avoid excessive heat build-up and to control growth. Such is more critical in warmer climes and in the early spring in the colder climes.

Mulches of various kinds -- pine needles, straw, leaves, peat, manure and hay -- have been used with varying degrees of success to protect greens and tees. Availability and "clean-up" are the major problems.

More recently, "Precision Pak", an excelsior mat covered with a loosely woven string net, has been tried at the Toro Research and Development Center. Results are promising, and it is believed the material may have merit.

(4) Soil Warming - Tests have been conducted at Lethbridge, Alberta; Tucson, Arizona; and Lafayette, Indiana (Purdue University). Also, studies at Texas A & M, University of Minnesota and the Toro Research and Development Center are being conducted.

This technique may have considerable merit in some areas, especially on greens, tees and other specialized areas. In combination with sprinkling, the system may permit keeping Bermuda green all winter.

Preventing Damage After Frost

(1) Keep traffic of all kinds off the area; pressures apparently cause the ice crystals to penetrate or puncture cells, causing mechanical damage.

(2) If traffic must be permitted, wash frost off with sprinklers before sunrise.

Properly Constructing Putting Greens and Athletic Fields

-Panel Discussion-

1. Some Physical and Chemical Considerations in Construction. By Dr. Roy L. Goss.

2. Sub Grades for Putting Greens. By Ken Putnam.

3. Selecting Soils and Fumigation. By Glen Proctor.

4. Seeding, Sodding, Top-dressing and Contouring the Putting Greens. By Henry Land, Sr.

5. Architectural Plans and Their Transfer to the Ground. By Milt Bauman.

Some Physical and Chemical Considerations In Construction

Roy L. Goss[1]

The foundation or base of a putting green or athletic field is as important as the same structure in a building.

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[1]Associate Agronomist and Extension Specialist in Agronomy, Western Washington Research and Extension Center, Washington State University, Puyallup, Washington.

If you expect it to be permanent, it must be scientifically and carefully constructed. When preparing a base, you must consider the following factors:

1. What is the residual base material - clay, sand, hard pan, etc.?

2. How deep is the residual base?

3. Are there any restrictive layers in the residual soil?

4. What are your climatic conditions - desert, rain forest --?

5. Will water drain into the site from adjacent areas?

The reason you must consider these five points and perhaps several others is to plan your drainage program. If your base or residual soil is highly permeable and has adequate depth, drain tile is unnecessary, regardless of the topography. If the topography is such that water does not drain into the site and the soil is only moderately permeable (0.25" per hour or over), it still may not be necessary to use drainage tile if a blanket of coarser material is placed over the residual base material before adding the top mixture. Just as a dam on a river will store large quantities of water to be relieved at a slower rate at a later time, pitrun, gravel, or coarse sand will serve the same storage role over more slowly permeable sub-soils.

If, as a last condition, the residual sub-soil is highly impermeable and drainage waters can feed into the site, tile drainage is a must even if you are in a low rainfall area. Inadvertently, over-watering can cause run-off on sloping topography and excess water can remain trapped if not relieved by tile drains.

HOW MUCH BASE MATERIAL

In areas where base material must be brought in, the availability of material is probably the most limiting factor. If pitrun (a natural deposit of gravel, rock and sand) of good quality and low percentage of fine sand, silt, and clay is available, depths ranging from 8-16 inches are desirable--greater depth should coincide with soil permeability and weather conditions.

If pitrun is not available, we must resort to thinner blankets, 4-8 inches, of highly permeable materials such as pea gravel, sand, or combinations of the two. Heavier blankets, in areas of poor availability, are usually too costly and the addition of drainage tile under thin blankets is the usual practice.

If the amount of fine material in pitrun is questionable, it should be carefully analyzed before using in any construction program. Obviously, with this type of porosity, the fine material can filter into a layer and defeat our purpose.

Top Mixture

The depth of a top mixture is determined by the use made of the area. If the site is to be a football field, we can get by with less depth than with a putting green. We must have at least 8 inches plus of top mix on a green for setting cups. Since we set no cups on football fields, we can grow good turf on 6 inches of soil and still have good root systems and anchorage. In previous root-study experiments (1), most roots of *Poa pretensis* varieties were found in the upper 4-6 inches. Roots are commonly found on young plantings (one year old or less) to depths of 12 inches or more, even when mowed to 1/4 inch high. As the plants become older, root development is greater at shallower depths.

FUNCTION OF TOP MIXTURE

The top soil must, above all, support plant life. This can be accomplished in completely inert quartz sands, provided we supply the 15 or so necessary elements for growth. Hence, any argument regarding the amount of sand, silt, and clay in a mixture is pointless if we meet the requirements of nutrients, water, air, and soil resiliency. A soil can be over 90% sand and produce good turf if sound nutritional and other management programs are followed. On the other hand, a soil can contain this much sand and produce physical problems of hardness, poor drainage, and poor root growth if not properly handled.

The allowable percent of silt and clay can be related to the intensity of use of the area, climatic conditions, and time of use. Small high schools, playing only 5 or 6 games annually in a climatically dry region can probably get by with soils of even silt loam nature. The same is practically true for a small golf course that won't average 50 rounds of golf per day in the best part of the season. However, in the coast region, the content of silt and clay must be kept very low, never to exceed 15% combined and preferably less. These two fractions can be puddled to the surface, reduce infiltration rates, and cause wet surfaces. Silt and clay must be determined by mechanical analysis.

The final test for a building soil is the sand particle sizes. This can be determined by a sieve analysis where the particles are physically separated and calculated. It has been suggested by California researchers (2) that the most desirable sand particle size range is 0.4 - 0.2 MM, and about 75% of the sand particles should be in this range. They further state that no more than 6 to 10% of the sand particles should be less than 0.10 MM and particles from 0.10 - 0.05 MM should be avoided. In our local recommendations we suggest no more than 15% of the sand under 0.25 MM. For those of you who do not have millimeter sieves or for sand and gravel suppliers who quote in mesh sizes, here is an approximate conversion:

100 mesh = 0.25 MM
60 mesh = 0.41 MM
25 mesh = 1.0 MM

Soil Blending

Obviously, if the available soil particles are too fine, a quantity of coarser material should be added. If you want 85% of your sand particles to fall in the range of 0.25 - 1.0 MM, here is a suggested guide for blending:

Your samples contains this % of usable sand	Then	Use this many parts of sand	To	This many parts of soil
85		0		100
75		10		15
50		35		15
25		60		15

Organic Matter

Organic matter in the form of fibrous sphagnum peat moss, sawdust, shredded bark, etc. will impart porosity, resiliency, water and nutrient-holding capacity to the soil. Quantities up to 20% by volume are recommended in the Northwest. These materials should be carefully mixed, off site, and deposited uniformly.

Nutritional Factors

An accredited soil testing laboratory should test the soil to determine what and how many nutrients to apply.

Since these specialized soils are so high to sand, they are normally considered impoverished. Hence, the following rule-of-thumb recommendations are usually made <u>if soil test results are not available</u>:

Single superphosphate	--	20 lbs./1000 sq. ft.
Muriate of potash	--	12 lbs./1000 sq. ft.
Lime**	--	100 lbs./1000 sq. ft.

**May or may not be recommended, depending on interior or coastal locations.

Nitrogen in the amount of 1 pound of available N from ammonium sulfate can be applied after seeding or immediately before to start the young plants. Urea formaldehyde can be incorporated at the rate of 15-20 pounds per 1000 square feet and worked into the surface 4 inches with good results and lasting effect.

Much more could be said about construction and no doubt better techniques will be found in the future, but for the present these suggestions are working well in practice and are vastly superior to old methods under today's pressures.

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Properly Constructing Putting Greens and Athletic Fields

-Panel Discussion-

II. Sub Grades For Putting Greens

Ken Putnam[1]

Building a green is like putting up a building--they both start with a good and proper foundation. In green construction we call this the sub base. If the green is being built on a fill, the sub base must be thoroughly compacted so as to eliminate any chance of the finished green settling. The finished sub base must be contoured the same as the finished green. This is to assure the best possible water action in the material above and also in the drainage system.

The drainage system is installed in the sub base. If tile is used, it is layed in a herringbone or a grid pattern. Some architects are not using tile--instead they build the sub base, then they cut a slot down the center from back to front. This slot is 6 to 8 feet wide and 16 to 20 inches deep. This runs to one side or the other in front of the green where it is picked up with tile and carried away. This slot is filled with gravel and the entire base covered with 6 inches of gravel.

Whatever type of drainage is used, be sure the sub base is properly constructed and properly contoured.

[1]Superintendent, Seattle Golf Club, Seattle, Washington.

Properly Constructing Putting Greens and Athletic Fields

-Panel Discussion-

III. Selecting Soils and Fumigation

Glen Proctor[1]

Selecting good soil for putting greens is getting to be quite a problem around bigger cities. In most cases, soils have to be transported long distances, which is costly. There will be a very few instances, where an ideal soil mix, for green construction can be found.

The best method is to go out and scour the area around where the construction will be, and find the best basic soil in your thinking. Then send a sample to Washington State University or to the United States Golf Association, Green Section, to have a mechanical analysis. They will tell you if the soil is suitable or not. If suitable, they will tell you what addition of sand, clay or organics will be needed to make the proper soil mix.

After getting this the next step is to select a large flat area where the soil components may be stockpiled. The basic soil should then be stockpiled in rows, so that the other components may be stockpiled in between the rows. Then get a large road grader to come in and run these materials back and forth, until thoroughly mixed.

If the finished material contains too much rock, it should be screened. A 1/2"mesh screen should be good.

Fumigating the soil is the next step. There are several materials available for this operation. Any repu-

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[1]Superintendent, Rainier Golf & Country Club, Seattle, Washington.

table dealer or your local research station can recommend a fumigant.

There are two different ways the fumigating may be done, either on the site of the green or off the site. The off-site fumigating will be more costly, but will accelerate the building program. Established clubs in rebuilding programs will be the main users of the off-site fumigating plan. It will save up to one week's time on the seeding date. Saving time is a big factor, when starting construction late in the growing season.

Properly Constructing Putting Greens and Athletic Fields

-Panel Discussion-

IV. SEEDING, SODDING, TOP-DRESSING AND CONTOURING THE PUTTING GREENS

Henry Land, Sr.[1]

After the base of your green has been properly laid out and contoured with a good pit-run material, move in your topsoil that has been mixed off the green site. Apply not less than one foot thick. Have enough topsoil to finish your contours and blend your mounts well into the green and the surrounding area. It takes about 300 cubic yards of topsoil for a 7,000 square foot green. This material can be spread with power equipment, except for the final raking and dragging. This has to be done by hand. After this, you are ready to work in lime and other fertilizers.

Use a hand seeder and apply not less than 5 pounds of bentgrass seed, of your choice, per 1000 square feet. Then rake the seed in lightly with a wire rake. A rake

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[1]Superintendent, Tacoma Golf & Country Club, Tacoma, Washington.

with wide teeth will pull too much seed, leaving it in wind rows. After this, roll it with a water roller about one-third full.

Top-dressing is a real important program. Top-dressings spring and fall gives your player a lot smoother green to play on if properly applied. Here are some good tips for applying top-dressing: (1) Be sure you have the proper soil mixture to prevent layers. (2) Aerify before top-dressing with 3/8 inch or 1/2 inch spoons. (3) Use a top-dressing machine to apply the top-dressing. This will give you a more even coverage. It is hard to get good coverage by the old hand method.

The power drag is a real time saver and does a much better job than the hand drag, and is not nearly so hard on the fellow pulling it.

Properly Constructing Putting Greens and Athletic Fields

-Panel Discussion-

V. ARCHITECTURAL PLANS AND THEIR TRANSFER TO THE GROUND

Milt Bauman[1]

The first thing to consider in building a new golf course or remodeling an old one is the selection of a competent golf course architect. In selecting an architect, I believe the club officials and the superintendent should be in agreement on the selection. Especially so if the superintendent is the one who will carry the plan out and do the construction work. I am sure that every competent golf course architect will cooperate, help, and work with

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[1]Superintendent, Overlake Golf & Country Club, Medina, Washington.

the superintendent as it is to his advantage to have harmony for a job to be well done. It is also my belief that if a club hires an architect, it is the responsibility of a competent superintendent to build as close to the set of plans as possible.

The agreement between the club and the architect will determine how detailed the set of plans will be. If the club hires the architect for close supervision during construction, the plans would not have to be as detailed on contouring as they would if the architect just made an occasional visit.

A competent architect will take a contour map, go over the ground, and then draw a detailed contour map for the layout of the course. Besides this, he will make a detailed contour map of each green and tee with correct elevations and a bench mark to start from. The first time a superintendent is handed a set of detailed plans for a putting green and aprons and collars, it gives him a little concern on whether or not he is capable of carrying out the plan.

Actually, following a set of plans is relatively simple. There are a few steps that should be followed. I will place them as I find them to be in this order. We are talking about contouring putting greens, but this will work for any contouring if you have a scaled detailed map.

1. Have a ruler, a tape measure, a spirit level, rod and tripod. If you can't get a spirit level, a string level can be used but is much more difficult to use. If it is a new course or if there is a great deal of remodeling to be done, I would advise buying a spirit level and rod as it is a tool that will be constantly used for the life of the golf course. A good outfit can be purchased for less than $150.

2. Start all contours and elevations from bench mark or some permanent object that shows the true elevations on your map.

3. Use your ruler from bench mark after you understand the scale so you know how many feet on the ground equals an inch on the ruler. In this manner you can spot your mounds and elevations with stakes.

4. If you are not using a prepared mix, you may at this time put in your stakes for final grade. If you are using different soils in a prepared mix, you may stake each individual level; or, if you can, it is possible to put in longer stakes and set your different grades with colored pencil or paint.

5. All grades and contours should be checked with the level before seeding.

6. If possible, have the architect come and look over the construction before final seeding.

Agronomic Research Report

On-going and new research in the Agronomy Program being conducted at the Western Washington Research and Extension Center at Puyallup, Washington is presented as follows:

I. LAWN AND PUTTING GREEN TURF NUTRITIONAL STUDIES

There are no changes in quality evaluations of either lawn or putting green turf over the last year. The 8-4-4 (pounds N, P, and K/1000 sq. ft./season) treatment on lawn turf is still producing the best turf. Soil levels of P and K, where none has been applied, are low enough yet to produce a deficient plant. The absence of P, however, is still causing a significant amount of *Ophiobolus* patch disease.

The 3/4 inch mowing height is still vastly superior to the 1 1/2 inch level. The differences are greatly accentuated in late winter when the accumulated thatch on the high cut becomes more evident.

The 12-4-8 (pounds N, P, and K/1000 sq. ft./season) treatment on putting turf remains the superior treatment. Phosphorus deficiencies are seasonally critical in plots receiving high N (20 and 12 pounds/1000/season). Both *Ophiobolus* patch and *Fusarium* patch disease are worse in those plots receiving no phosphorus.

II. SULFUR-PHOSPHORUS EXPERIMENTS

Field plots were initiated in the spring of 1966 to study the interrelationships between phosphorus, sulfur, and nitrogen. Potash will be applied as a uniform treatment of 8 pounds/1000 sq. ft./season. Data should be available on parts of this study in 1967.

Bands of sulfur were applied as split plots across randomized plots of 3 levels of N, 2 levels of P, and 3 levels of K at rates of 50, 100, and 200 pounds per acre. Results of sulfur application were evident within 3 weeks and all rates were effective. All fertilizer treated plots demonstrated greatly increased color and growth and the check plot showed some increase. Phosphorus deficient plots, not previously responding to N rates in winter and spring exhibited considerable increase in density, color, and growth rate, indicating a probability of a phosphorus/sulfur relationship. It was further noted that an approximate linear relationship exists between nitrogen and sulfur--the higher the N application, the greater the response to sulfur.

III. SPEEDWELL (VERONICA SPP.) CONTROL

Two additional experiments were conducted in 1966, one in April and one in July, on the control of *Veronica filiformis* at Olympia, Washington. Seasonal treatments were made to determine any differential results that may be influenced by season.

In both experiments, Zytron, at rates of 5, 10, and 15 pounds active ingredient per acre all produced excellent weed control. The higher rate caused some turf discoloration in the July experiment, due to warmer weather conditions. The 5 and 10 pound rates caused no burning. Zytron in combination with Mecopex and Chipco MCPP also produced excellent results. Mecopex and Chipco MCPP never produced over a 70% kill and that was with Mecopex at 6 pounds active per acre.

Other treatments including some organic arsenicals produced little or no results.

IV. NUTRITION AND OPHIOBOLUS PATCH DISEASE

Long term results show that *Ophiobolus* patch can be held in check with phosphorus applications under conditions of our research. Tentative results this year indicate that sulfur is likewise exhibiting an important role. Whether the effect of sulfur is one of lowering the pH of the surface soil and discouraging the disease or in correcting nutritional imbalances and imparting resistance is under investigation at this time. It is needless to say, however, that turfgrasses have a definite need for sulfur and some must be supplied. Your common sources are ammonium sulfate, single superphosphate, sul-po-mag, wettable and agricultural sulfur, etc. Suggested rates currently, until further information is available, are 40-50 pounds/acre per year. This can be divided in half and made in 2 treatments. There will be more on sulfur next year.

Turfgrass Diseases — A Research Progress Report

Charles J. Gould[1]

(in cooperation with V. L. Miller and Roy L. Goss)

Final readings were taken on most of the fungicidal and nutritional test plots for control of Fusarium patch, Corticium Red Thread and Ophiobolus patch during the past year. One new large scale screening test on Fusarium patch was started in the fall of 1965. This test consists of 23 different treatments, using both old and new fungicides. We had planned to conclude this test on January 1, 1966, but because of poor development of the fungus we are continuing the tests until January 1, 1967.

Much time has been devoted recently to analyzing data from the various experiments and preparing them for publication. Some of the results to date are listed below.

Fusarium Patch (F. nivale)

Fungicide Tests - The "standard" mercury-containing

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[1]Plant Pathologist, Western Washington Research and Extension Center, Washington State University, Puyallup, Wash.

fungicides (PMA, Calo-clor, and WSU mixtures) again gave good control of Fusarium patch. But since disease attacks were only of moderate intensity, we cannot yet adequately compare the old with the new fungicides. Those materials appearing most promising at this time are Velsicol 2-1 (similar to Calo-clor), Fore (Dithane M-45) and Polyram. Several other fungicides also appear promising. Only Polycide failed to reduce losses appreciably.

Many superintendents have asked us if fungicides are effective on dew-covered grass of if it rains hard soon after application. Both of these factors are being investigated. Under conditions of moderate disease attack PMA was sprayed onto grass covered with dew. Control was only slightly less than that obtained with regular PMA sprays applied to dry turf. Results were similar when a 1-inch drench (simulating rain) was applied one hour after each application.

Nutrition Tests - The only new development pertains to preliminary tests with sulfur. This material not only drastically reduced attacks by Fusarium but also markedly improved turf quality. Large scale experiments with sulfur are underway. See additional comments by R. L. Goss.

Corticium Red Thread (*C. fuciforme*)

Corticium was somewhat more abundant last winter than usual. The results of previous tests showed that cadmium fungicides provided better control than did other types. One application in the spring and another in the fall gave adequate control under normal conditions. In addition to spraying turf with fungicides it should be fertilized with nitrogen, properly balanced with phosphorus and potash, for best control.

Ophiobolus Patch (*O. graminis*)

Fungicide Tests - Repeated applications of certain fungicides, particularly those containing cadmiums or certain dithiocarbamates, gave good control in our tests.

Applications of Calo-clor at first appeared to be controlling the disease, but after repeated applications, many patches reappeared. Excellent control was obtained from applications of chlordane. The use of chlordane, together with a suitable nutrition program, should provide adequate control of Ophiobolus patch.

Nutrition Tests - Our tests have shown that for best control and for high quality turf, nitrogen should be properly balanced with P and K. But applications of ammonium sulfate alone reduced the disease remarkably in our plots. Continuous use of ammonium sulfate, however, may produce an excessively acid soil. It must also be used with care to avoid damaging the turf with "fertilizer burn." Note additional comments by Dr. Goss.

Minutes of the Research Committee Meeting

Western Washington Research & Extension Center

November 29, 1965

4:00 P.M.

The research committee was called to order by Chairman Milt Bauman at 4:00 P.M. Committee members present were John Harrison, Henry Land, Sr., Manny Gueho, Dick Malpass, and Clayton Bauman. Jack Daniels and Glen Proctor were not in attendance.

Milt Bauman asked for a report on turfgrass disease research from Dr. C. J. Gould. Chuck Gould indicated that the Fusarium and Red Thread work was being terminated this fall and winter and that he was in the process of writing up the results of these experiments. He indicated that the Washington State University mercury-cadmium compounds looked very good, and that many companies are vitally interested in the results of these tests. Mercury is still the best treatment for Fusarium and cadmium is the best for Red Thread.

Calo-clor still looks the best on Fusarium even though it is the most costly. Cadmium compounds in two applications look very satisfactory on Red Thread for normal turfgrass conditions.

Milorganite looks quite good, nutritionally, in small plots in its effect on disease build-up and control. There was less disease in plots with Milorganite than other fertilizers.

On Ophiobolus patch no fungicide gave any decent control. Chlordane at the rate of 4 ounces of 80% per 1000 sq. ft. every 3 weeks and ammonium sulfate fertilizer gave the best control.

At the present time there are 24 treatments in screening studies at $125 per material per treatment from the various companies. Part of the money has gone to purchase nylon screening for the plots to hasten the studies. This investigation is an aid both to the companies and to screen out the best materials for use in this area.

The research on the effect of fungicides and nutrition on disease development is a cooperative effort by Drs. Gould, Goss, and Mr. V. L. Miller who formulated the Washington State University mercury plus cadmium mixtures.

Chairman Milt Bauman asked for questions from the rest of the committee. John Harrison asked, "Have you tried different amounts of fertilizer with fungicides or with Milorganite for disease control?" Dr. C. J. Gould indicated that some work had been done in this area and, at the present time, he feels that urea formaldehyde produces more disease than others. Henry Land, Sr. asked the question, "Is ammonium sulfate more important in its ability to supply sulfur than in supplying nitrogen?" This question was answered by Dr. Roy Goss and indicated that both were important, but perhaps sulfur may be the most important.

Milt Bauman called on Dr. Goss for a report on agronomic turfgrass research programs. Goss indicated that in maintaining continuity of turfgrass disease studies, he feels that phosphorus appears to be playing an important role in the control of *Ophiobolus* patch disease. It was reported that only plots receiving no phosphorus treatment were strongly affected by *Ophiobolus* patch, particularly in the lawn turf in 1965. He indicated that additional studies would be initiated in the spring of 1966 on different types of phosphorus, rates, timing, and so forth to see if the disease could be checked in this method.

It was indicated that an ecologic study on the control of annual bluegrass has been initiated where 2 preemergence herbicides, 2 fungicides, and fertilization are in various combinations on these plots.

The studies on soil compaction were re-initiated this last summer by a graduate student, Ron Fream, who took considerable data on penetrometer ratings and infiltration studies. There were 7 different soil mixtures and 3 different rates of traffic up to 300 rounds daily over these plots to support the data. A report will be made later on these studies as part of a Master's thesis.

Nutritional studies have continued, as in the past, with closer observations on the effect of phosphorus, in particular. The 3-1-2 ratio (12 pounds N, 4 pounds P, 8 pounds K) still seem to be the best nutritional treatments for putting green turf.

On speedwell studies some excellent reports have come in that Zytron is effectively controlling speedwell.

Athletic fields responded very nicely this year to stands of Merion bluegrass and, where good sandy soil was used in the surface, the grass came through in good condition in spite of spring seedings.

Milt Bauman asked for additional questions, closed the research committee meeting, and turned the meeting back over to President Harvey Junor.

Minutes respectfully submitted by Roy L. Goss, Executive Secretary, Northwest Turfgrass Association.

Minutes of the Research Committee Meeting

Overlake Golf & Country Club

September 21, 1966

10:25 A.M.

Members present: Milt Bauman, Chairman, Dick Malpass, John Harrison, Henry Land, Sr., Glen Proctor, Jack Daniels, Clayton Bauman, Manny Gueho, Roy Goss, and Chuck Gould.

Attending guests: Archie Meade, Meridian Valley Golf and Country Club, Kent, Washington, and Woody Auge, Rainier Golf and Country Club, Seattle, Washington.

Milt Bauman called the meeting to order at 10:20 A.M. and asked for a reading of the minutes of the last Research Meeting. The minutes were approved as read. Dick Malpass moved that we incorporate the minutes of the Research Committee meeting into the Turfgrass Conference Proceedings so that all members of the Association could have the benefit of these research reports. The motion was seconded and passed.

Chairman Milt Bauman then called for a research report starting first with Dr. C. J. Gould. Dr. Gould reported that research plots were terminated on Ophiobolus patch disease, Red Thread, and Fusarium patch. The report indicated that all plots treated with PMA and Calo-clor in the Fusarium tests were superior to other treatments. In the case of Fusarium, Calo-clor and PMA were applied alternately.

The Fusarium test continuing at the Station where commercial products are being tested indicate that, out of the 24 compounds on test, all gave some control and Fore (Dithane M-45) looked quite good. Two new non-mercurials will be tested this fall and winter. The WSU mercury-cadmium compounds still look good. No commercial company has attempted to formulate this particular material yet.

The cadmium fungicides are still best on Red Thread. Dr. Gould indicated that he will probably recommend one spring and one fall application for home owners this next year.

Ophiobolus patch disease is still being controlled best with chlordane and ammonium sulfate. There are no fungicides that look as good as these two non-fungicidal treatments. Chuck Gould is not suggesting a preventative program at this time, but a curative program as outlined above. This report is consistent with English and Australian reports for ammonium sulfate and mono-ammonium phosphate are giving the best control.

Milt Bauman asked for questions from the Committee and some are as follows:

(1) Henry Land, Sr. asked if Calo-clor could be stretched to application intervals of three weeks instead of two.

Dr. Gould indicated not to stretch the application dates past two weeks. However, he did suggest that you could apply PMA and then in two weeks add Calo-clor or two treatments of PMA and one of Calo-clor within the proper time range.

(2) Glen Proctor asked about Acti-Dione Thiram combinations.

Dr. Gould indicated there was some control but not good. Jack Daniels indicated that he favors non-mercurials due to applicator hazards.

Milt Bauman asked Dr. Goss for his report on agronomic turfgrass research. Goss indicated that two experiments had been completed this year on the control of *Veronica* spp. and indicated that, out of all of the 15 materials applied, Zytron was still looking best. Ioxinal is looking fairly good but not as good as Zytron and other materials, such as MCPP, in various combinations are giving partial control up to about 50%. Goss indicated that treatments were started this spring in randomized plots with sulfur, phosphorus, and nitrogen with potassium being held as a constant factor. Within a year or so results should be available to show what the interrelationships are between phosphorus and sulfur on putting green turfgrass. This is all part of an effort to learn more about the action of sulfur and, also, its effect on *Fusarium* and *Ophiobolus* patch disease control.

Goss indicated that spring applications of sulfur at the rate of 50, 100, and 200 pounds per acre resulted in excellent turf up until the warm month of July, at which time excessive applications of sulfur caused some burning on the turf.

Goss suggested that, in relation to compaction studies already underway, if the group would not favor some research on the effect of wheeled vehicles, such as the Cushman, in its effect on turfgrass compaction or turfgrass wear; particularly, where they are being used on putting greens for spraying, etc. It was agreed by the group that some investigation should be made in this area.

It was moved and seconded, motion was made by Dick Malpass and seconded by Manny Gueho, that work be initiated immediately on developing new bentgrass bluegrass, as well as some fescue varieties, for western Washington conditions. This would involve some selection and some breeding techniques and would probably extend over a period of around five years. This was in response to a report concerning the value of the selection of bent made from the Hayden Lake Golf Course which is now being used on some golf courses in the west coast area. The grass is outstanding and superior in many respects and should be pushed quickly as a varietal release by the Pacific Northwest. Goss further reported that plots were established at Alderbrook Golf & Country Club on Hoods Canal on the control of Ophiobolus patch disease with applications of sulfur, ammonium sulfate, chlordane, urea, aldrin, and combinations of all of these materials. More will be reported later regarding the results of this research.

The Research Committee meeting was adjourned at 12:10 P.M. for lunch.

Minutes respectfully submitted by Roy L. Goss, Executive Secretary, Northwest Turfgrass Association.

Members of the Northwest Turfgrass Association

Adams, F.	Seattle, Washington
Agricultural Dealers Supply	Tacoma, Washington
Alderbrook Inn	Union, Washington
American Falls, City of	American Falls, Idaho
Anderson, M. E.	Tacoma, Washington
Ashworth, B.	Liberty Lake, Washington
Astoria G & C Club	Astoria, Oregon
Banks, Harvey	Bremerton, Washington
Bauman, Milt	Medina, Washington
Beardsley, Norris	Spokane, Washington
Beheyt, John E.	Kirkland, Washington
Bellevue Lawn	Bellevue, Washington
Bellingham G & C Club	Bellingham, Washington
Bentley Company	Seattle, Washington
Berry, H. Deryck	West Vancouver, B. C.
Bevens & Sons Spray Service	Seattle, Washington
Blair, Allen	Seattle, Washington
Blue Lake Golf Course	Twin Falls, Idaho
Bowers, Bob	Parkland, Washington
Cabinet View Country Club	Libby, Montana
Cahan, Richard	Seattle, Washington
Caldwell, City of	Caldwell, Idaho
Chase, Jack	Seattle, Washington
Chemical Weed & Pest Control Co.	Spokane, Washington
Cockburn, Robert	Everett, Washington
Coeur d'Alene Municipal GC	Coeur d'Alene, Idaho
Collins, Ron	Hillsboro, Oregon
Columbia-Edgewater Country Club	Portland, Oregon
Crane Creek Country Club	Boise, Idaho
The Dalles Country Club	The Dalles, Oregon
Diamond Alkali Company	Portland, Oregon
Dickie, James D.	West Vancouver, B. C.
Down River Golf Course	Spokane, Washington
Elliott, A. D.	Seattle, Washington
Everett G & C Club	Everett, Washington
Evergreen Memorial Park	Seattle, Washington
Everhart, Cliff	Spokane, Washington

Federspiel, Fred	Lake Oswego, Oregon
Fircrest Golf Club	Tacoma, Washington
Fischer, Bernie	Boise, Idaho
Fisher, J. R.	Seattle, Washington
Fisher, John R.	Issaquah, Washington
Floral Hills, Inc.	Alderwood Manor, Wash.
Fluter, E.	Portland, Oregon
Forest Lawn Cemetery	Bremerton, Washington
Gese, P.	North Bend, Washington
Gleeson, Al	Richmond, B. C.
Glendale G & C Club	Kirkland, Washington
Goddard, M.	Selah, Washington
Grays Harbor Country Club	Aberdeen, Washington
Greco, J.	Parkland, Washington
Greenacres Memorial Park	Bellingham, Washington
Greenup Spray Service	Seattle, Washington
Greenwood Memorial Terrace Co.	Spokane, Washington
Griffing, Bill	Bainbridge Island, Wash.
Gueho, M.	New Westminster, B. C.
Haines, John S.	Bellingham, Washington
Harrison, George	Tacoma, Washington
Harrison, John	Hayden Lake, Idaho
Hartman, Richard O.	Portland, Oregon
Haskell, Dick	Seattle, Washington
Hemphill Bros., Inc.	Seattle, Washington
Hercules Powder Company	San Francisco, Calif.
Hogan, Don	Seattle, Washington
Holms, John	Fairbanks, Alaska
Holyrood Cemetery	Seattle, Washington
Hoydar, Chuck	Seattle, Washington
Inglewood Country Club	Kenmore, Washington
Jaslowski, J.	Seattle, Washington
Johnstone, R. G.	Vancouver, B. C.
Jung, Jack	San Pablo, California
Junor, Harvey	Portland, Oregon
Kelso Elks Golf Club	Kelso, Washington
Kilassa, Donald	Spokane, Washington
Kuhn, Carl	Bellevue, Washington
Land, Henry (Jr.)	Seattle, Washington

Land, Henry (Sr.)	Tacoma, Washington
Latimer, D. W.	Olympia, Washington
Leonard, J.	Boise, Idaho
Lewiston G & C Club	Lewiston, Idaho
Lilly Co., Chas. H.	Seattle, Washington
Lilly Co., Chas. H.	Portland, Oregon
Lilly Co., Chas. H.	Spokane, Washington
Liotta, A.	Pullman, Washington
Liptac, Larry	Hillsboro, Oregon
Longview G & C Club	Longview, Washington
Lufkin, H.	Seattle, Washington
Maspass, Dick	Eugene, Oregon
Martin, W. R.	Newport, Oregon
Michelbook Estate Co.	McMinnville, Oregon
Michel Lumber Company	Lake Oswego, Oregon
Mihelich, J.	Enumclaw, Washington
Miller, Donald J.	Tacoma, Washington
Miller, R. E.	Portland, Oregon
Mitchell, C. B.	Clarkston, Washington
Moore, Lefty	Oak Harbor, Washington
Moses Lake Golf Club	Moses Lake, Washington
Mount View Cemetery	Walla Walla, Washington
Mountain View Memorial Park	Tacoma, Washington
New Meadow Lark Country Club	Great Falls, Montana
North Shore G & C Club	Tacoma, Washington
Northwest Mower & Marine Co.	Seattle, Washington
Northwest Olivine Company	Seattle, Washington
Oakbrook G & C Club	Tacoma, Washington
Pacific Agro Company	Seattle, Washington
Pangborn, Jim	Seattle, Washington
Polson Implement Company	Seattle, Washington
Peace Portal Golf Club	White Rock, B. C.
Postelwaite, Don	Portland, Oregon
Prineville Golf Club	Prineville, Oregon
Proctor, Glen	Seattle, Washington
Proctor, Larry	Tacoma, Washington
Putnam, Ken	Seattle, Washington
Quast, T.	Marysville, Washington
Rainbird Sprinkler Mfg. Co.	Vancouver, B. C.
Reed, Byron	Portland, Oregon

Rogue Valley G & C Club	Medford, Oregon
Roseburg Golf Club	Roseburg, Oregon
Royal Oaks Country Club	Vancouver, Washington
Salishan Beach Golf Club	Gleneden, Oregon
Sander, B.	Portland, Oregon
Scott, L. A.	Seattle, Washington
O. M. Scott & Sons Co.	Salem, Oregon
O. M. Scott & Sons Co.	Marysville, Ohio
O. M. Scott & Sons Co.	Oakland, California
Sears, Elmer	Seattle, Washington
Seattle Park Department	Seattle, Washington
Sham-Na-Pum Memorial Park	Richland, Washington
Shelton-Bayshore Golf Club	Shelton, Washington
Sheperd, D. L.	Portland, Oregon
Shoreline School District 412	Seattle, Washington
Ed Short Company	Seattle, Washington
Spokane Park Department	Spokane, Washington
Stitt, L. L.	Reno, Nevada
Sun Dance Golf Course	Nine Mile Falls, Wash.
Sunset Hills Memorial Park	Bellevue, Washington
Tacoma Metropolitan Park Dist.	Tacoma, Washington
Three Lakes Golf Course	Wenatchee, Washington
Tri-City Golf Course	Kennewick, Washington
Twin Falls, City of	Twin Falls, Idaho
United Supply Company	Tacoma, Washington
Vancouver Golf Club	New Westminster, B. C.
Van Waters & Rogers, Inc.	Seattle, Washington
Veterans Memorial Golf Course	Walla Walla, Washington
Ben Wagner's Nursery & Landscape	Walla Walla, Washington
Wagner, Croydon	Tacoma, Washington
Ramsey Waite Company	Eugene, Oregon
Walla Walla Country Club	Walla Walla, Washington
C. R. Walters Company	Bothell, Washington
Wandermere Golf Course	Spokane, Washington
Weddle, Douglas	Olympia, Washington
Wellington Hills Golf Course	Woodinville, Washington
Wenatchee G & C Club	Wenatchee, Washington
Werth, R.	Seattle, Washington
Western Golf Course Supply	Portland, Oregon
Western Plastics Corporation	Tacoma, Washington

White, Q.	Spokane, Washington
Washington Tree Service	Seattle, Washington
Zoller, John	Eugene, Oregon
Zook, S.	Portland, Oregon